United States Patent [19]

Clarke

[11] **3,921,040**

[45] **Nov. 18, 1975**

[54] **LOCKING SYSTEM**

[76] Inventor: **Walter Wilson Hugh Clarke,** Brooklands, Marsh Lane, Eversley, Hants, England

[22] Filed: **Nov. 2, 1973**

[21] Appl. No.: **412,095**

[30] **Foreign Application Priority Data**

Nov. 6, 1972 United Kingdom..... 51179/72

[52] **U.S. Cl.**..... **317/134;** 340/164 R

[51] **Int. Cl.²**..... **E05B 49/00**

[58] **Field of Search**..... 317/134; 70/278; 340/147 R, 147 A, 164 R

[56] **References Cited**

UNITED STATES PATENTS

3,136,307	6/1964	Richard	317/134
3,283,550	11/1966	Bradway	317/134
3,347,072	10/1972	Rose	317/134
3,518,655	6/1970	Saul	317/134
3,654,522	4/1972	Isserstedt	317/134
3,673,467	6/1972	Eisenreich	317/134

Primary Examiner—L. T. Hix

Attorney, Agent, or Firm—Cooper, Dunham, Clark, Griffin & Moran

[57] **ABSTRACT**

A locking system is provided which includes a key device which includes at least one electrical impedance. The key can be inserted into circuitry which contains adjustable impedances. The circuitry is such that when the adjustable impedances are set to predetermined values which match those of the impedances in the key device, a locking device which is operated from the circuitry is released. The exact circuitry can take many different forms. It may include provision for energizing an alarm after one or more incorrect attempts have been made to release the system by inserting the key and setting the variable impedances to incorrect values.

