Combo Lock

A six-key electronic lock for security or other purposes.

CHUNG YIU KO

Neighbourhood Watch schemes cover the land. Security in the home has a higher profile today than ever before and a simple electronic locking device could be worth its weight in missing cufflinks.

The circuit detects correct sequence input and provides a relay output suitable to trigger an electronic lock. Its main beauty is that it uses no ICs and keeps things simple and cheap. The correct combination is hardwired rather than programmed and the lock could be used to protect door openers, burglar alarms, car ignitions – the applications are limited only by your imagination. The circuit diagram is shown in Fig. 1.

The heart of the circuit is the sequential detector which interprets the correct sequence inputs from the key switches, turns the output on and activates a relay. An indicator (LED1) indicates that the correct number sequence has been entered. If the right numbers are entered but in the wrong order than the sequence detector is reset and the entire sequence must be repeated.

Alarm circuitry is incorporated in the design and this is activated if the digits not appearing in the combination are pushed.

How It Works

The sequence sensing circuit is constructed around Q1 to Q6, the key switches and the relay.

Initially Q1 to Q6 are non-conducting. As soon as key 1 is keyed Q2 is forward biased, collector current flows through R4 and the base and emitter of Q1. Q1 charges via R3 and R4 which provides sufficient bias to turn Q1 on. The voltage drop developed across R2 (due to Q1 collector current) briefly holds Q2 on and a constant current source is now available at the emitter of Q1, forming the power source for the remaining stages of the emitter follower.

The functions of Q3 and Q4, Q5 and Q6 are a similar except that the loading of the final stage is a relay coil and LED indicator. Obviously the keys must be keyed in correct sequence (1, 6 then 8 as shown in Fig. 1), otherwise there will be no power source available from one stage to another and the relay will never energize.

The incorporation of the keypad or key board enables the user to select any three digits of any combination number he chooses while the remaining keys are connected the reset/alarm mode input.

Whenever the unselected keys are pressed the circuit is reset by pulling Q1 base to negative (via D1 in alarm mode) and at the same time discharging C1. Q1 is biased off turning off Q2. At this stage the entire sequence must be repeated. The second half of the circuit is alarm warning circuitry. Whenever a reset/alarm key is keyed (except the actual reset key Q) the alarm will sound for a short duration.

Q7 and Q8 form a basic astable multivibrator circuit. Initially the oscillator is inoperative, because Q8 is biased off via resistors R14 and R11 to the positive

supply. As soon as a reset/alarm key is keyed, capacitors C4 charges via R16 with the polarity shown. Q8 becomes forward biased and the oscillation starts for a duration determined by the R11 and C-4 network.

Gradually C4 discharges across R11 to cut Q8 off and the oscillator stops.

Q9 is a simple direct-coupling emitter-output power amplifier. The circuit will operate well on 12V DC and draws a maximum standby current of 20mA. The maximum current is 400mA with the alarm and relay energized. This makes the device ideal for 12V car system or an AC derived supply.

Construction

Though stripboard could be used with care, the PCB is recommended and the overlay is shown in Fig. 2. The relay will fit directly onto the PCB. It is possible to use any relay having a 12V 300R or higher resistance coil, but it may be necessary to redesign the printed circuit layout or mount the relay off board.

The key switches are of push-to-make momentary action type and any switches of this type can be used. However a low profile keypad or keyboard is more desirable for ease of construction. After inspecting of the PCB for short circuits, broken tracks and any damage, the resistor should be soldered onto the board, followed by the capacitors, then the diode and transistors (care being taken with polarity of these components).

Once all the components are securely fitted onto the board, connect the corresponding wirings to the desired sequence and reset key switches.

In Fig. 1 the sequence number is shown as 1-6-8. Zero is for reset and the remaining unselected invalid keys are connected to parallel to the reset/alarm warning circuitry input. The PCB is purposely small so that it can be mated back-to-back with the key pad by two spacers, and tuck away in any suitable front panel. For door opener applications the unit can be fitted in a metal blanking plate (as used in house wiring) and mounted in the door frame, with the speaker wired remotely indoors. For automotive applications a small module case with metal front panel is most suitable. The base of the case can be secured onto the dashboard, with the metal front panel used to mount the complete unit.

