Keep thieves at bay: install our new

Deluxe Car Burglar Alarm

Stop your car from being stolen. This new state-of-the-art car burglar alarm features keyswitch operation, delayed entry and exit, automatic reset, and provision for an auxiliary battery.

by JOHN CLARKE and GREG SWAIN

We shouldn't really have to sell you on the concept of a car burglar alarm. Car theft is a growth industry in Australia, with more than 70,000 cars stolen last year. Small wonder that the Ignition Killer featured in the February issue is proving so popular – it provides a useful measure of protection at relatively low cost.

But the Ignition Killer does have drawbacks. It will not protect stereo equipment or other contents in the car, nor does it have an alarm to frighten the thief away. And while it will fool most joyriders, it will not stop a determined "professional" for too long.

By contrast, a properly designed and fitted car burglar alarm provides "front line" defence. It will sound an alarm if an attempt is made to gain access to the vehicle and this by itself is usually sufficient to deter the thief. Common practice is to add to the deterrent effect by fitting the vehicle with prominent warning stickers and a flashing dash panel lamp.

When we described the Ignition Killer project, we were quick to point out the drawbacks of many commercial car burglar alarms. In particular, we pointed out that many could be disabled simply by cutting the horn wires from underneath the vehicle or by disconnecting the battery.

For sure, it's possible to install commercial alarms that will frustrate all but the most professional thief. The trouble is, they usually cost an arm and a leg. Most sell for between $200 and $400 fitted although there are units that you install yourself for around the $100 mark.

The unit described here will set you back no more than about $70 but that's not to say that it's a cheap and nasty design. On the contrary. It includes a range of features normally found only on expensive commercial units and has a few more tricks besides.

Ten commandments

What features should be included to produce an effective car burglar alarm? In the "Open Road" for December 1983, the NRMA briefly surveyed a number of commercial units and gave a list of "Ten commandments". Let's take a look at these:

1. The alarm should protect all doors, bonnet and boot at least.

2. It should operate instantly when the boot is opened and when the bonnet lock is released.

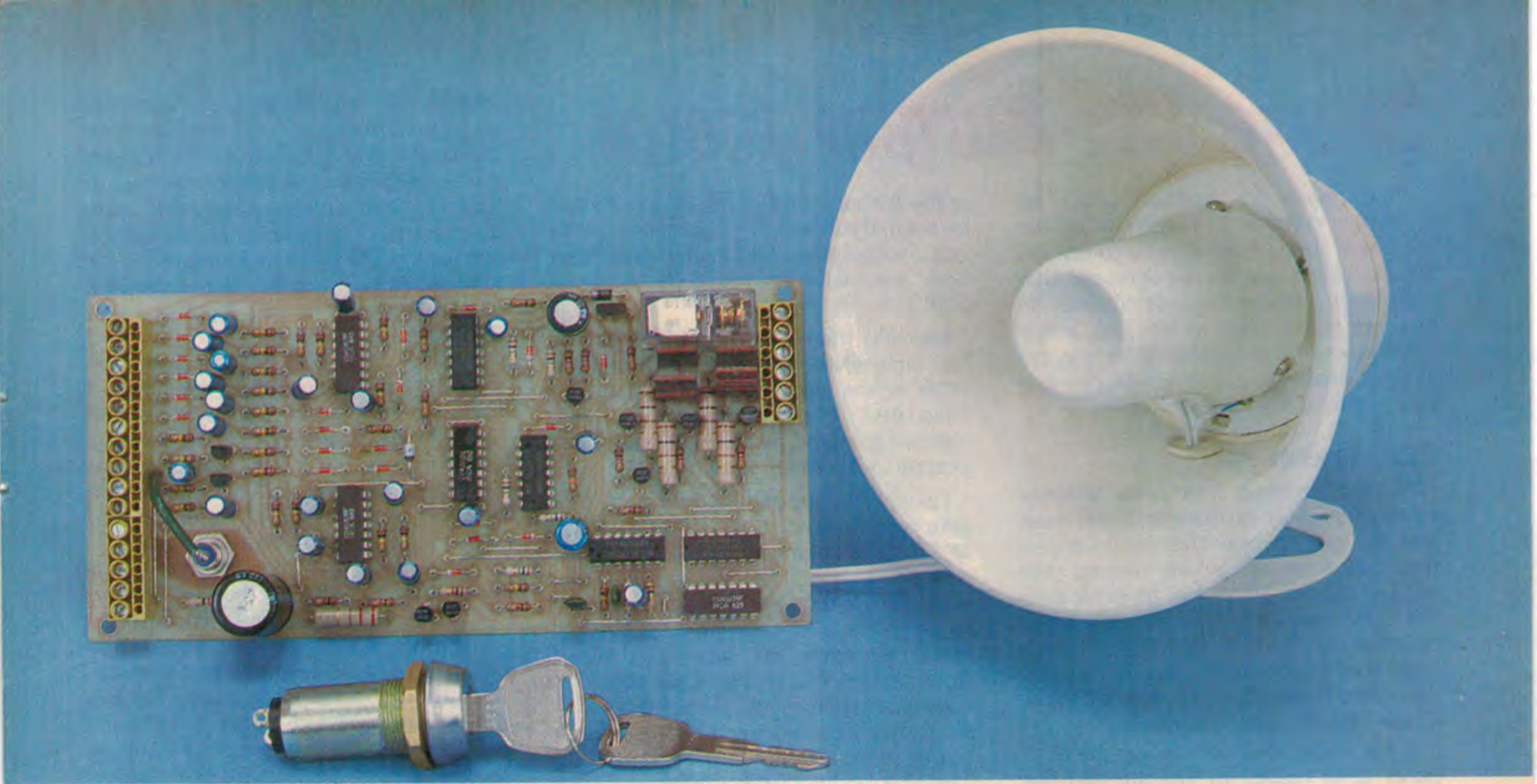
3. Air horns or a siren should be used, rather than the car's horn.

4. The alarm should be set from inside the vehicle or by an electronic key – not by a key or tumbler switch from outside the vehicle.

5. Entry delay should be between five and 10 seconds.

6. The alarm should cut out the ignition system.

7. If the alarm obtains its power from the battery, the wiring should be direct



and should be positioned so that it cannot be reached from under the vehicle.

8. Horns or sirens, and the wiring to them, should be placed so that they cannot be tampered with through the grille or from under the vehicle.