4 Claims, 6 Drawing Figures

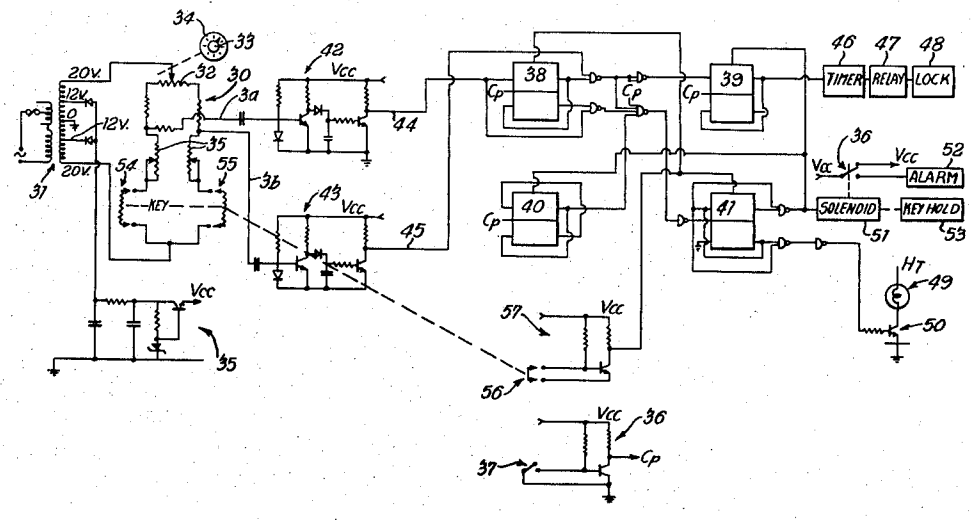


FIG. 1

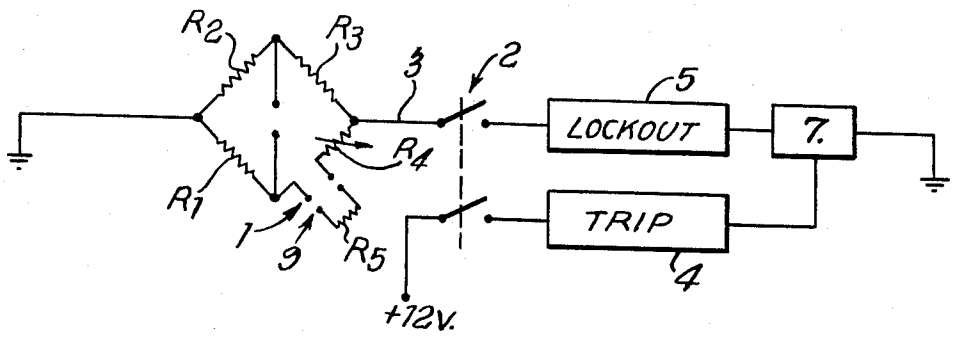


FIG. 2

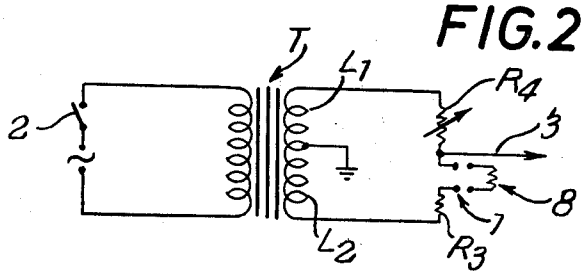


FIG. 3

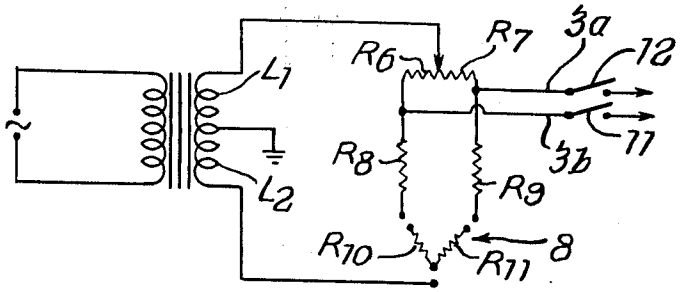
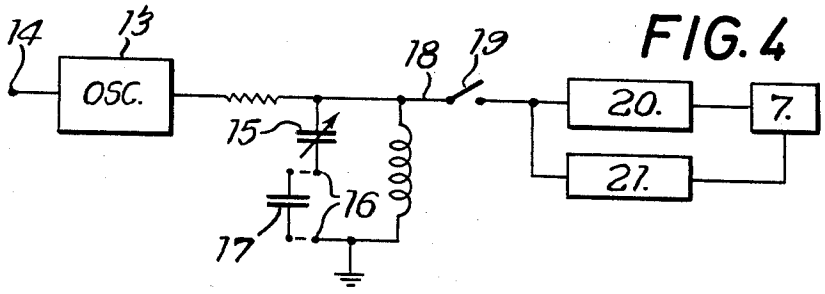


