Constructional Project

PICKPOCKET ALARM

BART TREPAK

It's in the bag if you want to dodge the artful pickpocket

THERE is safety in numbers, or so the saying goes, and it is certainly true that one feels a lot safer even at night when walking along a busy high street than along a deserted side street or alley. Despite this, it is probably more likely that you will be robbed in a large crowd than in an almost deserted side street.

Large crowds are a favourite haunt of pickpockets who tend to ply their "trade" at football matches, train stations or such venues as the Trafalgar Square New Year's Eve celebration which has unfortunately become notorious for such activities.

These criminals normally work in pairs or groups of three and the usual method seems to be that one man will "accidentally" bump into the victim or obstruct him or her in some way – a likely occurrence in a crowd. While apologising profusely he thus distracts the victim from the activities of the second thief who actually does the deed.

If a third member of the team is present, he poses as a passer-by and the proceeds of the robbery are quickly passed to him. Even if the victim detects something untoward, the second thief can appear totally innocent as he will have no incriminating evidence on his person.

IN THE BAG

The skill of these people has to be seen (or not seen!) to be believed and relies on a basic human response. If somebody steps on your toe or bumps into you, the brain's attention is instantly directed towards this and is unlikely to register a light touch on some other area of the body, especially a relatively remote one such as a coat pocket.

Women are perhaps even more vulnerable because they tend to keep all of their possessions in one neat package – a handbag – so that the thief is almost guaranteed in finding something more valuable than an empty pocket, and there is far less likelihood of the victim feeling anything.

The Pickpocket Alarm presented here is thus intended to provide a warning that the handbag is being interfered with. While not providing a deterrent, it should certainly give the would-be pickpocket something else to think about and either cause him to run off empty handed or at least prevent him from having another "dip" thus limiting your loss. Although it is designed primarily for a handbag, with a little ingenuity it could equally be applied to a pocket in a coat or jacket.

SENSOR

One of the biggest problems is choosing a sensor which can detect the presence of the thief's hand and this will, of course, depend to a large extent on the design of the handbag to which it is fitted. Initially, a proximity switch was considered, but this would probably be too unreliable and prone to false alarms.

The last thing that is required is to have an alarm which keeps going off in company, each time someone approaches the bag.

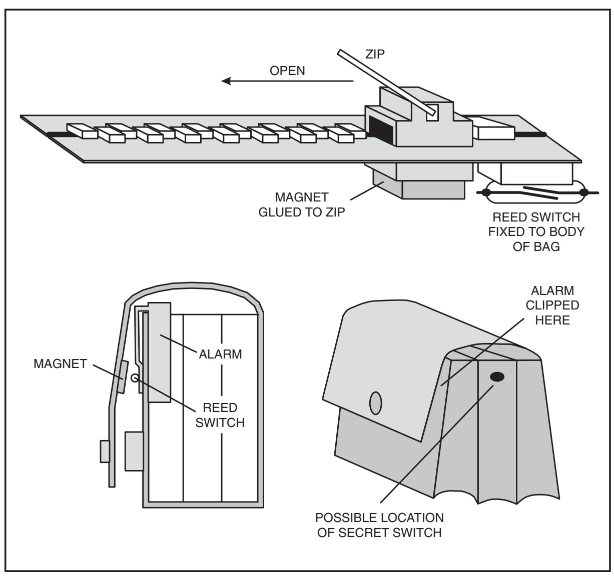


Fig.1. Some suggested ideas on how and where to mount the Pickpocket Alarm. The photograph on the left shows the reed switch mounted on the "pocket clip" and a small magnet to one side of the case.

Most handbags usually have some sort of flap or zip which must either be lifted or unzipped in order to gain access to the bag and this is probably the best area to consider when trying to think of a suitable sensor.

A small magnet mounted on the handbag flap or zipper and a reed switch secured on the body of the bag would appear to be the simplest solution. These components can be very small thus enabling them to be fitted unobtrusively in the bag.

