Constructional Project

MICRO SENSE ALARM

JASON SHARPE

A comprehensive alarm that can protect any object, particularly electronic equipment, uses piezo sensors combined with tilt switches, if required, stuck onto the equipment.

THANKS to modern technology electronic goods keep becoming smaller and more portable, unfortunately this also makes life easier for the thief. This alarm was designed to protect computers and their peripherals from being removed while unattended.

Items are protected by fixing piezo transducers to them, with self adhesive foam pads. When an attempt is made to remove the sensor a voltage is produced by the piezo crystal as it is distorted, which will set off the alarm. If the security loop is cut or short circuited the alarm will also be set off, tilt switches (and other types of switches) may be connected in series and parallel with the loop and fixed to the back of the sensors for even more security.

The source of the last trigger pulse is shown by three l.e.d.'s, this feature is useful in the case of false alarms to detect what caused the error, also when the alarm is first switched on it will show if the loop is open or short circuited. Features of the alarm are:

★ Uses sensitive piezo transducers
★ Three state security loop
★ Trigger source indicators
★ Status indicator
★ Auto turn off sounder

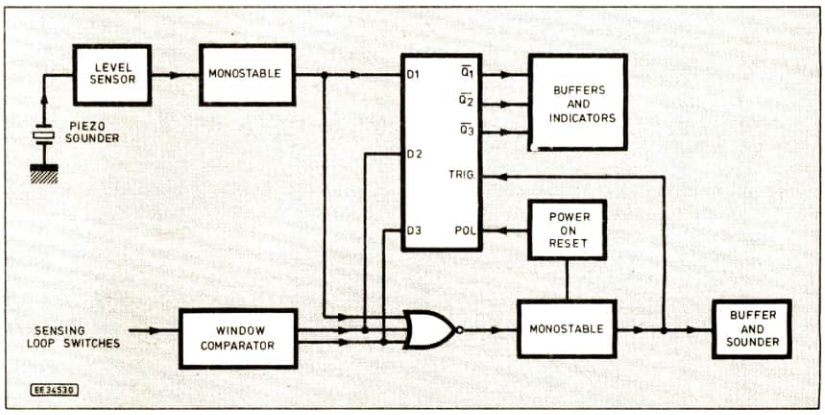
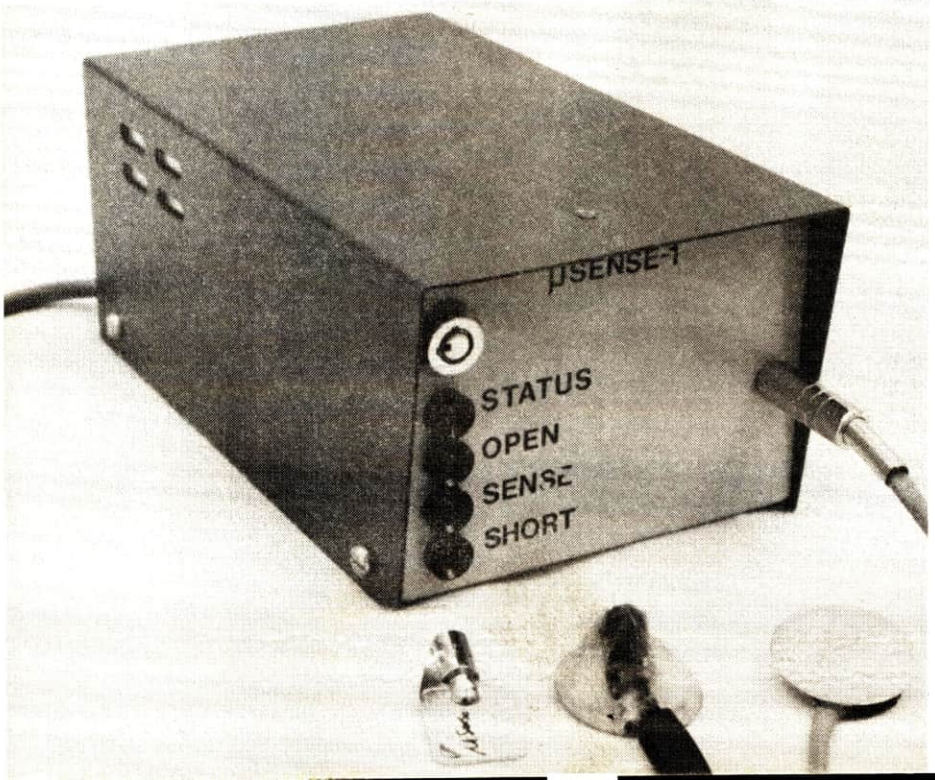