FIG. 4



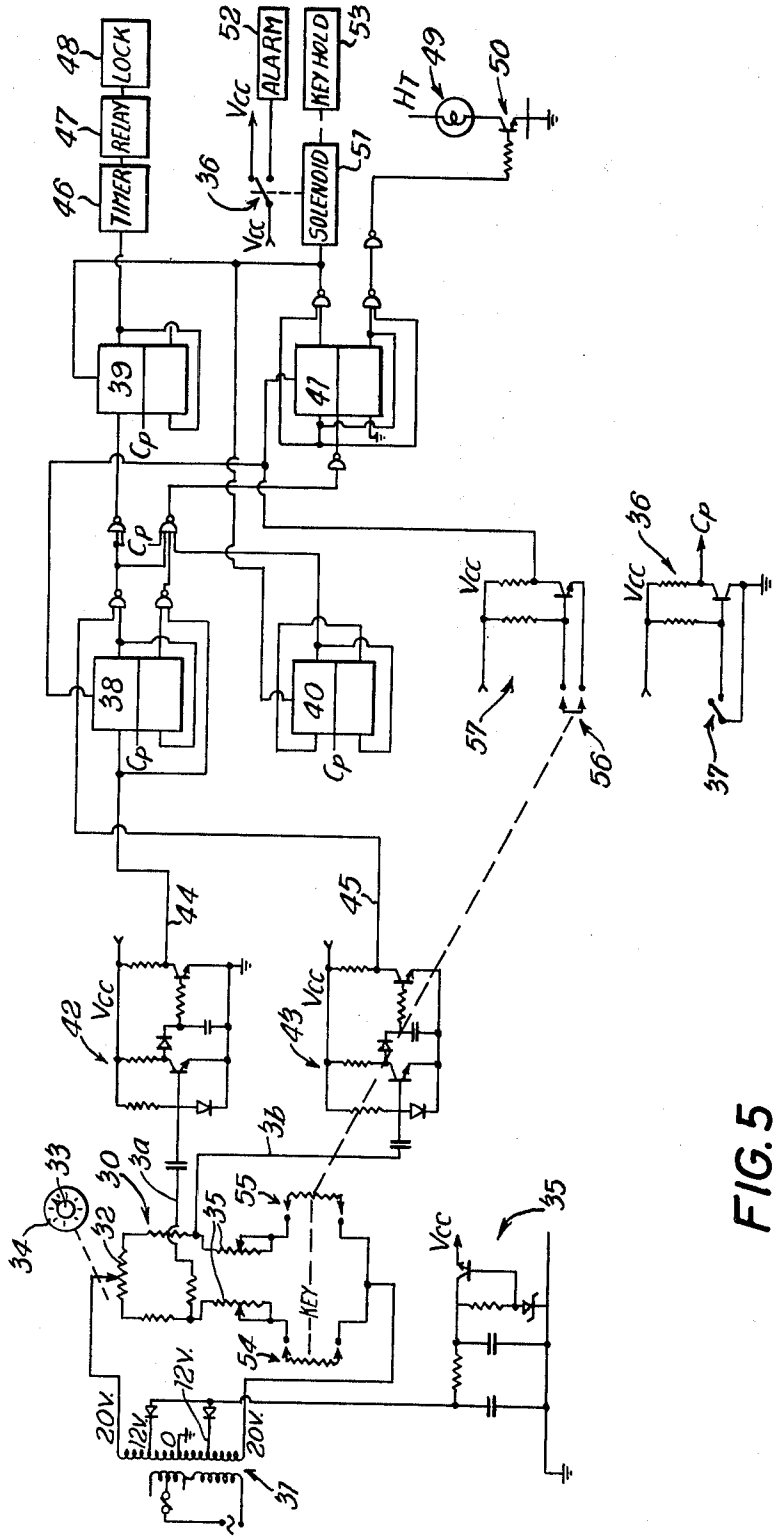
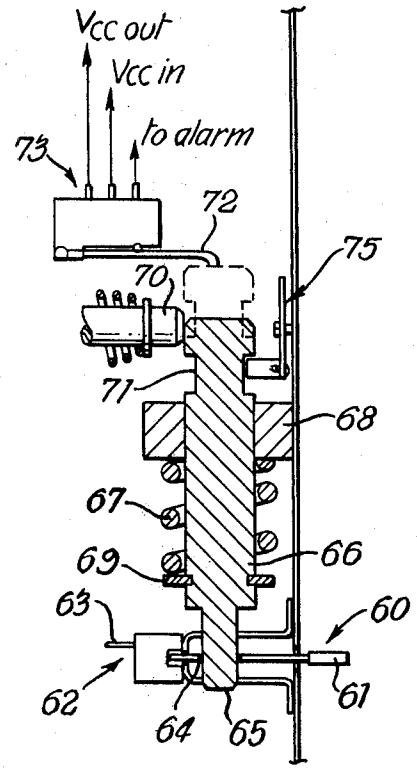

48
LOCK
47
RELAY
46
TIMER
52
ALARM
53
KEY HOLD
Vcc
36
Vcc
SOLENOID
51
HT
49
50
39
41
Cp
38
40
Cp
Vcc
57
56
Vcc
36
Cp
37
44
45
42
Vcc
43
Vcc
33
30
3a
3b
34
32
35
55
KEY
54
Vcc
35
20V.
12V.
12V
20V
37

FIG. 5

FIG. 6



LOCKING SYSTEM

FIELD OF THE INVENTION

This invention relates to a locking system which may be used for drawers, tills, doors, windows or other members which it may be desired to lock in position, or for disabling cash tills or power supplies, and many other applications where there is a requirement for only an authorised person or persons to be able to effect some kind of operation. The term "locking" should be interpreted accordingly.

SUMMARY OF THE INVENTION

In accordance with the invention, a locking system comprises a key device which includes at least one electrical component, circuitry with which the key device can be electrically associated, the circuitry being settable by an operator in such a manner as to provide one or more predetermined output signals when a predetermined combination of circuitry setting and associated key device exists, and means for tripping a locking device in response to recognition of the predetermined signal or signals.

