Build it yourself and save money

The microphone: for stage & PA

Pick it up and it automatically switches on. Put it down and it switches off. This high-quality microphone can be built for half the cost of comparable commercial units and boasts several novel features.

by BRANCO JUSTIC

Build a microphone you say? You've got to be kidding. You don't make microphones, you buy them ready made. Perhaps this is some kind of joke?

Well, we're not kidding. The microphone to be described here offers a performance that can only be equalled by expensive commercial units. It is very easy to build, you can buy all the parts for less than $20, and it boasts a list of impressive features:

■ Automatic switch on/switch off: pick "The Microphone" up, and it switches on automatically. Put it down, and it switches off automatically after a couple of minutes (can be extended to 20 minutes if required).

■ Inbuilt battery check: if you touch one of the metal screws on the base of the unit, a LED will light up to indicate that the battery voltage is OK.

■ Omnidirectional or unidirectional pickup: you can build the unit to suit your requirement simply by ordering the appropriate electret insert.

■ Output level selection: during construction, you can set the output level from a few millivolts all the way up to line level. Thus, the microphone can drive the sensitive inputs of stage and audio mixers, the auxiliary inputs of hifi amplifiers, and instrument amplifiers (ie, it can drive any amplifier).

■ Inbuilt equalisation: the internal circuitry is equalised to compensate for the usual lack of bass which is apparent with most electret inserts. This equalisation, or bass boost circuit, can easily be disabled if not required.

■ Low power consumption: the microphone consumes approximately one milliampere when it's on and an unmeasurably low current when it's off. The internal (alkaline) battery should last the length of its shelf life.

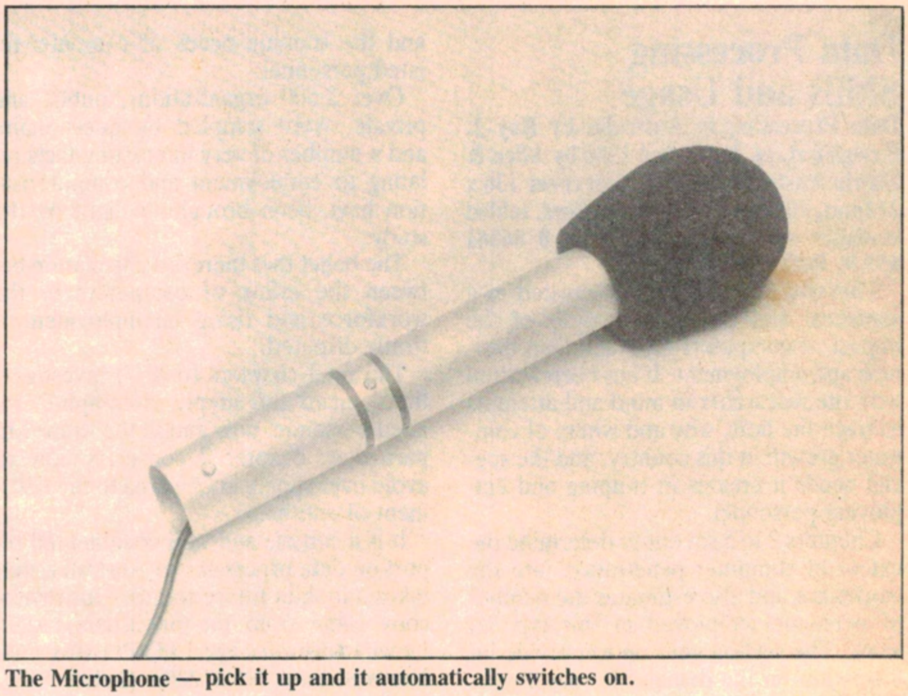
Electret microphone inserts

Electret microphone inserts have been available from electronic parts retailers for some years now. Most fall into the omnidirectional category which means that they pick-up sound equally from all directions.

They also offer good frequency response and sensitivity and are suitable for 'general purpose' and recording situations. However, they are not generally used in public address and live entertainment situations because they are prone to acoustic feedback.

Recently, at least one type of unidirectional microphone insert has become available from component dealers. These are more suitable for stage and PA work because they pick-up sound predominantly from one direction; ie. directly in front of the microphone insert.

It should be noted that these units also



The Microphone — pick it up and it automatically switches on.