Whilst the magnet is in close proximity to the reed switch, the contacts will be held closed and arranged to keep the alarm disabled. When the magnet is removed by lifting the flap or undoing the zip, the contacts will open thus triggering the alarm. Some handbags even have a magnetic clasp to hold the flap closed and if this is the case, it may be possible to utilise this magnet and save having to fit another one while the reed switch would be mounted in the bag and connected to the alarm unit via a small jack plug.

Another possibility, especially if the suggested case which has a "belt-clip" is used, is to mount the reed switch on the clip itself. This alarm unit can then be clipped to the bag under the flap (to which a magnet would be attached) thus removing the need for separate sensors or plugs and sockets.

IN SECRET

Naturally, the owner has to be able to get into her bag without the alarm being triggered and this can be simply achieved by having a secret push-to-make switch, which is pressed while undoing the bag, to mute the alarm. This would need to be unobtrusively fitted to the bag in a convenient position to enable it to be easily operated when required and this can also be connected to the unit via a lead terminated with a jack plug.

Here again, a switch of some sort mounted on or in the alarm unit itself would be preferable as this would make for a self-contained unit which could easily be transferred from bag to bag as required, without any modifications to the bags other than the fitting of a small magnet. In the prototype for example, a tilt switch was used for this purpose. These consist of two contacts mounted in a sealed chamber which contains a small globule of Mercury and this was arranged so that with the unit clipped into position in the bag, the contacts remain open. *(It is strongly recommended that a non-mercury tilt switch is used – see the* Shoptalk *page.)*

To operate the switch, the bag is tilted horizontally thus causing the mercury to move and bridge the contacts inhibiting the alarm. The arrangement illustrated in Fig.1 shows some possible solutions, although as mentioned previously, the final method adopted will depend largely on the handbag which is to be protected.

Another ploy adopted by some thieves when confronted by someone wearing a shoulder bag is to simply cut the strap and slip the whole bag from the victim. To protect against this eventuality, a thin wire could be threaded through or attached to the strap forming a normally closed loop. This may not be possible in all cases but if it is, this could be connected to the alarm just like another reed switch sensor via a jack plug.

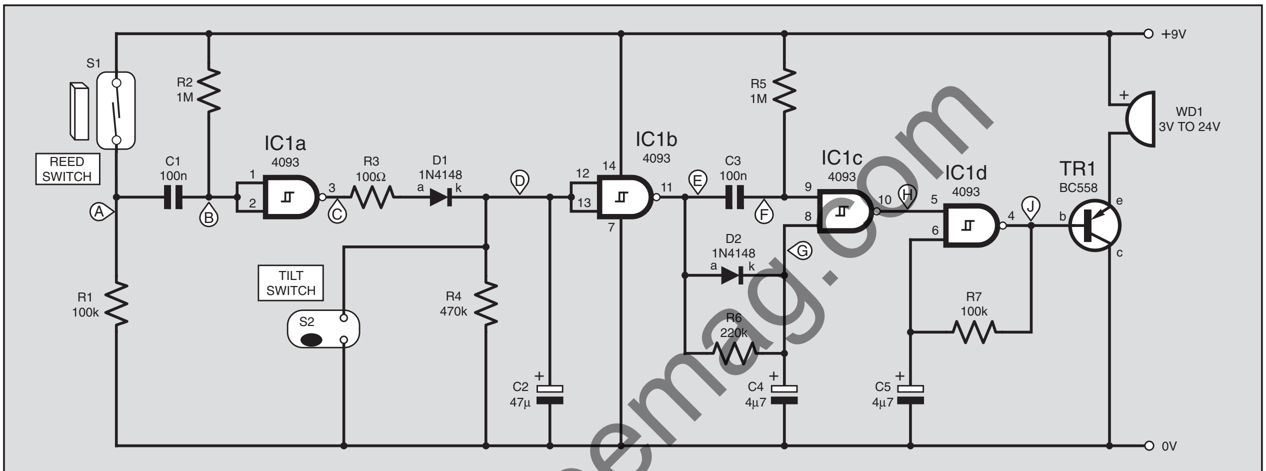


Fig.2. Basic circuit diagram for the Pickpocket Alarm. The ringed letters are the "take-off" points for the waveforms shown in Fig.3.