Thus, an authorised person will associate his key device with the above-mentioned circuitry, for example by inserting part of the key device into a socket containing suitable connections, will then set, for example, one or more dials which adjust the values of the electrical components in the circuitry, will then press a switch to energise the circuitry and, if he has correctly set the dials to match his key, he will then find that the locking system is automatically released. If he loses the key device, it alone cannot be used to trip the system and, if the dial setting or combination of settings associated with the lost key should become known to another person, he cannot trip the system without also obtaining the key device. The security of the system is thus relatively high. The settings for one key are inappropriate for another key.

The system can be provided with means for preventing removal of a key and for activating an alarm if an attempt is made to trip the system using dial settings inappropriate to the key used.

DESCRIPTION OF THE DRAWINGS

In order that the invention may be more clearly understood, some embodiments thereof will now be described, by way of example, with reference to the accompanying drawings, in which:

FIG. 1 shows schematically a relatively simple locking system using a resistance bridge,

FIG. 2 shows part of a locking system using a transformer bridge,

FIG. 3 shows a more refined system in which, in effect, a combination of two bridges is employed,

FIG. 4 shows schematically a system in which settable circuitry, when it is appropriately set and a correct key device is associated with it, produces an output signal in the form of a predetermined frequency oscillation,

FIG. 5 shows in more detail a further system in accordance with the invention, and

FIG. 6 shows a key-retaining and alarm-energising arrangement.

In the FIG. 1 embodiment a resistance bridge comprises in three of its arms resistors R_1, R_2 and R_3 and, in its fourth arm, an adjustable resistor R_4 and a pair of terminals 1.

Across one diagonal of the bridge there is connected an AC source (this could alternatively be DC).

The other diagonal of the bridge is connected between ground and an output line 3, the line 3 being connectable to the input of a lockout channel 5 by closure of one contact of a switch 2. A command signal from a source (e.g. + 12V DC) is applied to a trip channel 4 by closure of the other contact of switch 2. The exact circuitry of the tip and lockout channels 4 and 5 can be of various known forms and is arranged so that the command signal from the trip channel 4 is effective to release a locking device indicated at 7 unless the lockout channel is at the same time producing an output signal.

An authorised person will have a key device 8 which includes a fixed resistor R_5 to the ends of which are connected terminals 9 which can be connected to the terminals 1 of the bridge. For example, the terminals 1 of the bridge may be a pair of sockets, and the terminals 9 of the key device may be a pair of pins arranged to fit into the sockets. The key resistor could alternatively fit in the positions of any of resistors R_1, R_2 and R_3.

The authorised person also knows what specific setting of a dial which adjusts the resistor R_4 will give the resistor R_4 a value such that, when the key device 8 is connected to the circuitry, the resistance values of the four arms will represent a balanced condition.

Thus, the authorised person inserts or connects his key device, and then sets the dial to the predetermined setting. He then manually closes the switch 2 to sample the bridge output and connect the command signal to the unlocking or trip circuit. A substantially zero output signal appears on line 3 because the bridge has been balanced. In this condition the lockout channel 5 will not override the trip channel 4, so the device 7 will be energised and unlocked.

If the setting of resistance R_4 had been incompatible with the key resistor R_5 used as would be expected with an unauthorised person attempting to release the system, an output signal other than zero would have appeared on the line 3 when switch 2 was operated, causing the lockout circuit to function to prevent energisation and release of locking device 7; for example, the lockout channel output could open relay contacts in the output line of trip channel 4 to prevent the trip channel output operating locking device 7.

In the FIG. 2 embodiment, a bridge is again used but two arms consist of the respective halves L_1 and L_2 of the centre tapped secondary of a transformer T of which the primary is connected across the switch 2 and an AC source in series. In the other two arms of the bridge are an adjustable resistor R_4, on the one hand, and a fixed resistor R_3 in series with terminals 1 for receiving a key device 8, in similar fashion to that of the FIG. 1 embodiment. In this case the key device is shown in the same arm as the fixed resistor, but it could equally well be designed into the other resistive arm.

The FIG. 2 system operates generally in the same way as the FIG. 1 system to produce a substantially zero output signal on line 3 when the correct setting of resistor R_4 and the correct key 8 are simultaneously used. Trip and lockout circuitry similar to that indicated in FIG. 1 can be connected to the line 3 to control the locking device 7.