9. The alarm duration should be about two minutes, with automatic cut-out and reset.

10. Window stickers should indicate that the vehicle is carrying an alarm system, but not the make or type.

The NRMA survey covered some 27 different alarm systems. Of these, the best units only complied with the first eight conditions.

By contrast, this new EA design can meet all the above requirements except for the sixth. We'll have more to say about that later. Other features include a flashing dash panel lamp, keyswitch operation, an auxiliary battery (optional), and provision for tow-away protection. It can protect external driving lights and will instantly trigger if the ignition is switched on or if the leads to the car's battery are cut (provided, of course, that an auxiliary battery is fitted).

Inputs and options

The key to the versatility of this alarm is that the inputs are designed to detect a change of state. It does not matter whether an input is normally pulled low or tied high, or whether the input is open circuit. If there is any change on the input (ie, from 0V to +12V or vice versa), the alarm will trigger.

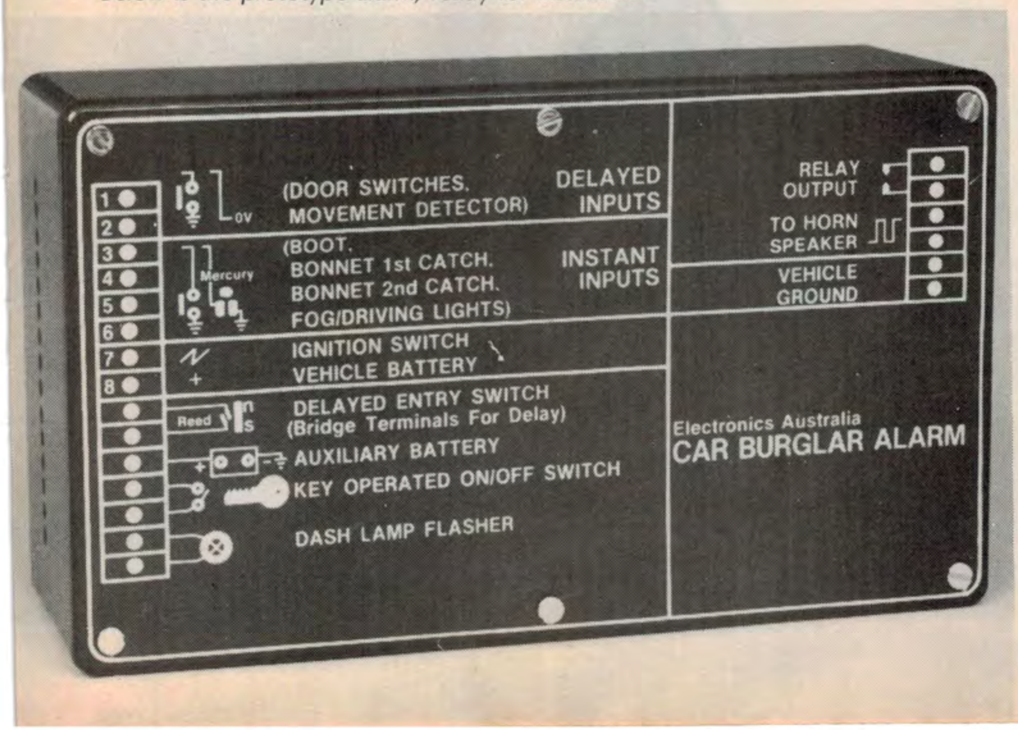
There are eight inputs in all, two providing 10-second delayed triggering and six providing instantaneous triggering. The delayed inputs monitor the doors and an optional ultrasonic movement detector (to be described later), while the six instant inputs monitor the boot, bonnet, external driving lights, ignition system and the vehicle battery.

When triggered, the alarm drives a separate horn-type loudspeaker for a period of two minutes and causes the hazard lights to flash on and off. At the end of the two minute alarm period, the unit automatically resets and rearms itself.

Several different techniques are used to trigger the alarm. The doors are protected by monitoring the courtesy light switches, the bonnet by fitting a spring-loaded switch adjacent to the bonnet catch, and the boot by fitting a mercury switch to the bootlid (a measure that also provides protection against tow-away). The ignition and battery inputs simply detect the presence or absence of voltage, while the driving lights are protected by monitoring the filaments.

There are other options. For example, some readers may prefer to forget about tow-away protection and monitor the bootlid by making a connection to the switched side of the bootlight. Other readers might prefer to protect the bonnet using a reed switch and magnet assembly. It's really up to the individual as to just how inputs 1-6 are used.

Below is the prototype alarm, ready for installation.



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What about the ignition cutout requirement referred to earlier? While we did not fit this feature directly to our car burglar alarm, we do recommend that readers also install the Ignition Killer. In fact, we believe this to be a far better scheme since the Ignition Killer can act independently as a last line of defence should the alarm be disabled.

Easy operation

While it's nice to have a lot of fancy features, a good car burglar alarm must also be easy to use. This design meets that requirement. When leaving the vehicle, all the driver has to do is turn the alarm on using the key operated on/off switch. He then has 10 seconds to leave the vehicle during which time the dash panel lamp remains fully lit to indicate that all inputs are disabled.

At the end of the exit period, the dash panel lamp flashes to indicate that the alarm is armed.

Entering the vehicle is just as easy – for the driver, that is – although we have included a rather clever "wrinkle" in the delayed entry input circuitry. Essentially, the reader has two options.

The first option is to bridge two terminals on the alarm to provide for normal delayed entry. This gives the driver 10 seconds to open the car door and switch off the alarm. As before, the dash panel lamp remains fully lit during this procedure.

The second option is to fit a reed switch across the two terminals instead of linking them. The delay circuitry will now operate only if the reed switch is momentarily closed. If the switch is not closed, the alarm will trigger instantly when the car door is opened.

In practice, the reed switch can be glued to the inside of the windscreen immediately adjacent to the pillar or the dashboard. Or it could be hidden in the external mirror surround or some other suitable location. To enter the car, the driver simply uses a small magnet to momentarily close the reed switch. He then has 10 seconds to open the car door and switch off the alarm as before.

How it works

At first glance, the circuit may seem quite complicated, comprising as it does eight CMOS ICs, 14 transistors, 25 diodes and associated components. But while there may seem to be quite a few components, the circuit can be simplified by breaking it down into six basic sections: input circuitry, alarm timer, delayed exit timer, delayed entry timer, dash lamp flasher, and horn speaker driver circuitry.

The action starts with the eight inputs at the lefthand side of the circuit. As can be seen, these all have a fairly similar circuit configuration with each input circuit built around an exclusive-OR gate, or XOR gate for short.