DELAYED ACTION

To save fitting further switches to disable the alarm, especially in the event of a false alarm due to the owner forgetting to operate the secret mute switch before opening the bag, this switch should also switch off the alarm even after it has been activated. To save unnecessary embarrassment in this eventuality, the circuit has been designed so that operating the secret switch will instantly reset the circuit.

If the mute switch is not closed when the bag is opened, the alarm will sound briefly but will then mute for a short period (about one second) allowing it to be reset. If the switch is still not pressed following an alarm condition (usually because the thief will not know of its existence), the alarm will then continue to sound for a period of 20 seconds. This should be long enough to cause any pickpocket to beat a hasty retreat but if this is considered too short or too long a time, it can easily be altered by a simple change in a component value.

Ideally, there should be no need to arm the circuit and the alarm should interfere as little as possible with the normal use of the bag. This circuit automatically arms itself, requiring no special procedures to be followed, when the bag is closed and once open, it can be left in this condition indefinitely without the alarm going off. Only at the instant of it being opened does the user have to operate the secret mute switch to ensure that the alarm does not sound.

CIRCUIT DETAILS

The basic circuit diagram for the Pickpocket Alarm is shown in Fig.2. Circuit modifications to give a full 20 seconds alarm time out is given in Fig.4.

Rather than attempting to re-invent the wheel with oscillators and speakers, a ready made piezo sounder, WD1, is specified to produce the alarm itself These are readily available and produce a loud piercing sound over a range of supply voltages from 3V to 12V or more, making them eminently suitable for use with a 9V battery supply. The sounder WD1 is switched on by transistor TR1 which itself is controlled by a simple oscillator built around IC1d. This causes WD1 to switch on and off at around 1Hz when an alarm condition has been registered, producing a much more distinctive pulsating signal, further unnerving the would-be thief who will, no doubt, already be on edge no matter how experienced he or she may be.

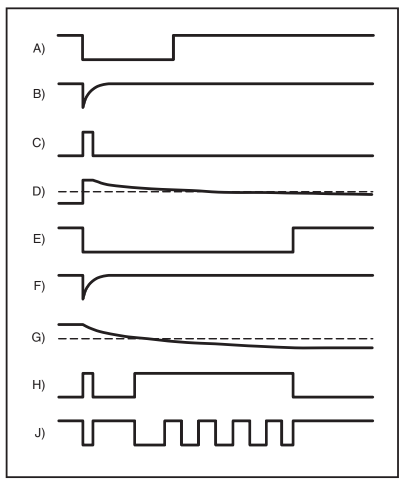


Fig.3. Typical waveforms at various points on the circuit.

Referring to the circuit waveforms illustrated in Fig.3, the output of gate ICld charges and discharges capacitor C5 via resistor R7 causing the output at (J) to switch high and low at around 1Hz switching the sounder WD1 on and off at this frequency, via the driver transistor TR1. The output of oscillator IC1d is normally held high causing the sounder to remain off while the output of gate IClc is low. Since IC1c is a NAND gate, it functions as a NOR gate for negative logic levels so that either of its inputs (F or G) going low will cause its output (H) to go high and serve to enable the oscillator.

STAND-BY

In the stand-by condition, reed switch S1 will be held closed, via the magnet, and the voltage at point A will be at the positive supply rail. When the switch opens, due to the bag being opened, point A will go low and a short negative going pulse will be applied to the input of IC1a, wired as a logic inverter, so that its output (C) will go high briefly.