In FIG. 3, a transformer bridge is again used, with the halves L_1 and L_2 of a transformer secondary forming two arms of the bridge. In the other side of the bridge, the two parts R_6 and R_7 of an adjustable potentiometer form two further arms which are connected to form parallel potential dividers including the other arms for two bridges involving the fixed resistors R_8 and R_{10} from one bridge and R_9 and R_{11} for another.

In this case, the key device **8** comprises two resistors R_{10} and R_{11} connected between three terminals. When the key device is associated with the bridge circuitry, the two end terminals of the key device contact terminals at the ends of resistors R_8 and R_9 and the central terminals contacts a terminal connected to one end of the transformer half L_2. Thus, when the key device is associated with or inserted in the circuitry, two inductance/resistance bridges are in effect formed, the output of one of which appears on a line *3a* and the output of the other of which appears on a line *3b*.

To use the FIG. 3 embodiment an authorised person inserts his key device **8** and sets the adjustable potentiometer, for example using a dial, to a predetermined setting which will balance the bridge which contains resistor R_{10}. He then closes a switch **11** which is ganged with a command signal switch (not shown, but equivalent to the lower part of switch **2** in FIG. 1), which sends the output signal on line *3b* and the command signal (e.g. + 12V DC) to memory and logic circuitry. If the key device and the potentiometer setting were both correct, the signal on line *3b* will be substantially zero. He then again sets the potentiometer, this time to a predetermined setting which should balance the bridge which contains the resistor R_{11} of the key device. Having done so, he closes a switch **12**, also ganged with a command signal switch (again not shown), which sends the output of line *3a* and the command signal to the memory and logic circuitry. If the second setting of the potentiometer has been appropriate to the key device being used, the signal on line *3a* will be substantially zero output signal. The memory and logic circuitry may be of any conventional type that is capable of producing an energising signal for the locking device in response to receipt of two substantially zero input signals from lines *3a* and *3b* and the command signals, but not in response to a non-zero input signal received from either or both line *3a* or *3b*.

In the embodiments of FIGS. **1**, **2** and **3**, the adjustable circuit components have in each case been shown and described as resistors, and the electrical component or components in the key device have been resistors. However, in general, the key and the bridge can include resistive, inductive and/or capacitive impedance elements in various dispositions and any one or more than one of these elements may be adjustable, for example by means of a respective dial. If more than one of them is adjustable, using more than one dial, then it will be necessary to make the appropriate combination of dial settings in order to set the circuitry ready for the key device.

It can be seen from FIG. 3 that the bridge circuit can be of a more complex form than the simple bridge shown in FIG. **1**. Alternatively, a plurality of simple bridges such as are shown in FIG. 1 could be used, and a single key device containing several resistors which are simultaneously connected into the several bridges when the key device is connected into the bridge circuitry, for example by being plugged into a socket provided with appropriate connections.

FIG. **4** shows part of a further embodiment of the invention wherein an oscillator circuit **13** is provided with power from a DC input terminal **14**. The oscillator includes a variable capacitor **15** and a pair of terminals **16** to which a key device including a fixed capacitor **17** can be connected. The output line **18** of the oscillator is connected by closure of a switch **19** to frequency-selective circuitry, which can include a narrow-band trip sub-channel **20** and a wide-band lockout sub-channel **21** (as disclosed in our U.S. Pat. No. 3,829,836, which will produce an output signal to trip or release a locking device **7** only when its input signal is within a certain, and preferably very restricted, frequency band and no other frequencies are present at substantial intensity.

The authorised person possesses the key device containing the capacitor **17** and also knows the predetermined dial setting which will set the capacitor **15** to a value such that, with the set capacitor **15** and the key capacitor **17** in the oscillator circuit the oscillator **13** will produce an output signal on line **18** which is within the predetermined restricted frequency band. Release of the locking device **7** will thus be produced by closure of switch **19**. If either the key device is wrong or the capacitor **15** is wrongly set, the locking device **7** will not be released. Once a wrong frequency on line **17** has been applied to the sub-channels by closure of switch **19**, lockout will occur and subsequent attempts to operate the system correctly will not succeed.