Fig. 1. Block diagram of the Micro Sense Alarm.



A block diagram of the Micro Sense Alarm is shown in Fig. 1 and Fig. 2 shows the full circuit diagram without the power supply unit.

The output from the piezo transducers is fed into an inverter arranged as an amplifier, the input sensitivity is set by VR1 and R1, the higher their combined resistance the higher the input sensitivity. The output of the amplifier is fed into another inverter which translates the analogue signal into a digital high or low.

Components R3, TR1, R4, C1 and a further inverter form a monostable which has the affect of "stretching" the short pulse received from the piezo transducer. If the input becomes high (i.e. a trigger pulse has been sensed) C1 is discharged via TR1, when the input goes low again C1 starts to charge via R4, the inverter squares the output to produce a high pulse which is longer than the input pulse.

Most security loops are just wire loops, which means they can be shorted out and disabled, the security loop on this alarm has an 18k resistor from the loop input to ground, which is fixed to the last sensor in the chain. Inside the alarm the input has an 18k resistor connected to positive, this

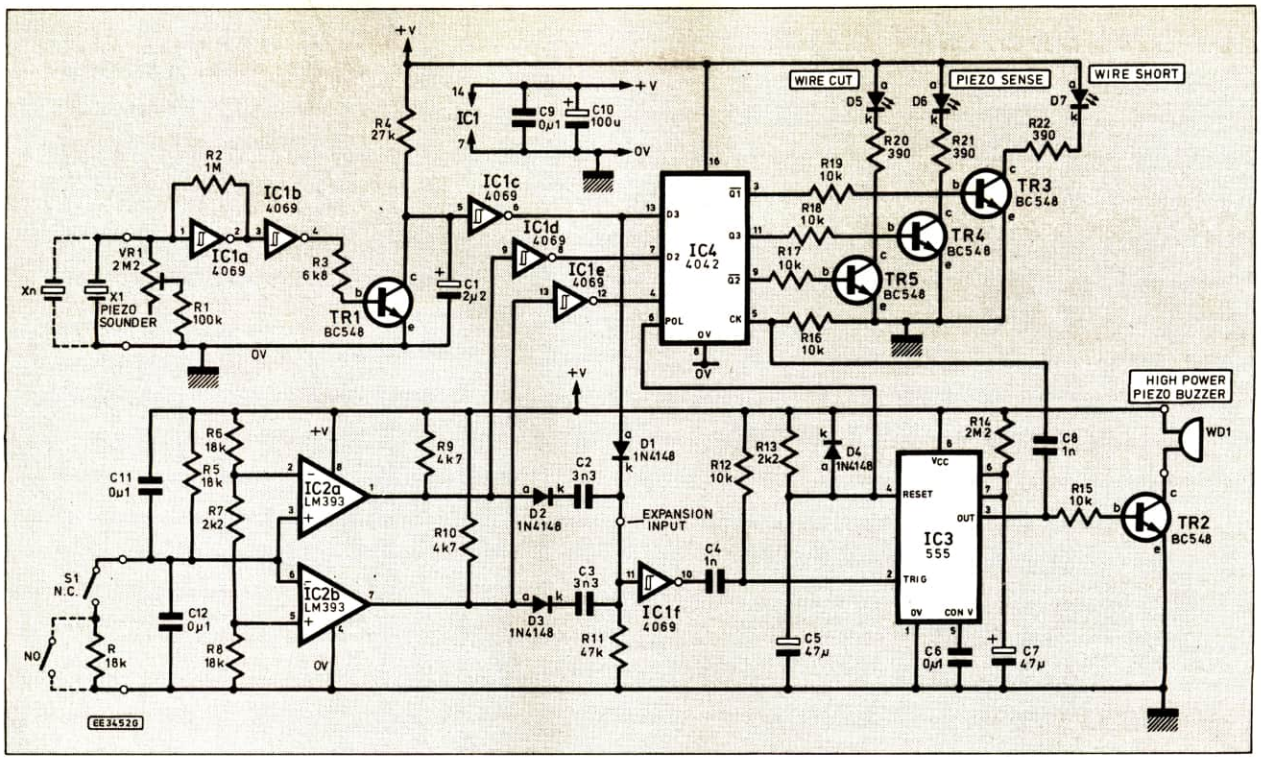


Fig. 2. Circuit diagram of the Micro Sense Alarm.

forms a potential divider with the external resistor so the input is normally at half the supply voltage, capacitors C11 and C12 are to remove noise from the input signal.

Component IC2 (LM393) is a dual comparator, the loop input is fed into the inverting input of one of the comparators (pin 6) and the non-inverting input (pin 3) of the other. Resistors R6, R7 and R8 also form a potential divider, which is connected to the inverting input of one comparator (pin 2) and non-inverting input of the other (pin 5), the voltage at pin 2 is slightly more than half the supply voltage, and slightly less at pin 5, this is known as a "window comparator".

If the input voltage exceeds that at pin 2 (this would happen when the security loop was open circuit), pin 1 will go high, or if it is less than that at pin 5 (security loop short circuited), pin 7 will go high. R9 and R10 tie the outputs high to make the signal compatible with the CMOS Schmitt inverter inputs.

This type of security loop makes it possible to include normally closed and normally open switches in the loop (e.g. tilt switches as mentioned before).