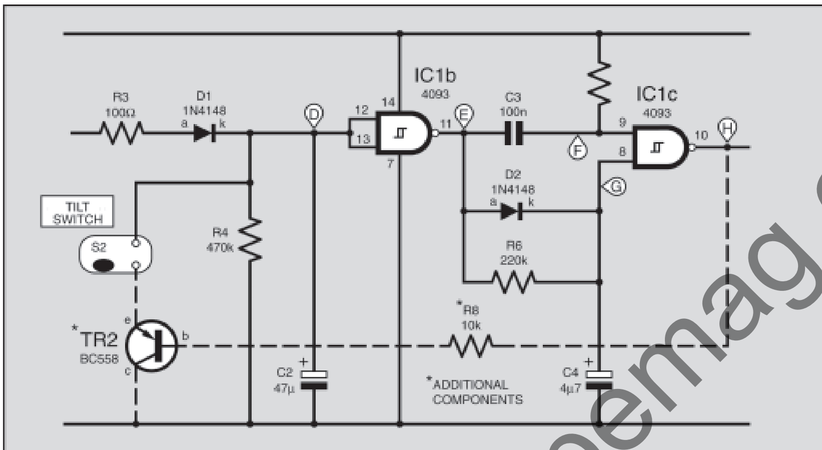


Fig.4. Circuit modifications to prevent alarm reset once triggered.

This will cause capacitor C2 to charge to about 9V via resistor R3 and diode Dl, provided the secret mute switch S2 remains open. If this switch is closed, capacitor C2 will be prevented from charging so that the output of IC1b will remain high and the alarm stays silent.

Assuming that C2 does charge, the input of gate IC1b will go high causing its output (E) to go low. Meanwhile, the output of IC1a will have gone low again and with diode Dl now reverse biased, capacitor C2 will commence discharging via resistor R4 so that output E will remain low for around 20 seconds. This time can be increased or decreased by increasing or decreasing the value of R4 and if very much longer alarm times are required, the value of C2 could also be increased.

While the output of gate IClb is high, capacitor C4 is charged to 9V via diode D2 so that both inputs of IClc are high and the alarm muted, but when this output goes low, point G will also go low briefly and so during this short period the alarm will sound. The values of capacitor C3 and resistor R5 are chosen to make this time about 100ms producing only a short bleep to serve as a warning that the bag has been opened.

If the secret switch is now operated, capacitor C2 will be instantly discharged causing the output of gate IC1b to go high again and the circuit will revert to its stand-by condition. This gives the legitimate user a second chance to switch off the alarm should they forget to do so while opening the bag. The thief, not knowing about the secret switch, will, of course, not do this and when capacitor C4 discharges via resistor R6 (which should take a further second or so) the other input of IClc (point F) will go low causing the alarm to sound until C2 has eventually discharged.

The alarm can still be silenced in this condition by operating the secret switch and this could be considered a disadvantage especially if a tilt switch is used to provide this function. This could be activated inadvertently by the thief if he attempted to snatch the bag despite the alarm going off. Since this alarm is only intended to provide a warning to the user and hopefully scare off the attacker, should matters progress to this point it would probably be best to allow the bag to be taken rather than risk injury if violence is threatened, in which case it would be immaterial whether the alarm continued to sound or not.

FULL TIME

If, however, you would prefer to have the alarm sound for the full 20 seconds or so, the circuit should be modified to include transistor TR2 and resistor R8 as shown in Fig.4. (Note that this modification is not shown in the circuit board layout drawings, but there should be plenty of room on the board for the two additional components.)

In normal operation when the alarm is not sounding, transistor TR2 will be turned on and will therefore have no effect on the operation of the circuit. Once the output of IC1c goes high and the alarm sounds however, TR2 will be turned off thus preventing switch S2 from discharging capacitor C2 causing the alarm to continue for its full term. Should this occur accidentally, the legitimate owner will also be unable to switch off the alarm and in this situation it may be a good idea to fit another reset switch on the alarm unit itself connected directly across C2.

The waveforms appearing at various points in the circuit, shown in Fig.3, should help in clarifying the operation of the circuit. The dotted lines signify the input threshold voltage of the CMOS gates within IC1 above which logic high is recognised.