Basically, the output of an XOR gate is high only when one input is high and the other is low, and is low otherwise. We have used this characteristic to derive a positive-going pulse whenever there is a change in the input state.

To achieve this, one input of each XOR gate is connected to the other input via an RC delay circuit consisting of a 100kΩ resistor and a 10μF capacitor. Thus, when the input signal changes state, one input of the XOR gate changes state immediately while the other is delayed from making this change until the 10μF capacitor charges to about 8V. The result is a positive-going 100ms output pulse.

Note that some of the 10μF capacitors are tied to the positive supply rail while the remainder are tied to ground. This was done to simplify the printed circuit board (PCB) layout and in no way alters the operation of the circuit.

Inputs 1-6 are all tied to the +12V rail via 100kΩ pullup resistors, while the 1μF capacitors provide decoupling to prevent false triggering. Normally, the trigger switches are open circuit and inputs 1-4 are held high. If a switch closes (as when a door is opened), the input is pulled low and the corresponding XOR gate produces a 100ms pulse.

Inputs 5 and 6 function in similar manner except that they are normally held low by the driving light filaments and are pulled high if the ground connection is broken. The corresponding XOR gate then produces a 100ms pulse as before. Diodes D1-D6 prevent damage to the XOR gates in the event that a positive voltage higher than their own supply is applied to the inputs.

Voltage sensing inputs 7 and 8 use transistors Q1 and Q2 to switch the inputs of XOR gates IC2d and IC2b between the high and low states. In the case of the ignition input (7), Q1 is normally off and the inputs to IC2d are high. When the ignition is switched on, Q1 turns on and pulls the input signal to IC2d low.

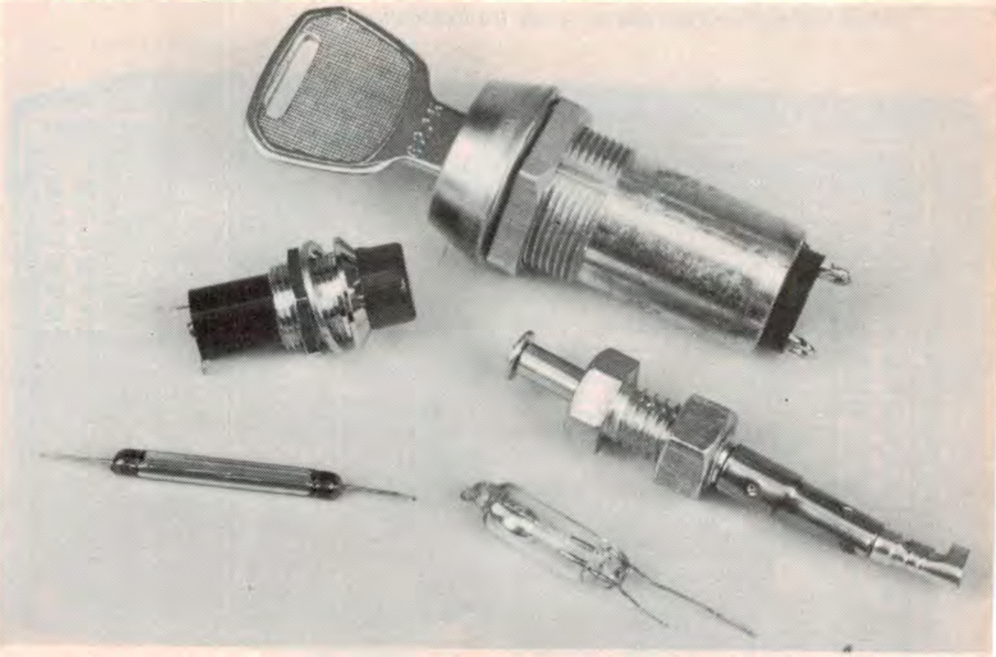
Q2 works in reverse fashion. It is normally biased on by the battery voltage but turns off if the battery leads are cut.

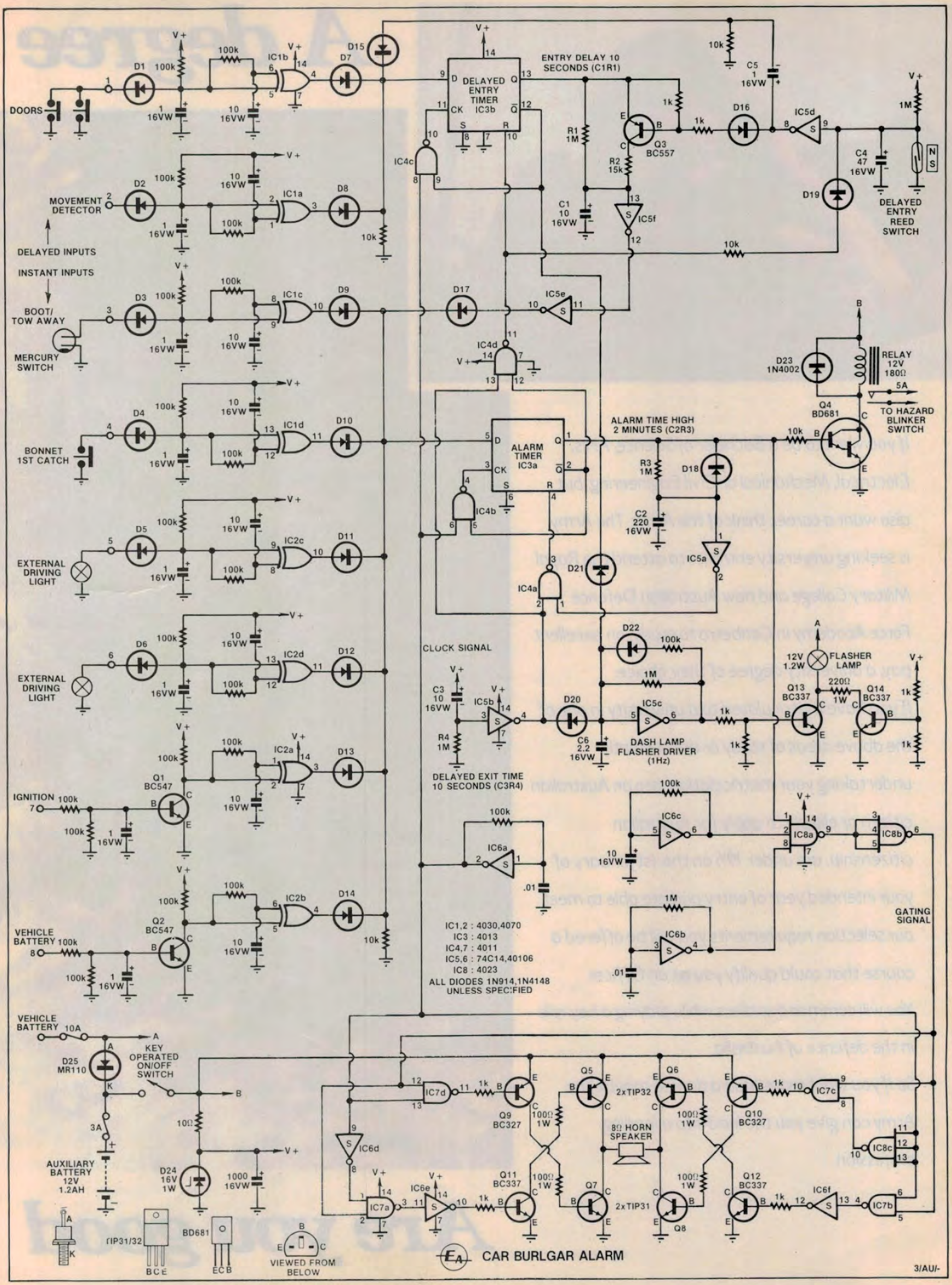
The outputs of IC1a and IC1b are fed to diode OR gate D7 and D8, and then applied to the data input of D-type flipflop IC3b. Likewise, the outputs IC1c-IC2d are connected to the data input of IC3a via diodes D9-D14. Note that both data inputs are normally tied low via a 10kΩ resistor.