The outputs of the window comparator and the piezo sensing circuits are connected to the data inputs of a quad D-type latch (IC4) and also to a diode OR gate (D1, D2, D3), more trigger inputs from other sources could be connected via diodes to this point (a spare hole has been left on the p.c.b. for any other inputs).

The OR gate output is connected to the input of an inverter, the output goes low when a trigger pulse is received, this momentarily takes pin 2 (trigger) of IC3 (555) low which triggers the monostable. When the trigger pin of IC3 is taken below 1/3 of the supply voltage the output (pin 3) goes high, but timing will not start until the trigger pin goes above 1/3 of the supply voltage, R12 and C4 are used to stop the trigger pin from being held low for long. R11 holds the inverter input low when there are no trigger pulses.

When the output of IC3 goes high TR2 is turned on which sounds the buzzer, this also provides a short pulse via C8 and R16 to pin 5 of IC4 to latch the conditions of the trigger lines to the indicators.

A power on reset circuit is formed by C5, R13 and D4 which prevents spurious triggering and indicator displays at switch on.

A relay could be used instead of or as well as a buzzer (providing the current does not exceed 80mA) and connected to a N.O. or N.C. loop on a main alarm system.

POWER SUPPLY

The power supply circuit diagram is shown in Fig. 3. The power supply is a basic 5V regulator circuit with VR2 and R23 added to increase the output voltage of the regulator to 6.8V, a sealed 6V 1AH lead acid battery is connected to the output.

If mains power is removed the battery will supply the circuit, D10 prevents the regulator from being damaged by reverse current in this condition. D11 is a tricolour l.e.d. when the alarm is switched off and the mains is on the l.e.d. will be green, when the alarm is switched on the l.e.d. will become amber, if the mains is turned off when the alarm is switched on it will become red.

The prototype used a 9-0-9V 1A transformer and 7805 regulator (1A) this can supply ample current for the alarm, which takes ≅20mA to ≅60mA depending on its state and the type of sounder used. Thus a siren could also be powered (the BC548 may need to be changed for a higher power one). Alternatively a 9-0-9V 0.5A transformer and 78M05 regulator (0.5A) maybe used, if any other type of supply is used it must be current limited, as when the battery is fully discharged it can draw an initial charging current of 3A.