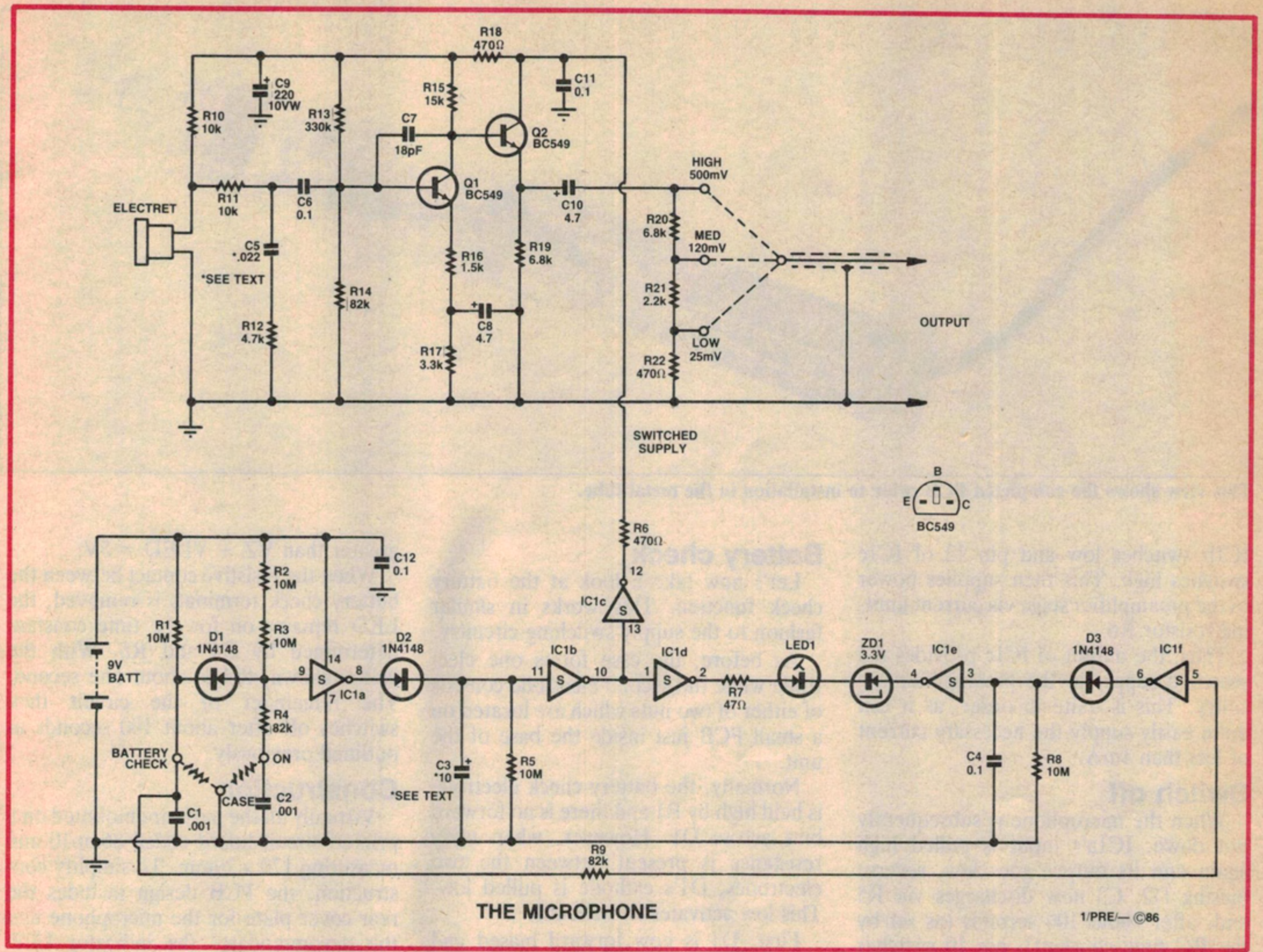


Fig.1: Q1 and Q2 form the microphone preamplifier while IC1 makes up the touch-controlled logic circuit.

fall into the close working category. They exhibit good sensitivity only when the sound source is very close to the microphone (around 20cm or less).

This brief description will help you to decide which type of electret insert is the most suitable for your application. Either type may be specified when you order the parts for this project.

How it works

Fig.1 shows the circuit diagram. It can be broken into two sections: a two-stage microphone preamplifier based on Q1 and Q2, and a touch-controlled logic circuit based on hex Schmitt inverter IC1. We'll begin with the microphone preamplifier.

The action starts at the electret insert at the extreme left of the circuit. R10 provides biasing for the FET buffer stage inside the electret, the output of which is coupled to an equalisation circuit consisting of R11, C5 and R12. This provides approximately 8dB of bass boost.

If, however, a flat frequency response is desired, the bass boost feature can be disabled by replacing C5 with a 0.1uF monolithic capacitor.

The output of the equaliser is coupled to common emitter amplifier stage Q1 via capacitor C6. This stage has a fixed gain of approximately 20dB and its output is directly coupled to the base of Q2 which, with its associated components, serves as an emitter-follower.