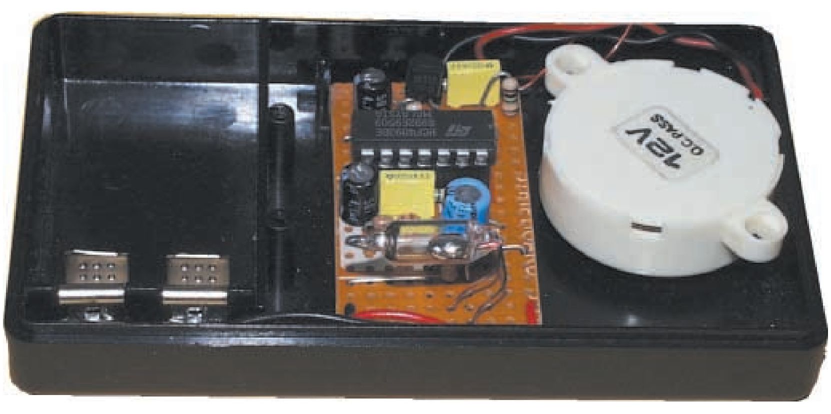
For clarity, this is shown as one voltage level at about half of the supply but in fact, the gates in the CMOS 4093 specified are Schmitt triggers which means that the input thresholds are different for rising and falling input voltages. This characteristic is very important in this circuit and apart from making the outputs switch cleanly even with slowly rising or falling input voltages, it makes it possible for ICld to function as an oscillator.

CONSTRUCTION

There are perhaps as many ways to build this circuit as there are types of handbag on the market so that the following should be regarded only as a guide. While the solution presented should be suitable for a great many types, it is best to consider first how and where the sensors will be mounted and only when this has been done should the construction of the unit begin.

If the sensor(s) and/or a reset switch are to be mounted on the bag itself, these should be fitted with jack plugs or some other type of connector with matching sockets on the alarm box. This will allow the alarm to be disconnected from the bag and fitted to another as occasion demands.

If a number of sensors are required (because the bag has multiple pockets or compartments for example) these should be wired in series so that any one sensor operating will cause the input to go low. For this reason too, any sockets fitted to the box should be switched types and arranged to short out should the sensor not be plugged in.



Internal view showing the battery contacts and siting of the alarm buzzer.

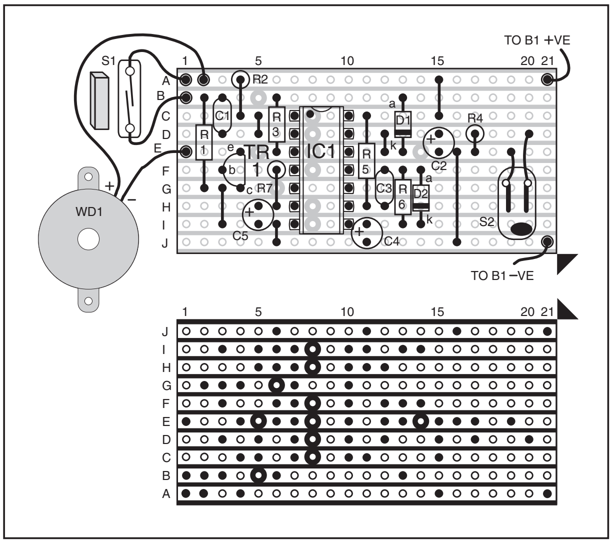
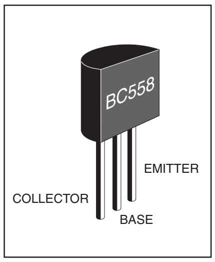


Fig.5. Stripboard component layout, off-board wiring and details of breaks required in the underside copper strips. The transistor pinouts are shown inset right.



COMPONENTS

Resistors

R1, R7	100k (2 off)
R2, R5	1M (2 off)
R3	100Ω
R4	470k
R6	220k
R8	10k (see text)

All 0·25 5% carbon film

See SHOP TALK page

Capacitors

C1, C3	100n polyester (2 off)
C2	47µ radial elect. 16V
C4, C5	4µ7 radial elect. 63V (2 off)

Semiconductors

D1, D2	1N4148 signal diode (2 off)
TR1, TR2	BC558 *pnp* transistor (2 off – see text)
IC1	4093 quad 2-input NAND Schmitt trigger

Miscellaneous

WD1	3V to 30V d.c. piezoelectric buzzer
S1	sub-min, normal open, reed switch with magnet
S2	tilt switch, non-mercury type if possible – see text

Stripboard, size 21 holes x 10 strips; plastic case, size 103mm x 62mm x 23mm, with battery compartment and pocket clip; 14-pin d.i.l. socket; 9V (PP3) battery; connecting wire; optional 3·5mm switched mono jack socket, with plug (see text); solder etc.