CONSTRUCTION OF THE SENSORS

Connect a stereo 3.5mm jack plug to one end of a piece of two core screened

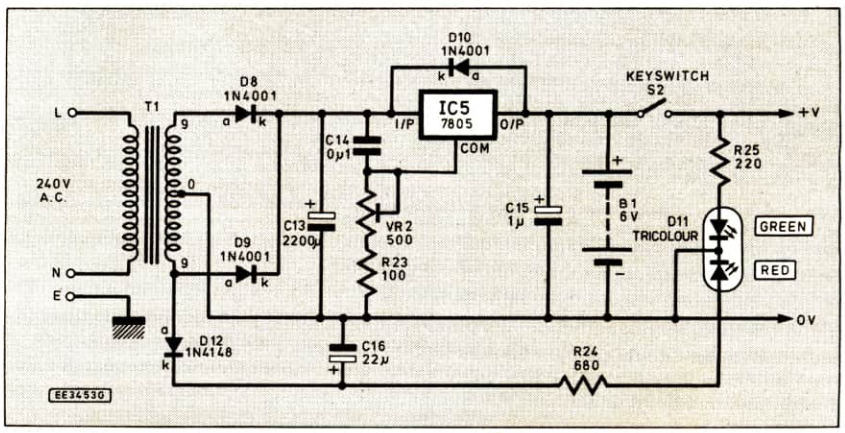


Fig. 3. Circuit diagram of the power supply.

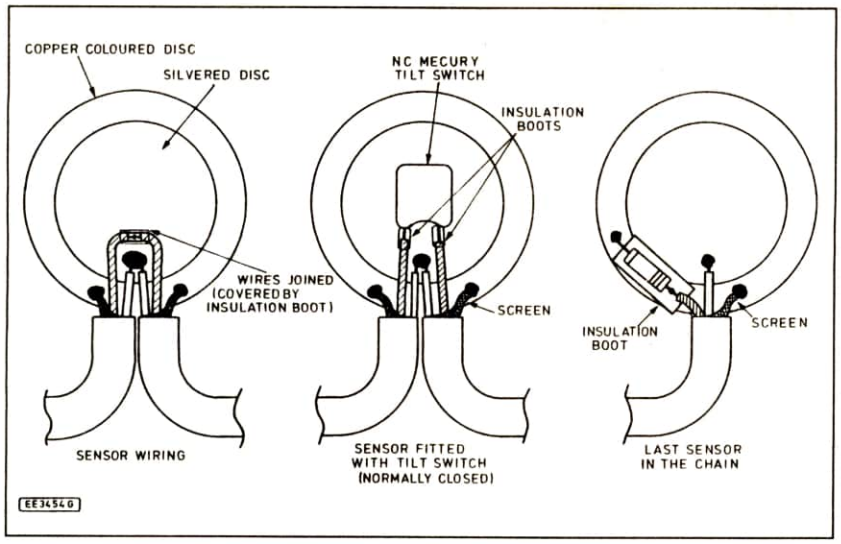
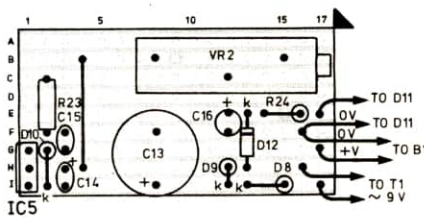
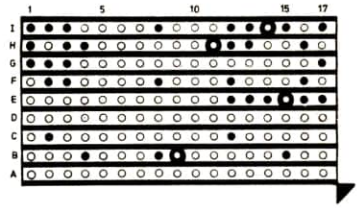
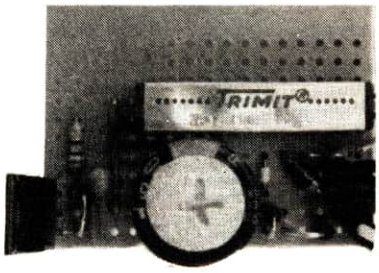