The addition of this latter stage gives the microphone a low output impedance. This is to ensure that high frequency components are not attenuated when the preamplifier output is connected to very long coaxial cables (50 metres or more). C8 rolls off the low frequency response of the common emitter stage (Q1) below 20Hz.

Finally, the signal at the emitter of Q2 is coupled via C10 to an attenuator network (R20, R21 and R22). This attenuator enables the constructor to select one of three different output levels: 25mV for low impedance microphone inputs on public address amplifiers and mixers; 120mV for high impedance inputs on PA amplifiers and instrument amplifiers; or 500mV for line inputs of hifi amplifiers etc.

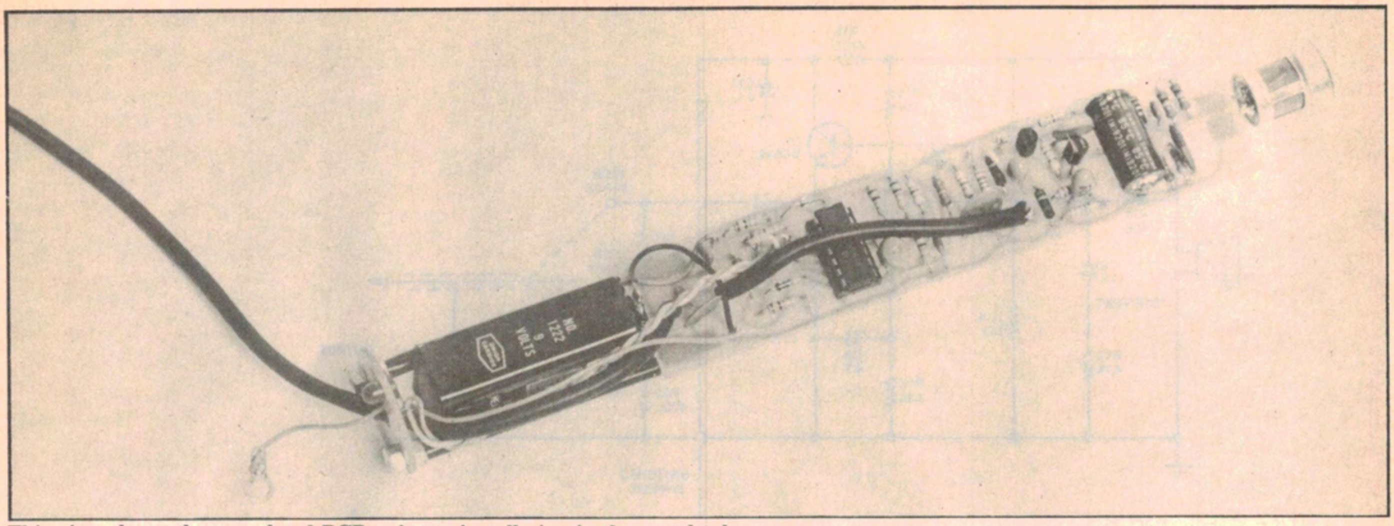
Touch control circuitry

The touch control circuitry switches the supply to the microphone preamplifier, and provides the battery check function. Here's how it works:

With no hand contact, pin 9 of IC1a is pulled high via R2 and R3. This means that pin 8 will be low and, since pin 11 of IC1b is pulled low by R5, pin 12 of IC1c will also be low. Thus, no power will be supplied to the microphone preamplifier.

When the microphone is picked up, the user's hand bridges two electrodes. One of these electrodes is formed by the metal case of the microphone, while the other consists of a 1cm-wide collar which is wrapped around the case but insulated from it with plastic tape.

The hand resistance between the 'on' terminal (metallic strip) and the case pulls pin 9 of IC1a low via R4 and thus pin 8 switches high. Capacitor C3 now quickly charges via D2 and so pin 10 of



This view shows the completed PCB prior to installation in the metal tube.

IC1b switches low and pin 12 of IC1c switches high. This then supplies power to the preamplifier stage via current limiting resistor R6.

Thus, the output of IC1c provides the switched supply to the preamplifier circuitry. This is quite in order, as it can quite easily supply the necessary current of less than 1mA.

Switch off

When the microphone is subsequently put down, IC1a's input is pulled high again and its output goes low, reverse biasing D2. C3 now discharges via R5 and, after about 100 seconds (as set by the RC time constant), pin 10 switches high and pin 12 of IC1c goes low.

Result: the microphone stays on for approximately 100 seconds after the removal of hand contact. This time constant can easily be extended to around 20 minutes by using a higher value for C3. This will allow the microphone to be used in a stand for quite long periods of time between hand contacts.

Note that C3 should be either a low leakage aluminium or tantalum electrolytic.

Battery check

Let's now take a look at the battery check function. This works in similar fashion to the supply switching circuitry.

As before, the case forms one electrode while the second electrode consists of either of two nuts which are located on a small PCB just inside the base of the unit.