Approx. Cost Guidance Only **£9** ***excluding batt.***

CIRCUIT BOARD

The stripboard topside component layout and details of breaks required in the underside copper tracks are shown in Fig.5. This board accommodates all of the components except the battery, sounder and optional jack sockets for connecting the sensors and the secret reset switch (if fitted). These are connected to the board by flying leads.

With this form of construction, it is just as important to break any connections that are not required as it is to make those that are and so construction should begin with breaking the copper tracks at the points indicated. This is best done with a special tool available for this purpose or by simply using a handheld 2·5mm twist drill. There are 10 track breaks required.

Once this has been done, the components may be fitted as shown. Note that there are a total of six links required and these can be made from discarded resistor leads.

As IC1 is a CMOS device, it is therefore prone to damage by static so it is best to use a 14-pin i.c. socket for this component. The i.c. being plugged in after all the other components have been fitted and the soldering completed. When inserting the i.c. ensure that it is inserted the correct way around.

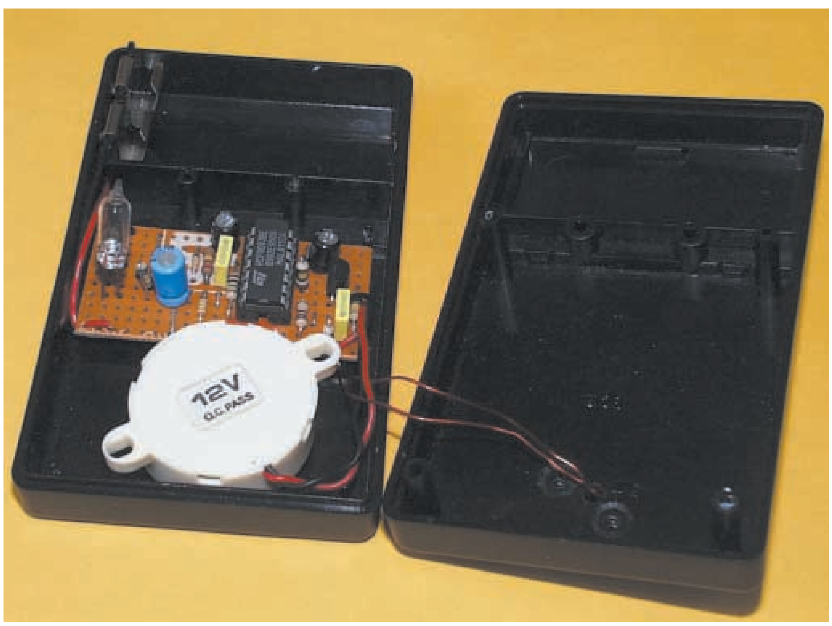
As mentioned, IC1 is a CMOS quad Schmitt NAND gate type 4093. Some readers may have a spare quad NAND gate type 4011 which, although having the same logic function and pinouts, is **not** suitable for use in this circuit.

Also, double-check that the transistor TR1 (and TR2 if used), diodes Dl and D2 and capacitors C2, C4 and C5, which are electrolytic devices, have been soldered on the board the correct way round. The electrolytics are normally marked either with a grey stripe on the body or a negative sign (sometimes both) adjacent to the negative lead which should be connected to 0 volts or the battery negative terminal. Transistor TR1 is a *pnp* device and although a BC558 has been specified, virtually any small *pnp* device can be used.

BOXING UP

The box specified has a battery compartment suitable for a PP3 type battery and special battery contacts which clip into the box are supplied. Red and black wires should be soldered to these contacts before they are fitted into the box and the free ends then connected to the appropriate points on the board.

It may be possible to fit the sounder inside the box in which case a suitable hole should be drilled in the box adjacent to it to allow the sound out and prevent it from being unduly attenuated. Some sounders (usually the louder ones) will be too large to fit inside the box in which case they will need to be mounted on the box or perhaps even remote from it. While a loud sound is of course preferable, especially as it is likely to be attenuated by being inside the bag, a reasonably loud volume will no doubt alert the user should any attempt to open the bag be made.