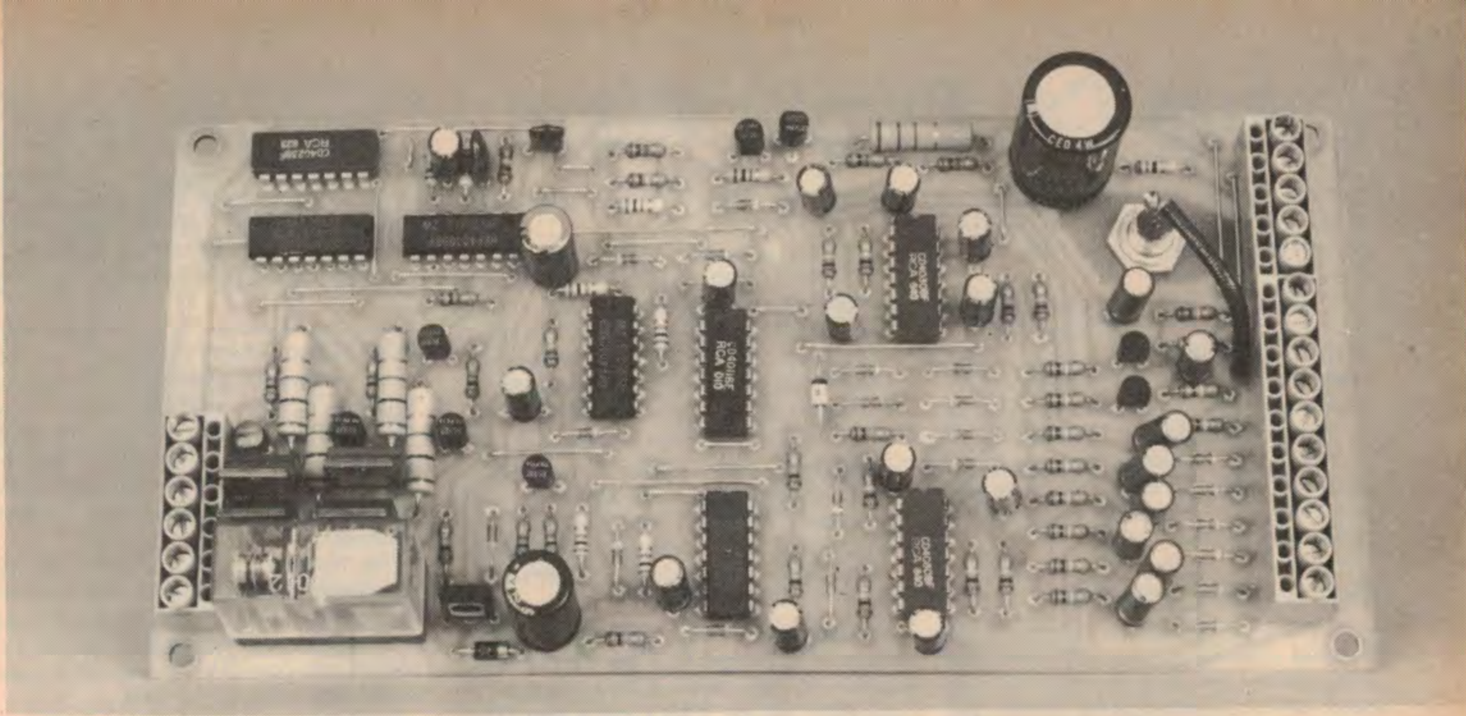
Here's how this circuitry works. A D-type flipflop has two complementary outputs designated Q and $\overline{Q}$. When the Reset input is low, the Q output will follow the Data input at the positive edge of the clock waveform. In other words, if the Data input goes high, the Q output will also go high when the next positive going clock pulse is received.

IC3a is the alarm timer. Its clock signal is gated by IC4b which has its pin 5 input connected to $\overline{Q}$. Thus, when $\overline{Q}$ is high, IC4b inverts the clock signal and passes it

Alarm accessories (clockwise from top): barrel-type keyswitch, spring-loaded automotive switch, mercury switch, reed switch and bezel lamp.