Normally, the battery check electrode is held high by R1 and there is no forward bias across D1. However, when body resistance is present between the two electrodes, D1's cathode is pulled low. This low activates two circuits.

First, D1 is now forward biased and pulls pin 9 of IC1a low. This switches the microphone on for 100 seconds (if it isn't already on) as outlined above. During this time, pin 12 of IC1c is high and so pin 2 of IC1d is also high.

Second, the output of IC1f (pin 6) switches high and quickly charges C4 via D3. Pin 4 of IC1e thus switches low and the full battery voltage is applied across R7, LED 1 and zener diode ZD1. The LED will light to indicate that the battery is OK as long as the supply voltage is greater than VZ + VLED = 5V.

When the resistive contact between the battery check terminals is removed, the LED remains on for the time constant determined by C4 and R8. With the values shown, this is about one second. The remainder of the circuit then switches off after about 100 seconds as outlined previously.

Construction

Virtually all the parts are mounted on a printed circuit board coded 86mp10 and measuring 170 x 29mm. To simplify construction, the PCB design includes the rear cover plate for the microphone and this accommodates the indicator LED and the battery check terminals.

The battery check terminals simply consist of two nuts which secure the cover PCB to two 70mm-long threaded rods. These rods, in turn, are soldered to large copper pads at one end of the main board.

Begin construction by enlarging several holes in the PCB to the diameters indicated in Fig.2. This done, cut along the required line to separate the main PCB and rear cover. The rear cover PCB can

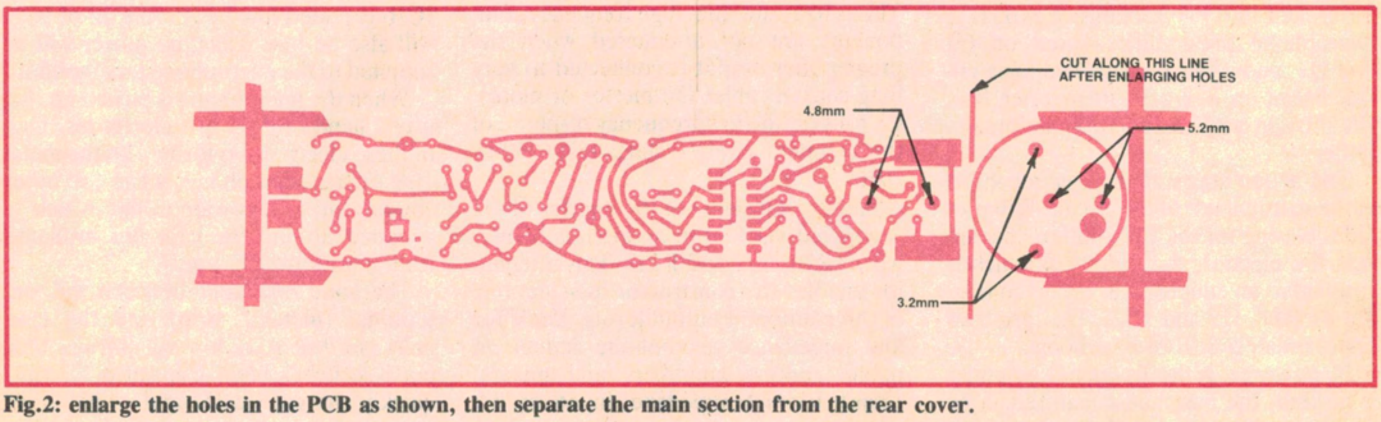


Fig.2: enlarge the holes in the PCB as shown, then separate the main section from the rear cover.

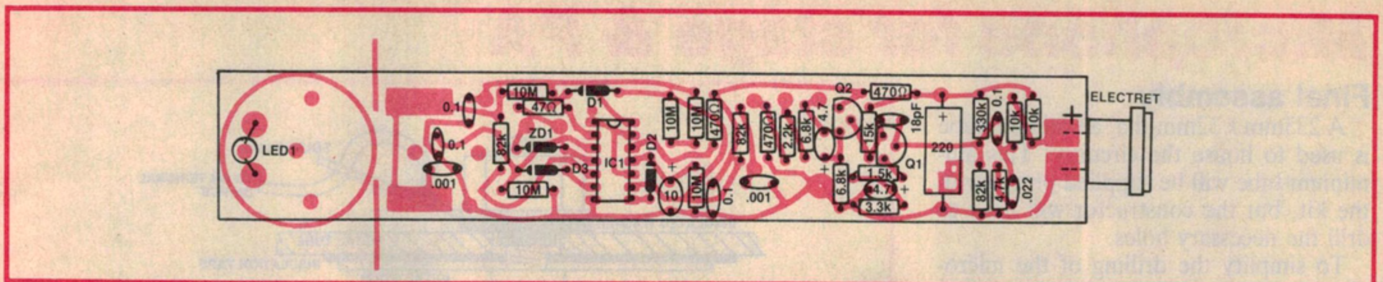


Fig.3: follow this parts layout diagram when installing the parts on the two PCBs.