The alarm in the circuit shown is not going to wake the street; in its present configuration it is more of a loud indication that the incorrect sequence has been entered. It would not be difficult to fit a second relay into the alarm section of the circuit which could trigger a bell alarm, or a flashing neon arrow with "Burglar" written on it, or even to release an enormous weight from the second floor onto the burglar... ■

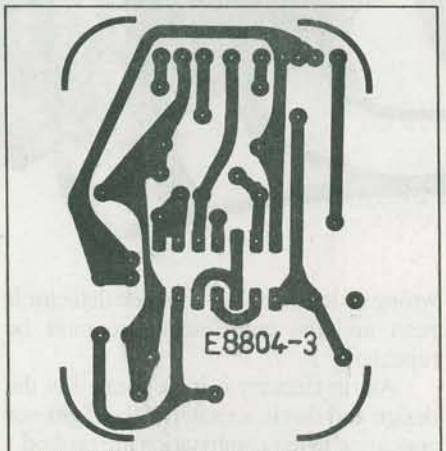

Fig. 3. The printed circuit board

PARTS LIST

Resistors (all 1/4W 5%)

R 1, 5, 8 .....470R
R2, 6, 9..... 150R
R3, 7, 15 .....1K0
R4 .....82R
R10, 12..... 51OR
R11, 13, 14..... 56K
R16 .....5K0

Capacitors

C1, 2, 3 ..... 3u3 12V electro.
C4..... 100u 12V electrolytic
C5, 6 .....20n ceramic

Semiconductors

Q1,3,5 MPS3904 (Radio Shack 276-2009)
Q2,4,6,7,8 MPS2907 (RS 276-2023)
Q9.... TIP3055 (RS 27-2020)
D1 1N4001
LED ..... red LED

Miscellaneous

RLA1 12V relay 300R or higher
Keypad or push-to-make switches
PCB, PCB pins (16), wire, nuts and bolts.

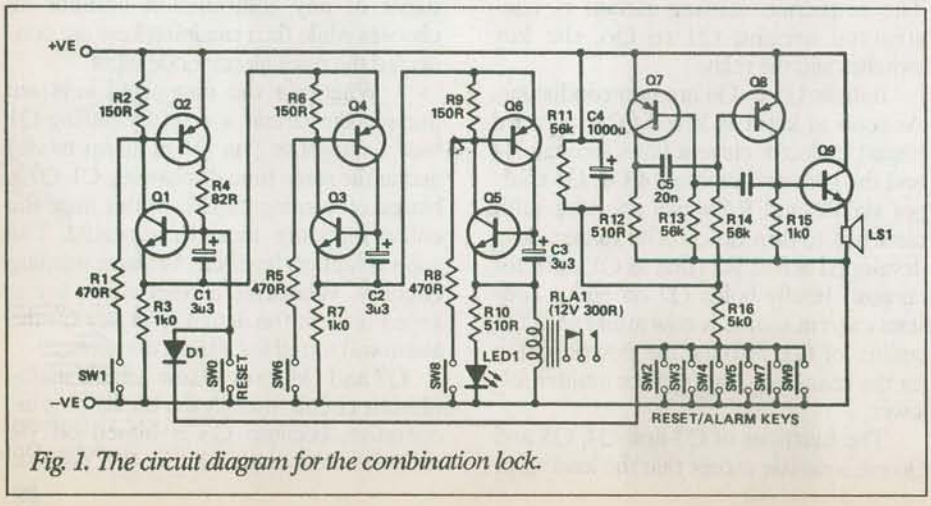

Fig. 1. The circuit diagram for the combination lock.

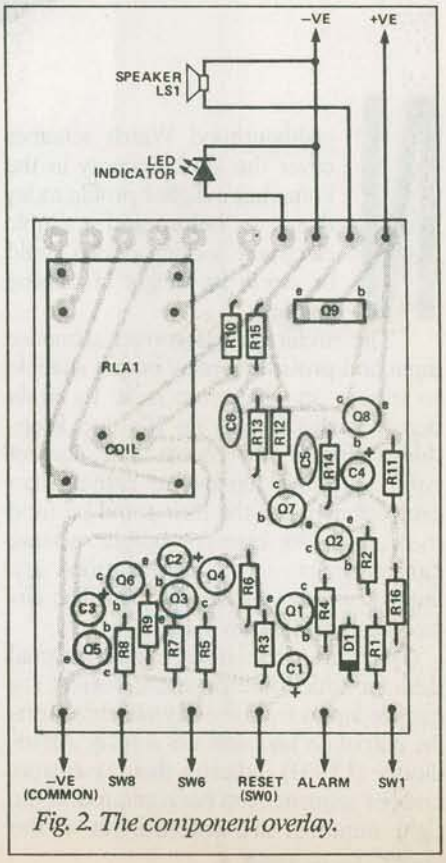

Fig. 2. The component overlay.