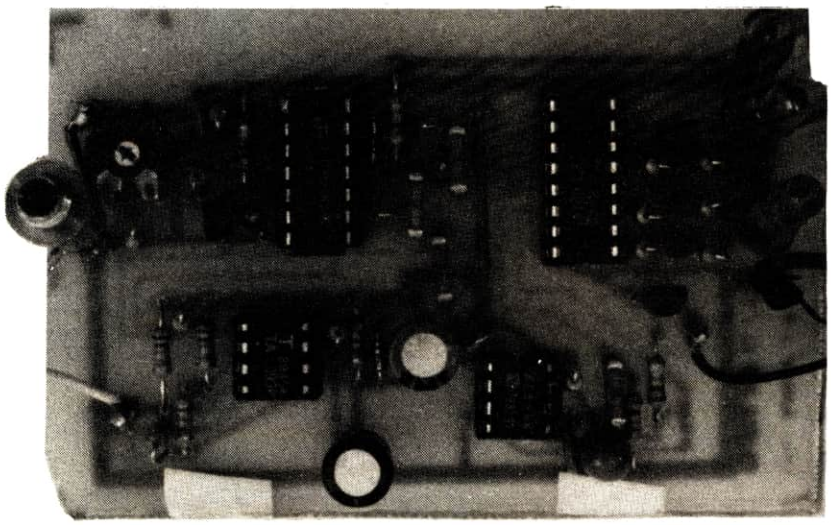
Fig. 4. Construction and wiring of the sensors.

Fig. 5. Wiring of the p.s.u. stripboard.









cable of required length, and a chain of piezo transducers to the other, solder the copper outside part of the transducer to the cable screen and connect other wires as shown in Fig. 4. Be careful not to get the sensor to hot, especially the silvered disc as this will begin to desilver if it gets to hot.

The last sensor in the chain should have an 18k resistor soldered between the security loop wire and ground (outer disc). When the unit has been tested (see Testing section) the sensors can be given extra protection by applying silicon rubber on the solder side of the sensors.

CONSTRUCTION

The Veroboard layout for the power supply is shown in Fig. 5, construction is quite simple, but check the polarities of the capacitors and diodes. In the prototype IC5 (7805) was used to fix the board into the box, and was mounted on a heatsink insulator.

When the case has been drilled the transformer can be fixed in place, and the mains lead connected (the Earth of the mains cable should be connected to the case), the output leads can then be connected to the power supply board which is fixed in place by means of a screw through the regulator tag.

COMPONENTS

See SHOP TALK Page

Resistors

R1	100k
R2	1M
R3	6k8
R4	27k
R5, R6, R8	18k (3 off)
R7, R13	2k2 (2 off)
R9, R10	4k7 (2 off)
R11	47k
R12, R15 to R19	10k (6 off)
R14	2M2
R20 to R22	390 (3 off)
R23	100
R24	680
R25	220

All ¼W ±10% carbon film.

Potentiometers

VR1	2M2 skeleton preset
VR2	500 multiturn preset

Capacitors

C1	2µ2 tantalum 35V
C2, C3	3n3 poly. layer (2 off)
C4, C8	1n poly. layer (2 off)
C5	47µ radial elect. 16V
C6, C9, C11, C12, C14	0µ1 ceramic (5 off)
C7	47µ tantalum 10V
C10	100µ radial elect. 16V
C13	2,200µ radial elect. 16V
C15	1µ tantalum 35V
C16	22µ radial elect. 16V

Semicondutors

IC1	4069UBE Hex inverter
IC2	LM393 voltage comparator
IC3	555 timer
IC4	4042 quad clocked D-latch
IC5	7805 +5V 1A voltage regulator
TR1 to TR5	BC548 *npn* silicon (5 off)
D1 to D4, D12	1N4148 (5 off)
D5 to D7	high brightness red l.e.d. (3 off)
D8 to D10	1N4001 1A 50V rec. (3 off)
D11	tri-colour l.e.d.