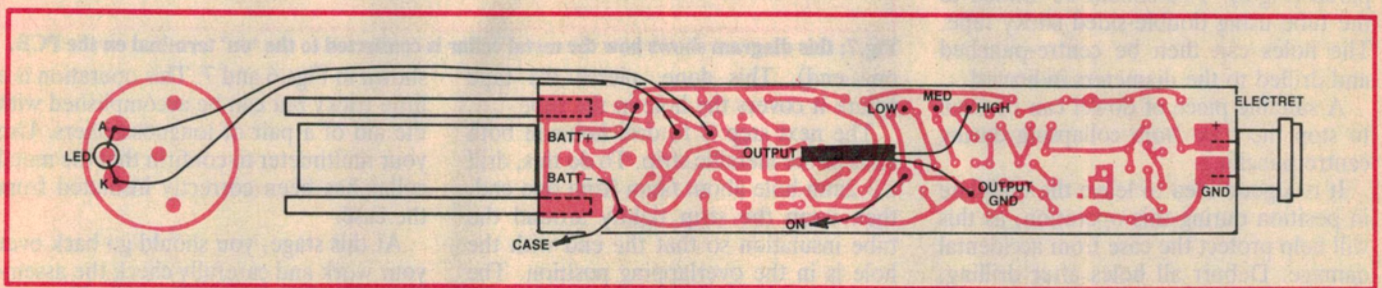


Fig.5: wiring detail for The Microphone. Use shielded microphone cable for the output lead.

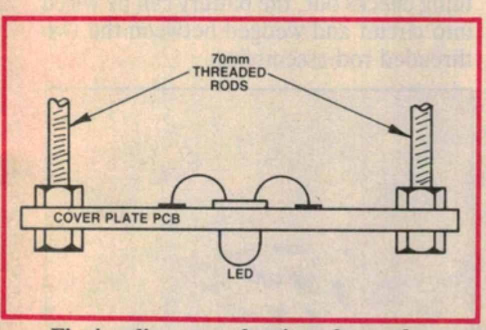


Fig.4: diagram showing how the two threaded rods are fastened to the cover plate PCB.

then be cut and filed to a circular shape about 28mm in diameter.

Fig.3 shows the parts layout on the two PCBs. No special procedure need be followed when installing the parts but watch the orientation of the semiconductors and the electrolytic and tantalum capacitors. Also, push the transistors down onto the board as far as they will comfortably go before soldering the leads. An IC socket was used for the prototype but this can be considered optional.

The electret insert is supported on two stout pieces of tinned copper wire. These, in turn, are soldered directly to the copper side of the PCB. Bend the leads at right angles so that the insert is centrally located as shown in Fig.6.

The next step is to mount the LED and the threaded rod assemblies on the cover PCB as shown in Figs.3 and 4. This done, slide two 53mm x 3mm-dia. plastic sleeves over the threaded rods. The rods can then soldered to the pads provided on the main PCB (note: tin the PCB pads first).

The remainder of the wiring can now be completed as shown in Fig.5 but don't connect the battery at this stage. The large holes in the main PCB act as a clamp for the shielded output cable (see Fig.6). We connected the inner conductor to the high level output terminal but you can also choose either the low or medium level outputs to suit your particular requirements.

Note that the lead to the metal collar for the switch-on function is soldered to a PC stake on the copper side of the PCB, and should be about 250mm long. Terminate the free end of this lead with a solder lug.

The other external lead is the earth lead. This should be about 115mm long and is routed through the hole in the centre of the cover plate PCB, along with the microphone cable. It should also be terminated with a solder lug.