CAR BURLGAR ALARM
ENTRY DELAY 10 SECONDS (C1R1)
DELAYED ENTRY TIMER IC3b
DOORS
MOVEMENT DETECTOR
DELAYED INPUTS
INSTANT INPUTS
BOOT/ TOW AWAY
MERCURY SWITCH
BONNET 1ST CATCH
EXTERNAL DRIVING LIGHT
EXTERNAL DRIVING LIGHT
IGNITION
VEHICLE BATTERY
DELAYED ENTRY REED SWITCH
RELAY 12V 180Ω
TO HAZARD BLINKER SWITCH
ALARM TIME HIGH 2 MINUTES (C2R3)
ALARM TIMER IC3a
CLOCK SIGNAL
DELAYED EXIT TIME 10 SECONDS (C3R4)
DASH LAMP FLASHER DRIVER (1Hz)
12V 1.2W FLASHER LAMP
GATING SIGNAL
IC1,2 : 4030,4070
IC3 : 4013
IC4,7 : 4011
IC5,6 : 74C14,40106
IC8 : 4023
ALL DIODES 1N914,1N4148 UNLESS SPECIFIED
VEHICLE BATTERY 10A
KEY OPERATED ON/OFF SWITCH
D25 MR110
AUXILIARY BATTERY 12V 1.2AH
D24 16V 1W
8Ω HORN SPEAKER
2xTIP32
2xTIP31
TIP31/32
BD681
VIEWED FROM BELOW
3/AU/-



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to IC3a's Clock input (pin 3). Now comes the tricky bit. When the Data input (pin 5) goes high (ie, when an input is triggered), $\overline{Q}$ goes low and the output of IC4b goes high.

What this now means is that the Q and $\overline{Q}$ outputs will not be affected when the Data input subsequently goes low after 100ms, since no further clock pulses can reach IC3a. The flipflop thus remains latched with Q and $\overline{Q}$ high and low respectively.

The high Q output of IC3a is used to gate on (via IC8a) the horn speaker driver circuit to sound the alarm. At the same time, it charges capacitor C2 via resistor R3. After about two minutes, the voltage across C2 reaches a level sufficient to switch Schmitt trigger IC5a to a low output.

Since pin 2 of IC4a is normally high, it follows that pin 3 of IC4a will also now go high. This resets IC3a to its normal state with Q low and $\overline{Q}$ high, thus switching off the alarm at the end of the two minute period. At the same time, diode D18 rapidly discharges C2, pin 3 of IC4a goes low, and pin 5 of IC4b goes high, thus allowing clock pulses through to the Clock input.

The circuit is now re-armed, ready for the next 100ms pulse on the Data input.

Note that if it were not for D18, C2 may not be fully discharged before the next trigger input. Depending on the circumstances, this could result in an alarm time that was considerably shorter than two minutes.

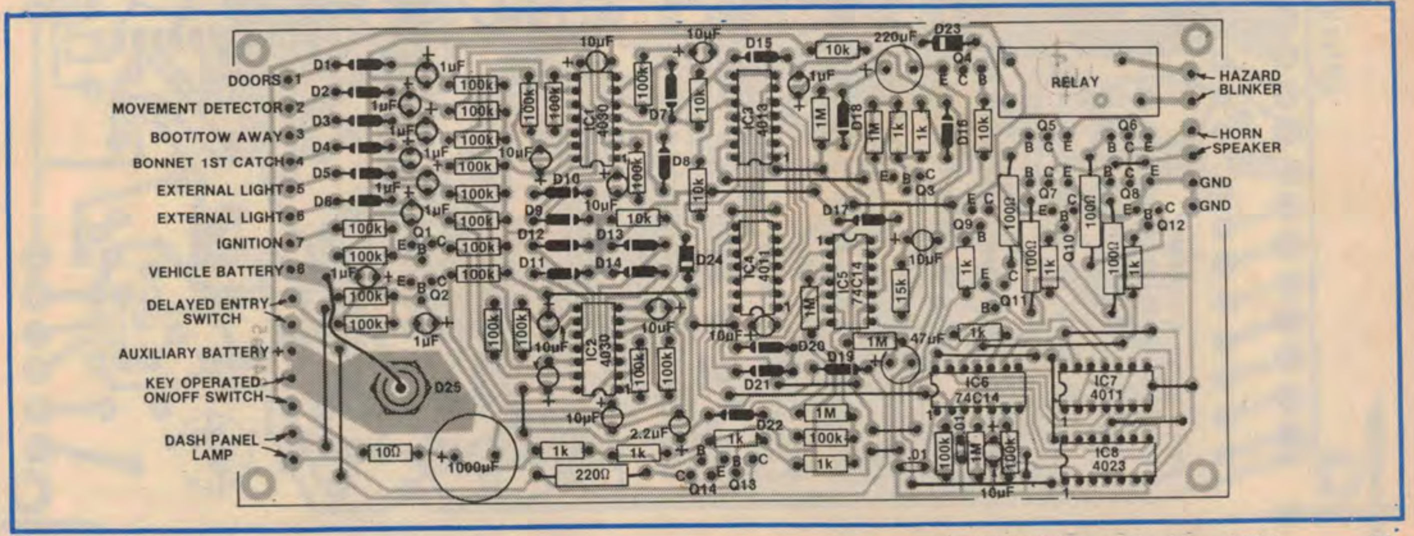
Delayed entry timer

IC3b is the delayed entry timer and functions in similar fashion to IC3a. Initially, Q is low, $\overline{Q}$ is high and clock pulses are gated through IC4c to the Clock input (pin 11). When a positive-going pulse is applied to the Data input, the Q output goes high and $\overline{Q}$ goes low to stop the clock pulses as above.

Assuming for the moment that transistor Q3 is off, C1 now charges via R1. After about 10s, the voltage across C1 reaches the trigger threshold of Schmitt trigger IC5f. The output of IC5e then switches high and applies a positive voltage to the Data input of IC3a which then functions exactly in the manner described above.

The result of all this chicanery is that the alarm again sounds for two minutes but only after a 10s delay.

IC3b is reset using IC4d. When $\overline{Q}$ of IC3a goes low, the output of IC4d goes high and Q and $\overline{Q}$ of IC3b are forced low and high respectively. IC3b is held in this state for the duration of the alarm time. At the end of the alarm time, $\overline{Q}$ of IC3a



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switches high again and the output of IC4d goes low. IC3b is now re-armed and ready to accept the next input to its Data pin.

If that's all a bit too much for you, consider it this way. The delayed entry inputs trigger IC3b which in turn triggers IC3a after a 10s delay. During the following two-minute alarm period, IC3b is held in the reset state by IC4d and the $\overline{Q}$ output of IC3a. Finally, at the end of the alarm period, both Reset inputs go low and the alarm is re-armed ready for the next trigger input.

Delayed entry switch

So much for the basic operation of the delayed entry timer. But just when you think you've got it all figured out, we now inject a complicating factor: the delayed entry switch circuit. This comprises C4, IC5d, Q3 and associated components.