Completed unit showing general positioning of components and leads going to the clip-mounted reed switch on the outside of the case.

Outer face of the "handbag/pocket" clip (above left) showing position of the magnet-operated reed switch and (above right) the inner face showing the switch wiring, which passes through a hole in the case to the circuit board.

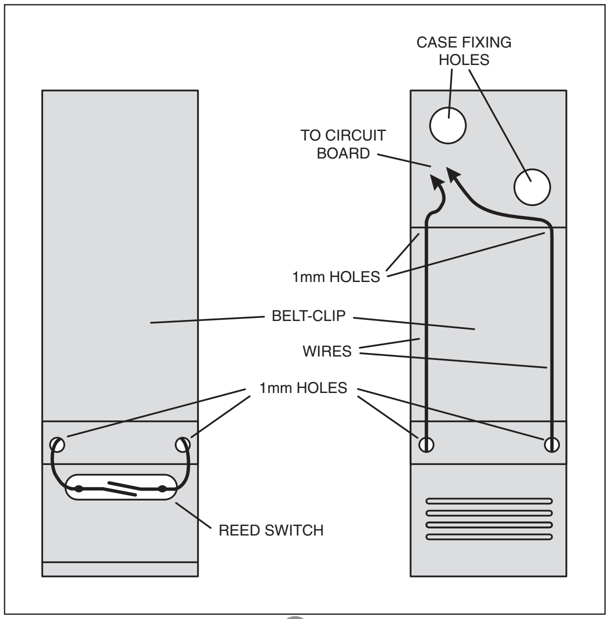


Fig.6. One suggested method of mounting and wiring the magnet-operated reed switch on the case belt-clip.

BELT-UP

The box also has provision for a "belt-clip" which can be mounted by drilling two 5mm holes in the positions marked and securing it with the screws provided. This will provide the possibility of clipping the alarm to the bag. Depending on the design of the bag, it may be possible to have the reed switch sensor S1 mounted on the clip itself leaving only a small magnet to be glued to the inside face of the bag flap adjacent to the switch, with further sensors (if required) added by fitting jack sockets as previously mentioned.

If this method of construction is adopted, the "belt-clip" should first be modified by drilling four 1mm holes in it, see Fig.6 and photographs. Two wires (28s.w.g. enamelled copper wire was used in the prototype) can then be passed through these holes and soldered to the reed switch as shown. The leads of the reed switch should first be bent at right angles to match the holes drilled in the clip so that a small neat solder joint can be made.

When bending the leads of the reed switch, extreme care should be taken as it is very easy to crack the glass and destroy the device. The leads must be gripped by a pair of pliers next to the glass body of the device and the bend made about 2mm from the glass seal.

Once the reed switch has been mounted, it should be encapsulated in Araldite to prevent damage. A small hole will also be required in the box adjacent to the two clip mounting holes to enable the wires from the sensor to be passed through for connection to the circuit board.

TESTING

Once assembly is complete, the unit can be tested by connecting a battery and placing a magnet near to the reed switch S1 and then removing it. This should cause the sounder to emit a short "bleep". If no further action is taken, the alarm should now emit a series of intermittent "bleeps" for about 20 seconds before switching off.

Replacing the magnet should have no effect but if it is removed again, the sequence should be repeated but this time the reset switch (S2) should be operated while the magnet is removed and this time no initial "bleep" should be sounded and the alarm should remain off. Finally, the unit should be triggered and reset after the initial "bleep" and once the full alarm has been started to check that the reset switch works in these situations.

If the modification of Fig.4 has been fitted, the reset switch should have no effect once the full alarm is sounding. There are no high frequency voltage changes in this circuit so that if necessary, the voltages at various points in the circuit can be followed by monitoring them with a multimeter and compared against the waveforms shown in Fig.3.

The Pickpocket Alarm can be mounted in a handbag for a final test when the operation of the circuit is satisfactory. A suitable position for the magnet should be found and this should be secured to the flap opposite the reed switch on the clip with a suitable adhesive – see Fig.1.

Hopefully further "field" testing will not be required but should it occur, the thief should be unable to commit his crime quietly, attracting more attention than he bargained for. □