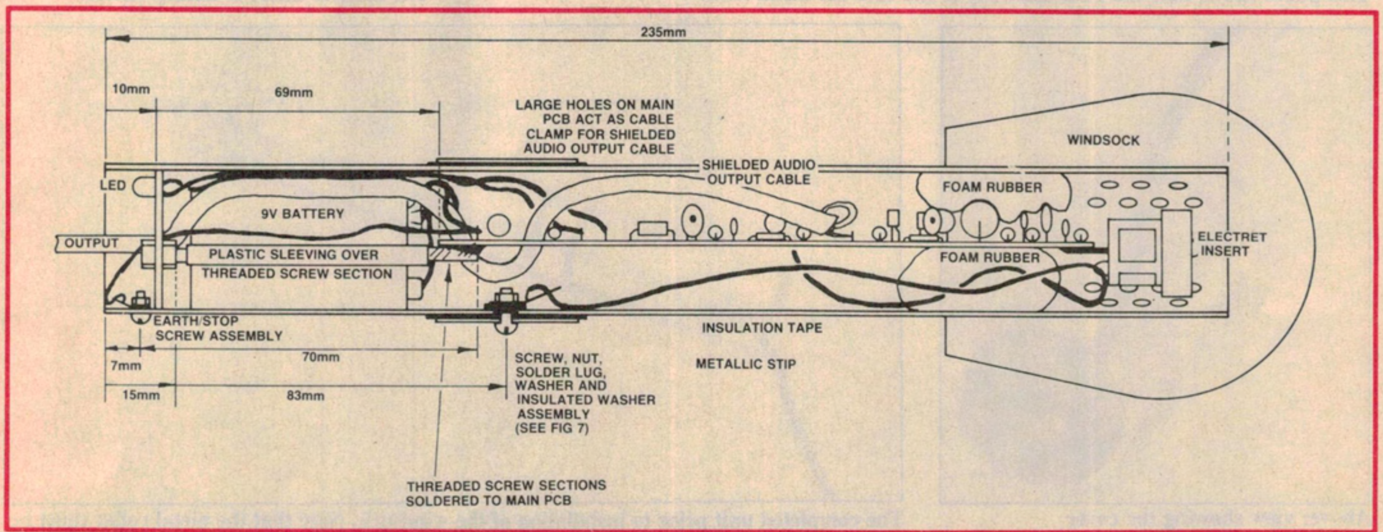


Fig.6: how it all goes together. Note routing of output cable and foam rubber packing.

Microphone for stage & PA

Final assembly

A 235mm x 32mm-dia. aluminium tube is used to house the circuitry. This aluminium tube will be supplied precut with the kit, but the constructor will have to drill the necessary holes.

To simplify the drilling of the microphone case, a template has been prepared (Fig.8). This should be affixed to the tube using double-sided sticky tape. The holes can then be centre-punched and drilled to the diameters indicated.

A suitable piece of dowel can be used to stop the tube from collapsing during centre punching.

It is a good idea to leave the template in position during this operation, as this will help protect the case from accidental damage. Deburr all holes after drilling, then wrap a couple of layers of insulation tape around the tube where the metallic strip is to be mounted (ie, so that it covers the single hole located about 80mm from one end). This done, pierce the tape where it covers the hole in the tube.

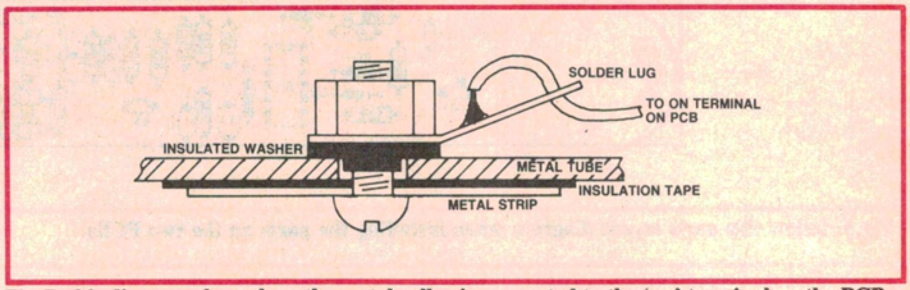
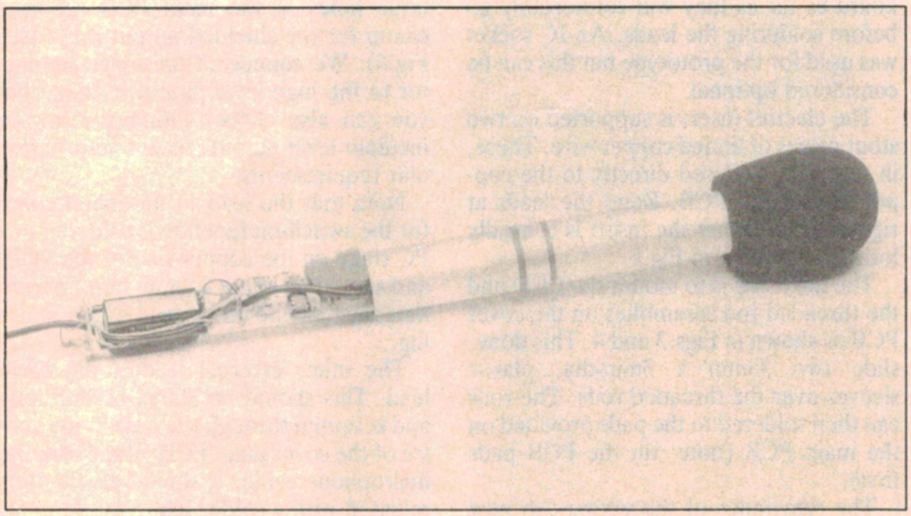


Fig.7: this diagram shows how the metal collar is connected to the 'on' terminal on the PCB.