Let's first assume that the switch contacts are shorted to provide for normal delayed entry. It follows that the output of IC5d will be high and thus transistor Q3 will be off. In this case, the delayed entry timer functions exactly as described above to provide a 10s entry delay.

Now suppose that we substitute a normally open reed switch as shown on the circuit diagram. Furthermore, let's initially assume that the reed switch is left open circuit. The delayed entry switch circuit now comes into play. Here's how it works.

When power is first applied, the Reset input of IC3b goes high for 10s (we'll explain why later) and quickly charges C4 to +12V via the 10kΩ resistor and D19. Thus, the output of IC5d goes low. Now when the Q output of IC3b goes high, Q3 is biased on and charges C1 via R2.

We've now got a whole new ballgame. Whereas it previously took 10s for C1 to charge via R1 (1MΩ), it now only takes about 150ms to charge via Q3 and R2 (15kΩ). So, as far as the thief is concerned, the alarm triggers instantly if a door is opened.

The 10s entry delay can be activated by momentarily closing the reed switch. This action rapidly discharges C4, forcing the output of IC5d high and turning Q3 off. C1 can now charge only via R1 and so the 10s delay is restored.

But that's not the end to the electronic skullduggery. When the output of IC5d switches high, a short positive-going pulse is applied to the Data input of IC3b via C5 and D15. This triggers the delayed entry timer which means that the alarm will sound 10s after the reed switch is closed.

So it doesn't matter whether or not a door is opened after the reed switch is closed. The alarm will still sound after a 10s delay (unless, of course, the driver enters the car and switches the alarm off).

Delayed exit timer

Schmitt trigger IC5b forms the delayed exit timer. When power is first applied, C3 pulls pin 3 high and the output (pin 4)

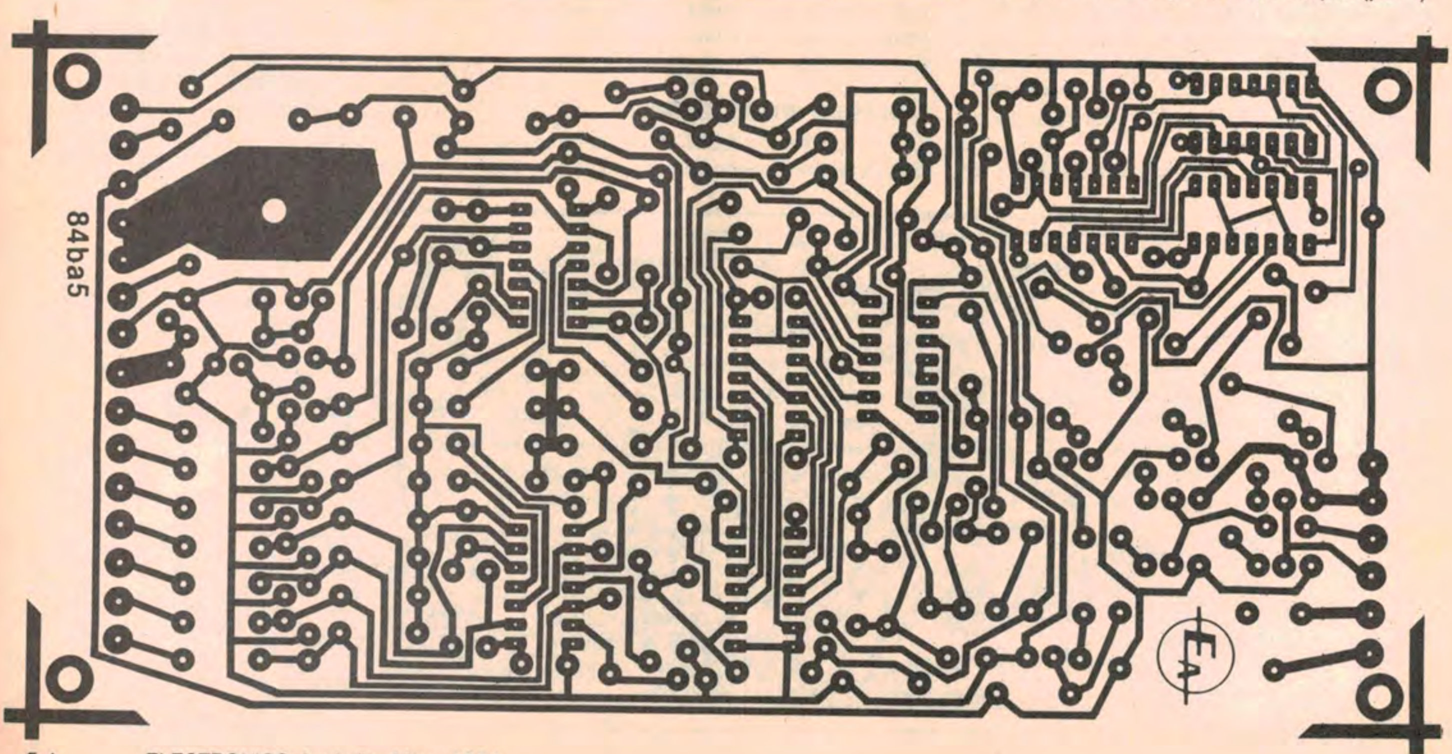
We estimate that the cost of parts for this project is approximately