Where a lockout arrangement is provided, its output can be arranged to operate some kind of visual or audible alarm to give a warning that an unauthorised person, using the wrong key or setting, is attempting to release the system. It may also be arranged to operate an arrangement which holds the key device in association with the bridge or other detecting circuitry, for example by energisation of an electromechanical latch which engages with the key device. Thus, the same key device will not be able to be used again in an attempt to effect unauthorised release of the system. Both these latter features will be described in more detail with reference to FIG. **5**.

FIG. **5** illustrates a further locking system in accordance with the invention. The components and their interconnections are evident from the drawing and will be described only briefly. The resistance bridge **30** is fed from the mains via a mains transformer **31** and contains a potentiometer **32** the wiper of which can be set by turning a knob **33** associated with a numbered dial **34**. Two variable resistors **35** in the bridge will be preset in different ways for different installations so as to determine what combination of key and dial setting will release that installation. It can be seen that the circuit is a double bridge similar to that shown in FIG. **3**, and it has two output lines *3a* and *3b* corresponding to those in FIG. **3**. A conventional DC power supply circuit **35** provides a supply voltage V_{cc} which is applied through a solenoid operated switch **36** to various points in the circuitry as indicated by the references V_{cc}. A circuit **36** includes a normally open switch **37**, which may be a press-button switch, which is accessible to the operator and which when closed produces a positive clock or trigger voltage C_p which goes back to zero when the switch is opened. Voltage C_p is applied to the points marked C_p in the logic circuitry to control the operation thereof. As can be seen, the logic circuitry includes four flip-flops marked **38**, **39**, **40** and **41**, respectively. Each of them may be a Texas Instruments TTL 7473

bistable flip-flop, for example, and they are connected as shown to carry out the necessary logic functions. Circuits **42** and **43** provide a zero output signal on their respective output lines **44** and **45** in response to receipt of an input signal from lines **3***a* and **3***b* and produce positive output signals on lines **44** and **45** in response to zero input signals from lines **3***a* and **3***b*.

When flip-flop **39** provides an output signal that energises a conventional timer circuit **46** which in turn energises a relay **47** for a predetermined period, such as a few seconds, and the relay energises an electrically released lock **48,** thus releasing it, for the corresponding period.

When an output signal is produced from the lower side of flip-flop **41** a warning light **49** is energised from a suitable supply by the conduction of a transistor **50.**

When an output signal is produced from the upper half of flip-flop **41** a solenoid **51** is energised which switches switch **36** to a position where it applies voltage V_{cc} to an alarm **52,** for example an electric bell, at the same time disconnecting the voltage V_{cc} from the main circuitry of the system. Solenoid **51** also operates a key hold mechanism **53** which prevents the key from being withdrawn from a socket into which it has been inserted, as will be more clearly described below.

To operate the system, an operator inserts his key into a suitable key-receiver and this connects two resistors **54** and **55,** contained in the key, into the bridge as shown. The key also includes a bridging contact **56,** which for the sake of simplicity is shown connected to the resistors **54** and **55** by a broken line, across a pair of contacts in a circuit **57** which in response provides a presetting signal to the logic circuitry making it ready to operate.

The operator then sets knob **33** to one predetermined position intended to produce a zero output from the bridge on line **3***a* and presses and releases switch **37** to generate a clock pulse C_p. He then sets the knob **33** for a second time to a predetermined position which should produce a zero output signal on line **3***b* and presses switch **37** again to generate a further clock pulse C_p.

If both dial settings have been correct, the logic circuitry causes timer **46** and relay **47** to operate so that lock **48** is released for a predetermined time, enabling the operator to, for example, walk through a door which had been locked thereby.

The following table shows the manner in which the logic circuitry operates, and the consequences.

	First dial setting	Second dial setting.	Result
A.	Right	Right	Lock 48 released
B.	Right	Wrong	Lamp 49 on
	Wrong	Right	
	Wrong	Wrong	
C.	Right	Wrong	Alarm 52 on and key held
	Wrong	Right	
	Wrong	Wrong	
D.	Right	Right	Lock 48 released and lamp 49 off

In the above table, the correct operation first time is shown at A, resulting in release of the lock.

Had the person got either or both of the two dial settings wrong, as shown at B, the lamp **49** would have come on after both dial settings had been made and after both closures of switch **37.** Thus the operator would be shown that one or both of his settings had been incorrect, but he would not be told which. If, following that, he makes two correct dial settings as shown at D, lock **48** will release and lamp **49** will go out. However, if at his second attempt he again gets one or both of the dial settings wrong, as shown at C, solenoid **51** is energised and the alarm **52** goes on, the circuitry is de-activated by removal of the voltage V_{cc}, and the key hold mechanism **53** is operated to retain the key.