The next step is to drill holes in both ends of the metallic strip. To do this, drill a 3.2mm hole about 6mm from one end, then wrap the strip tightly around the tube insulation so that the end with the hole is in the overlapping position. The location of the second hole can then be marked and drilled to size.

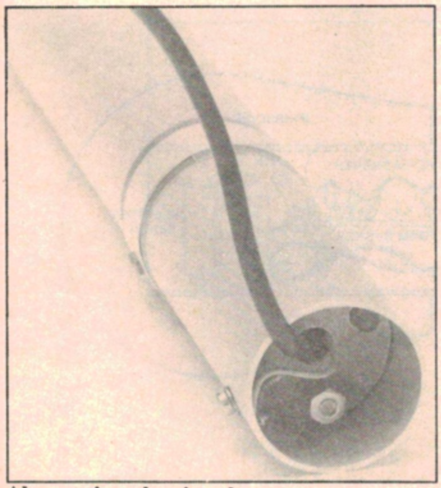
You can now install the metal collar and terminate the lead to the PCB as shown in Figs.6 and 7. This operation is a little tricky but can be accomplished with the aid of a pair of longnose pliers. Use your multimeter to confirm that the metal collar has been correctly insulated from the case.

At this stage, you should go back over your work and carefully check the assembly against the wiring diagram. If everything checks out, the battery can be wired into circuit and wedged between the two threaded rod assemblies.

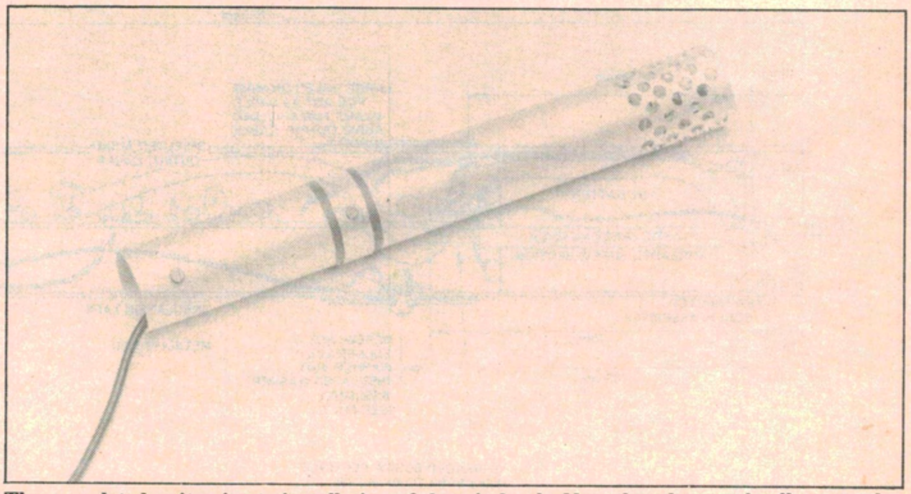


This photo shows how the PCB assembly is slid into the metal tube.

The "business" end of The Microphone. The electret insert is clearly visible.



Above: view showing the cover plate PCB.



The completed unit prior to installation of the windsock. Note that the metal collar must be correctly insulated from the case (see Fig.7).

The PCB assembly can now be slid into the aluminium tube (see Fig.6) and the earth/stop screw assembly installed. Be careful not to short out any of the PCB tracks during this procedure. We used a couple of small pieces of foam rubber as an anti-rattle measure.

Finally, install the windsock and check that the LED on the cover plate PCB lights when you touch one of the adjacent nuts. After that, it's simply a matter of plugging it in and trying it out.

PARTS LIST

- 1 PCB, code 86mp10, 170 x 29mm
- 1 electret microphone insert (see text)
- 1 235mm x 32mm-dia. aluminium tube
- 1 piece of metallic strip, 120 x 12mm
- 1 windsock
- 2 70mm x 3mm threaded rods
- 4 3mm nuts
- 2 53mm lengths of plastic sleeving
- 2 solder lugs
- 1 insulating washer
- 2 machine screws, nuts and washers to suit
- 1 length of shielded microphone cable plus plug to suit

Semiconductors

- 2 BC549 NPN transistors
- 3 1N4148 silicon diodes
- 1 3.3V 400mW zener diode
- 1 red LED (5mm)
- 1 74C14 or 40106 hex inverting Schmitt trigger

Capacitors

- 1 220uF 16VW axial electrolytic
- 2 4.7uF 16VW tantalums
- 1 10uF 16VW tantalum
- 4 0.1uF monolithics
- 1 0.022uF greencap
- 2 0.001uF disc ceramics
- 1 18pF disc ceramic