Miscellaneous

S1	s.p.s.t. microswitch
S2	s.p.s.t. key operated switch
X1 to Xn	piezo transducers number as required
T1	9V-0-9V 20VA mains transformer
B1	6V 1AH sealed lead acid battery

Stereo jack plug and socket as required to connect sensors; l.e.d. mounting clips; 14 pin d.i.l., 16 pin d.i.l. and 8 pin d.i.l. (2 off) i.c. sockets; metal case approx 102mm x 102m x 180mm; p.c.b. available from the *EE PCB Service,* order code EE783; stripboard, 9 strips by 17 holes; sticky pads as required for sensors; tilt switches as required – see text.

Approx cost guidance only **£28** *Excluding battery*

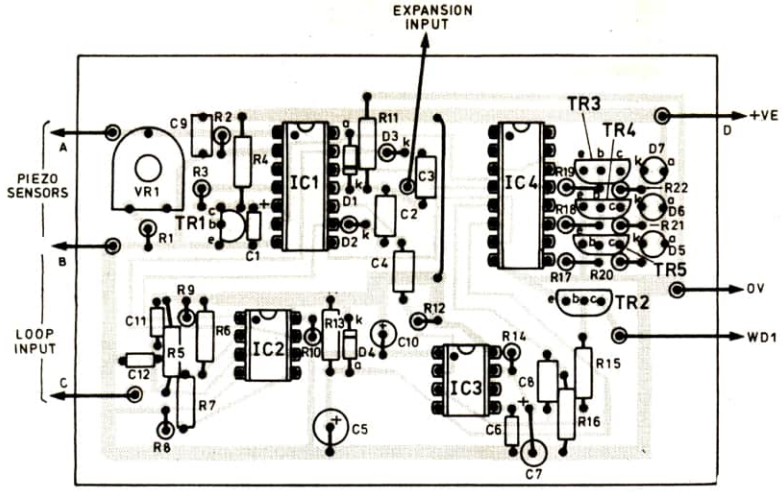


Fig. 6. P.C.B. layout and wiring for the Micro Sense Alarm.