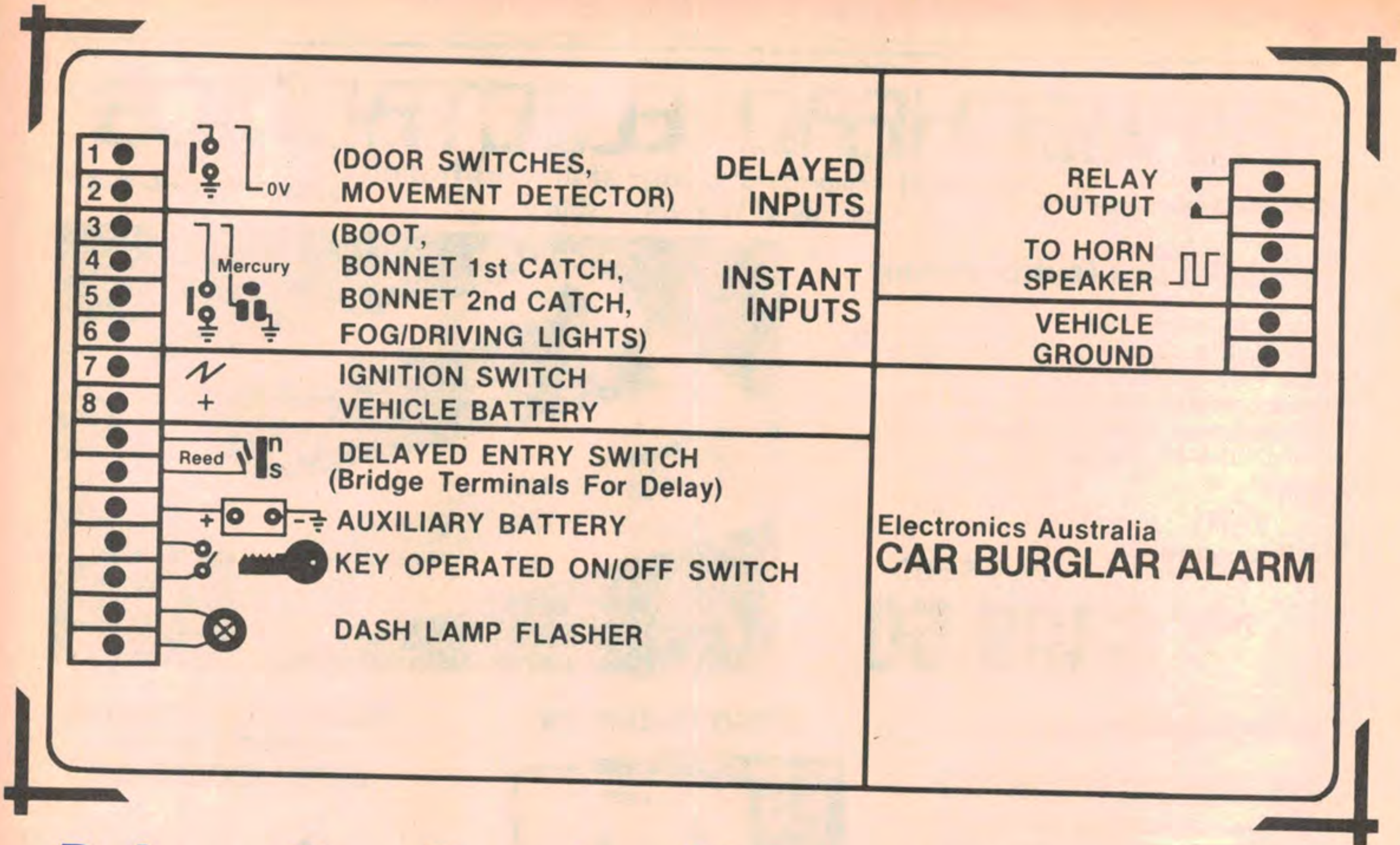
$70

This includes the horn speaker but not the cost of an auxiliary battery or extra switches.

Specifications:

Inputs	Two delayed, six instant
Delay times	10 seconds delayed exit, 10 seconds delayed entry
Power supply	+12V from vehicle battery with provision for auxiliary battery backup
Alarm time	Two minutes with automatic re-arming at end of alarm time
Alarm output	1kHz tone modulated at 100Hz and 1Hz driving an 8Ω horn speaker
Current consumption	13mA standby mode, 500mA when alarm is triggered
Miscellaneous	Flashing dash panel lamp, key-operated on/off switch, provision for tow-away protection





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goes low. Pin 2 of IC4 and pin 13 of IC4d are thus also pulled low, which means that the Reset inputs of IC3a and IC3b are held high.

C3 now charges via R4 and, after about 10s, switches the output of IC5b low. The Reset inputs of IC3a and IC3b also now go low and the alarm is armed and ready for action.

IC5c is wired as a Schmitt trigger oscillator and drives transistor Q13 and the dash panel lamp. Notice that IC5c has two feedback paths connected between pins 5 and 6: one via the 1MΩ resistor and the other via the 100kΩ resistor and diode D22. When pin 6 is high, C6 quickly charges via both feedback paths. However, when the output is low, D22 is reverse biased and C6 can discharge only through the 1MΩ resistor.

The output of IC5c thus has a 1:10 duty cycle which means that the lamp turns on for 100ms once every second (ie, the lamp flashes at a 1Hz rate). Transistor Q14 is permanently biased on and, together with its 220Ω collector resistor, provides a 50mA standing current path through the lamp. This measure is designed to extend lamp life by ensuring that the filament is kept just above the point of incandescence.

Diodes D20 and D21 have no effect on the circuit except during the delayed entry and exit times. During the delayed exit time, for example, the output of IC5b is low and thus pin 5 of IC5c is held low by D20 which is now forward biased. The output of IC5c will therefore be high and so the dash lamp remains fully lit for the duration of the exit time.

At the end of the exit time, pin 4 of IC5b goes high, D20 is reversed biased, and the dash lamp circuit commences normal operation.

Similarly, pin 5 of IC5c is held low via D21 and the $\overline{Q}$ output of IC3b during the delayed entry time.

Horn speaker driver

As mentioned previously, the alarm sounds when the Q output of IC3a goes high. The horn driver circuit has been devised so that it draws very little current in the quiescent state.

Let's assume that the alarm has been triggered and that the Q output of IC3a has gone high. This does two things: it applies a gating signal to 3-input NAND gate IC8a and it turns on Darlington transistor Q4. Q4, in turn, drives a single pole relay with output contacts connected in parallel with the hazard flasher switch.

D23 protects the transistor against back EMF from the coil when the relay turns off.

The remaining two inputs of IC8a are connected to the outputs of Schmitt trigger oscillators IC6b and IC6c. The first oscillator operates at about 100Hz while the latter has a nominal output of 1Hz. When Q of IC3a is high, their outputs are gated through to the output of inverter IC8b and form the gating signal for the horn speaker driver circuit.

This gating signal is connected to one input of NAND gates IC7a, b, c and d. When the gating signal is low, the NAND gate outputs are high and transistors Q7, Q8, Q9 and Q10 are off. IC6e and IC6f invert the outputs of IC7a and IC7b, and so Q5, Q6, Q11 and Q12 are also off.

When the gating signal goes high, a 1kHz tone signal for the horn speaker is gated through to the transistor driver stages by the IC7 NAND gates. This 1kHz tone signal is generated by Schmitt trigger oscillator IC6a which, incidentally, also provides clock signals for IC3a and IC3b. Note that the 1kHz signal is inverted before it is applied to IC7a and IC7c.