Resistors (0.25W, 5%)

5 x 10M, 1 x 330k, 3 x 82k, 1 x 15k, 2 x 10k, 2 x 6.8k, 1 x 4.7k, 1 x 3.3k, 1 x 2.2k, 1 x 1.5k, 3 x 470 ohm, 1 x 47 ohm

Where to buy the parts: a kit of parts for this project is available from Oatley Electronics, 5 Landsdowne Pde (PO Box 89), Oatley, NSW 2223. Telephone (02) 579 4985. Price: $19.95 with omnidirectional electret insert; $21.95 with unidirectional electret insert. These prices include pack and post. Note: microphone cable not supplied.

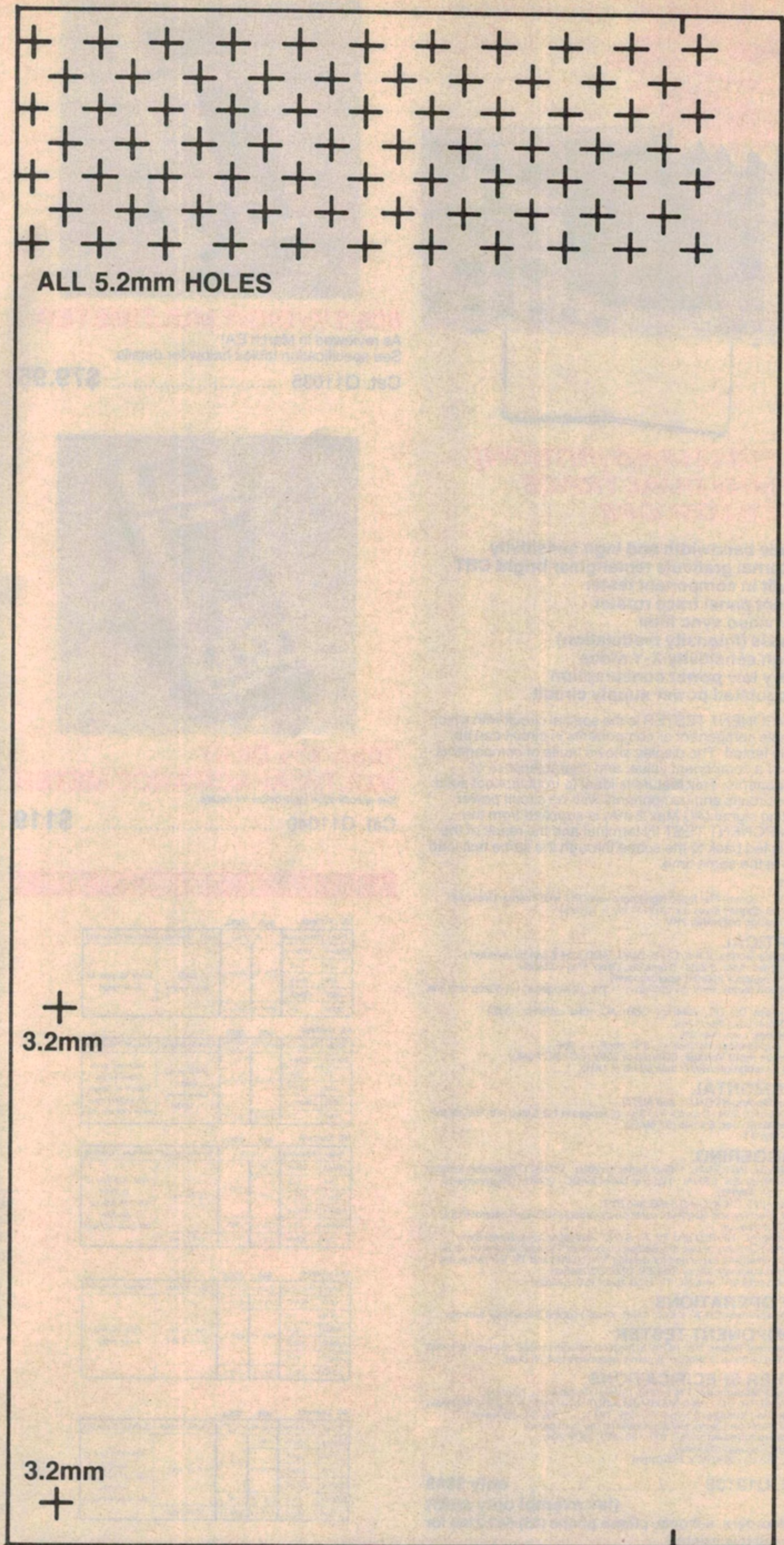


Fig. 8: Use this actual size template to drill the holes in the metal case.