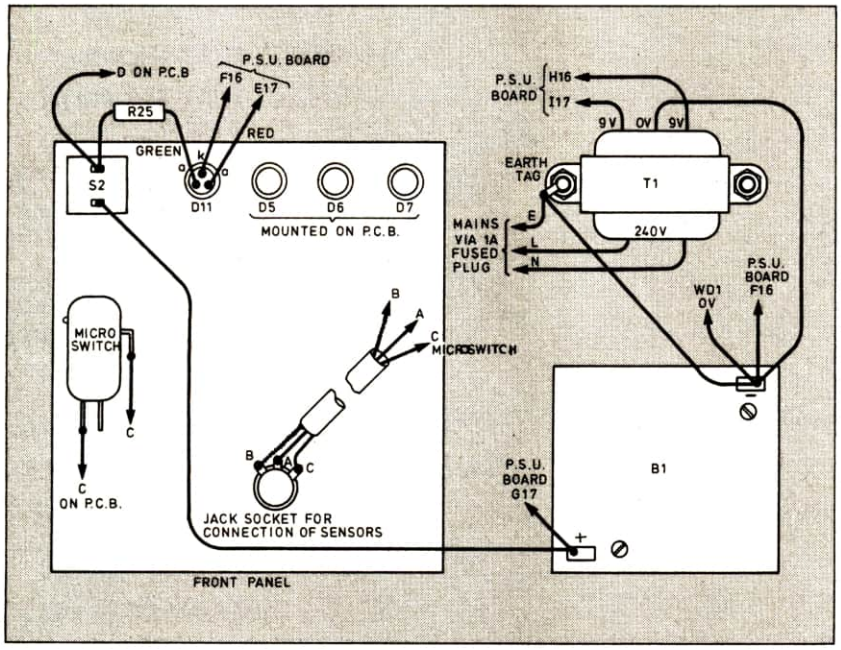
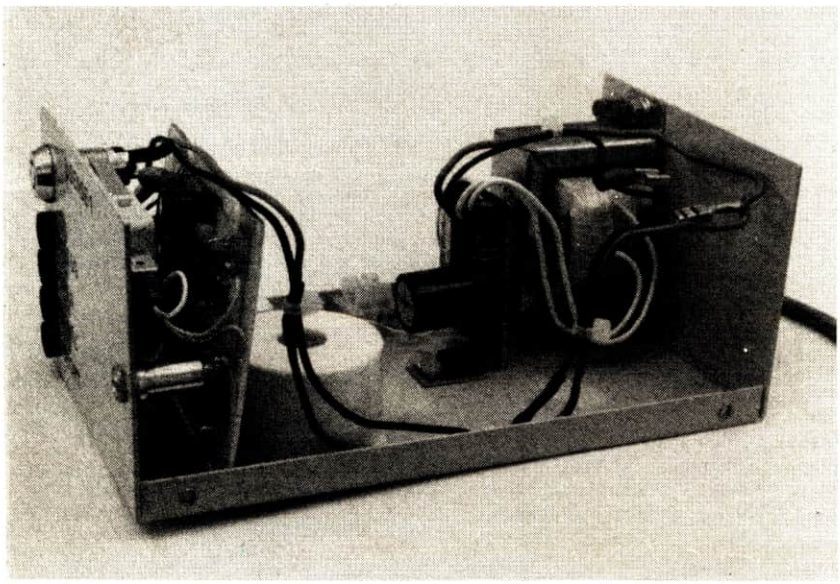
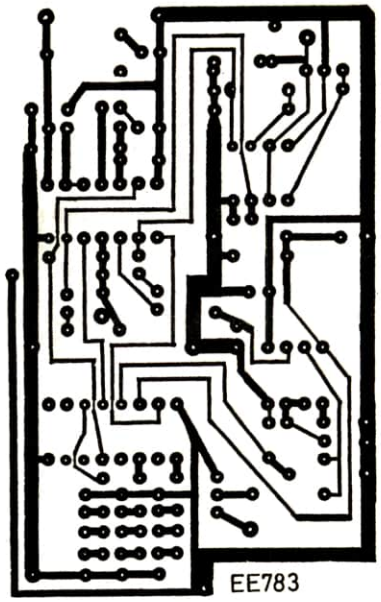


Fig. 7. Interwiring of the off-board components in the alarm.

Internal layout of the prototype alarm. The lead acid battery B1 has been removed to show the p.s.u. board and transformer.





ALARM BOARD

Assembly of the p.c.b. is quite straightforward (Fig. 6), insert the i.c. sockets and link first, then the diodes and resistors, and then the transistors, capacitors and Veropins. Before inserting the l.e.d.'s place insulation boots (or insulation stripped from some wire) ≅2.5cm long onto their leads and insert them into the p.c.b., also solder the large tag (screen) of the stereo socket firmly to the 0V pin (between the loop and sense inputs), connect the other leads and the buzzer.

After testing the board may be fixed into the case (see Fig. 7 for wiring information). The case used for the prototype was made of steel and is not recommended as it is quite hard to work with, cases of similar style made of aluminium are generally available.

POWER SUPPLY TESTING

When the power supply has been assembled in the box, you should check that the case is connected to earth, using an ohmmeter. When the mains is connected to the unit the output from the board should be set to 6.8 volts, by adjusting VR2.

Connect the sensors to the alarm board, and also a power supply (≅5V). Try connecting the security loop input to ground, and also disconnecting the wire from the input, both of these actions should cause the alarm to sound and the appropriate l.e.d.s to light, to reset the alarm remove and reconnect the power (**NOTE:** when testing the alarm it might be a good idea to cover the hole in the sounder with tape to lower the sound level slightly).

Tapping the piezo sensors with a small metal object should also set the alarm off. Adjust the sensors to the required sensitivity using VR1. When the unit has been tested it can then be installed in the drilled case as shown.

Switch S1 is a microswitch arranged so that it is held closed when the case is fixed together. Thus anyone opening the case will trigger the alarm. The unit is now ready for use. □