The transistor driver stage operates in push-pull mode. When the output of IC6a goes high, the output of IC6f also goes high and turns on transistors Q12 and Q6. At the same time, the output of IC7d goes low and turns on transistors Q9 and Q7. One side of the horn speaker thus goes to the positive supply rail while the other goes to ground.

Similarly, when the output of IC6a goes low, Q6, Q7, Q9 and Q12 all turn off and Q10, Q8, Q11 and Q5 turn on. In this manner, each side of the horn speaker is switched at a 1kHz rate from one polarity to the other.

This 1kHz tone is modulated at 100Hz by IC6b, while IC6c switches the tone on and off at a 1Hz rate (ie, on for 0.5s and off for 0.5s). The result is an ear-piercing alarm tone that's sure to attract attention.

Power supply

Power for the alarm circuit is derived from the vehicle battery and also from the optional auxiliary battery. Note that the auxiliary battery is charged via D25. This diode prevents the auxiliary battery from discharging into the vehicle battery should the latter go "flat".

Supply line decoupling is provided by a 10Ω resistor and a 1000μF capacitor, while zener diode D24 protects the circuit from voltage spikes. Short circuit protection is provided by fusing the vehicle and auxiliary battery supply lines to 10A and 3A respectively.

Construction

Construction of the Car Burglar Alarm is a heck of a lot easier than understanding how it works. All the parts are mounted on a PCB coded 84ba5 (88 x 181mm) and this is housed in a plastic zippy case measuring 190 x 60 x 110mm. A Scotchcal front panel gives the unit a professional appearance as well as providing a legend for all the external wiring connections.

Begin construction by installing the 22 wire links, then mount the diodes, resistors and capacitors. Note that the diodes and electrolytic capacitors must be mounted with due regard to polarity so check your work carefully as you proceed. The diode type numbers can be gleaned from the circuit diagram.

Diode D25 is a 10A stud-mounting type and should be screwed securely to the PCB using the nut and lockwasher supplied. The anode terminal is then connected to the PCB using 1mm-thick tinned copper wire. This lead should be insulated with spaghetti tubing.

The transistors can be mounted next and should be pushed down onto the PCB as far as they will comfortably go. As with the diodes, you will have to refer to the circuit diagram for the type numbers. Make sure that you install the transistors the right way round.

External connections to the alarm are handled by PCB-mounting terminal blocks. A 6-way section is installed adjacent to the relay while 5-way and 10-way sections are mounted at the other end of the PCB adjacent to the input diodes.

PARTS LIST

1 PCB, code 84ba5, 88 x 181mm
1 plastic zippy case, 190 x 110 x 60mm
1 12V single pole relay, 180Ω
1 8Ω horn speaker
1 Scotchcal front panel, 190 x 108mm
1 10-way PCB-mounting terminal block
2 6-way PCB-mounting terminal blocks
1 barrel-type keyswitch
1 12V bezel lamp (red)
1 reed switch and magnet set
4 12mm standoffs
1 mercury switch
1 spring-loaded automotive switch
1 12V motorcycle battery, 1.2Ah capacity or greater (optional)
1 3A fuse
1 10A fuse
2 in-line fuseholders

Semiconductors

2 4011 quad 2-input NAND gates
1 4013 dual D flipflop
1 4023 triple 3-input NAND gate
1 4030, 4070 quad 2-input XOR gate
2 74C14, 40106 hex Schmitt triggers
1 BC557 PNP transistor
2 BC547 NPN transistors
4 BC337 NPN transistors
2 BC327 PNP transistors
1 BD681 NPN Darlington transistor
2 TIP31 NPN transistors
2 TIP32 PNP transistors
1 1N4002 100V diode
1 MR110 10A 100V diode
1 16V 1W zener diode
22 1N914, 1N4148 diodes

Capacitors

1 1000μF/16VW PC electrolytic
1 220μF/16VW PC electrolytic
1 47μF/16VW PC electrolytic
11 10μF/16VW PC electrolytic
1 2.2μF/16VW PC electrolytic
9 1μF/16VW PC electrolytic
2 .01μF metallised polyester

Resistors *(¼W, 5% unless stated)*
6 x 1MΩ, 23 x 100kΩ, 1 x 15kΩ, 5 x 10kΩ, 10 x 1kΩ, 1 x 220Ω 1W, 4 x 100Ω 1W, 1 x 10Ω

Miscellaneous
Hookup wire, tinned copper wire, automotive connectors, machine screws and nuts, shakeproof washers, warning stickers, solder, etc.

Assembly of the PCB can now be completed by installing the CMOS ICs and the relay. Note that all the ICs are CMOS devices so solder the supply pins (7 and 14) first to enable the internal static protection diodes. The hazard flasher relay can be regarded as optional – if you want to save a few dollars it can be deleted from the circuit along with Q4 and D23.

Finally, the Scotchcal label can be affixed to the lid, the various holes drilled in the case, and the PCB mounted on 12mm standoffs. Use shakeproof washers under all mounting nuts, as this project will be subject to a good deal of vibration.

Testing

The test procedure is as follows:

- switch on the alarm and check that the dash panel lamp remains fully lit for 10s. Check that none of the inputs can trigger the alarm during this 10s exit time.
- check that the dash panel lamp flashes at the end of the exit time and that all inputs now instantly sound the alarm. Inputs 1-6 can be test triggered by momentarily shorting them to ground; input 7 by applying +12V to the input; and input 8 by shorting the base of Q2 to ground.
- check that the alarm sounds for about two minutes when triggered and that the relay closes.
- check that the alarm sounds after a 10s delay if the reed switch terminals are momentarily shorted.
- short the reed switch terminals permanently and check that the delayed trigger inputs sound the alarm after a 10s delay (the entry time). Check that the dash panel lamp is fully lit during the 10s delay.

Finally, make sure that you install the alarm in a professional manner. Use 10 x 0.2mm (or thicker) hookup wire for all external connections and terminate all leads in suitable connectors. In fact, it is a good idea to purchase an assortment of automotive quick connectors, bullet connectors and lugs before commencing installation.

The alarm can be mounted in any convenient location but, for most cars, the best place will be under the rear parcel shelf inside the boot. The auxiliary battery can also be mounted in the boot and should be securely clamped. Run leads to the front of the vehicle alongside existing wiring looms and don't omit the in-line supply fuses or you could get a fire in the event of a short.

The horn speaker can be mounted in the engine bay, but make sure that neither it nor the wiring to it is accessible from outside the vehicle. In fact, the effectiveness of this alarm ultimately depends on just what sort of a job you make of the installation.