Thus, the circuitry illustrated avoids giving unnecessary alarm by permitting an authorised person to make a mistake at his first attempt to release the system, without the alarm being energised, and warns him that he has made the mistake. An authorised person will then in all probability get the correct settings at his second attempt and will release the lock.

An unauthorised person will get the warning when his first attempt is incorrect, but only after his attempt has been completed, so that he will not know which of the two dial settings was wrong, he thus has no clue when he makes his second attempt and is equally likely to get one of the dial settings during the second attempt wrong as well, thus producing the alarm and retention of his key.

FIG. **6** shows a key **60** in the form of a plastics plate (seen from one edge) into one end **61** of which the resistors **54** and **55** are incorporated. Leads from the resistors can be in printed circuit form on the upper surface of the key **60,** extending to the left-hand end of the key, so that when that end is inserted into a conventional edge-connector **62** (as used for connecting to the edges of printed circuit boards), the resistors become connected into the bridge by means of the leads illustrated at **63.**

A hole **64** in the key is in line with the end **65** of a plunger **66** when the key is in the inserted position. Plunger **66** is biased downwardly by spring **67** compressed between a fixed part **68** and a shoulder **69** on the plunger **66,** but is normally retained in the upper position (as shown in broken lines) by a plunger **70** of solenoid **51** engaging in a notch **71** on plunger **66.** Plunger **66** in the upper position also presses the actuator **72** of a suitable switch, such as a miniature snap-action switch **73** (corresponding to switch **36** in FIG. **3**), upwards so that V_{cc} is passed by the switch to the system circuitry. When solenoid **51** is energised its plunger **70** is withdrawn from the notch **71,** plunger **66** is driven downwards by spring **67** to engage in the hole **64** and hence lock the key into the apparatus. At the same time, actuator **72** is released so that switch **73** switches voltage V_{cc} from the system circuitry into the alarm **52** to actuate the alarm. The mechanism can be re-set internally using a pivoted plunger-lifting lever **75.**

The above-described systems can be used to provide a very large number of keys for different persons, every key having elements in it different from all other keys, and hence requiring to be used with different values of bridge setting for every person. This defeats the possibility of breaking the system by obtaining one authorised person's code setting and stealing another authorised person's key.

I claim:

1. A locking system comprising a key device which includes at least one impedance, key receiving means, circuitry in which said at least one impedance can be connected by associating said key with said key receiving means, said circuitry including at least one variable

impedance, manually operable means for setting the value or values of said at least one variable impedance, a locking device, means for releasing the locking device when said at least one variable impedance has been correctly set to a value or plurality of values having a predetermined relationship with the value or values of the at least one impedance in the key device when the key device is associated with the key receiving means, including alarm means, said circuitry being adapted to energise the alarm means in response to an incorrect setting, and wherein the circuitry is adapted to energise the alarm means in response only to the last of a plurality of incorrect settings, whereby to permit at least one incorrect attempt at releasing the locking device to be made without energising the alarm means.

2. A locking system as claimed in claim **1** comprising warning means, the circuitry being adapted to energise the warning means in response to a first incorrect setting of the variable impedances.

3. A locking system as claimed in claim **2** wherein a plurality of settings of said at least one variable impedance are required to constitute a correct setting and the circuitry is adapted to energise the warning means only after all the plurality of settings have been completed, whichever of said plurality of settings was incorrect.

4. A locking system comprising a key device which includes at least one impedance, key receiving means, circuitry in which said at least one impedance can be connected by associating said key with said key receiving means, said circuitry including at least one variable impedance, manually operable means for setting the value or values of said at least one variable impedance, a locking device, means for releasing the locking device when said at least one variable impedance has been correctly set to a value or plurality of values having a predetermined relationship with the value or values of the at least one impedance in the key device when the key device is associated with the key receiving means, wherein said circuitry includes first circuit means for generating a control signal depending upon the correct or incorrect setting of said at least one variable impedance, and said releasing means is responsive to said control signal, and further including switch means manually operable to couple said first circuity means to said releasing means.

* * * * *