Assembly Manual for the

MICROWAVE OVEN LEAK DETECTOR

K-3095

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While microwave ovens are generally well-designed and safe to use, the human factor (even Murphy's Law) can thwart the manufacturer's efforts and possible unsafe levels of microwave energy may be radiated without warning. Simple and inexpensive to build, this project will indicate if your oven is safe . . .or not.

THE MICROWAVE oven is one of the most recent examples of advanced technology finding application in the home. Many thousand such devices are sold for domestic use in Australia alone each year, while commercial units have long been found in restaurants and snack-bars.

The microwave cooking method, while unlikely to usurp conventional cooking methods, has distinct advantages. It is usually quicker; two to five times quicker in fact. Because it heats the foods directly, but does not heat the bowl or container, the food can be left enclosed. The process is often cleaner and less utensil-consuming as a result. Because the energy penetrates below the surface of a lump of food and does not rely so completely on conduction, it can be used for rapid defrosting of foods. (See "How a microwave oven works").

Unfortunately, the microwave energy is quite dangerous. It must be carefully contained within the cooking chamber. The window is usually sealed to the radiation by a fine metal grille similar to heavy duty fly-screen. The door fits flush and firm, and the instructions warn against allowing any distortion of the door. All ovens have safety circuits preventing the power being applied with the door open. Some ovens have as many as five interlocks against accidental activation without correct door closure. They do not, unfortunately, incorporate an alarm which warns if a leak occurs. This can happen if the door is slightly bent by being closed on a lump of stray food or if damaged during a domestic fracas.

In view of these things it seems wise to have some additional method of checking for leakage.

LEAK DETECTORS

There are some commercial leak detectors available. The most common one is made by the CSIRO. This consists of some circuitry, including a LED, encapsulated in a clear plastic tube. Entirely passive in operation, it illuminates the LED if the integral 62 mm long dipole is exposed to radiation of approximately the safe recommended limit. The CSIRO device is the cheapest available and sells for around $15. In operation it is satisfactory, but has two drawbacks. Firstly, were the hot carrier diode to be destroyed, as could happen for any

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number of reasons, including being exposed to cook strength signal, a 'safe' report would always be given. In other words, the device cannot easily be checked. Secondly, the output is go/no-go. No indication of gradual increase in leakage is available.

So, if leakage from your oven has been gradually getting worse, you won't know until it reaches the level that trips the sensor (admittedly this may still be well below the harmful level).

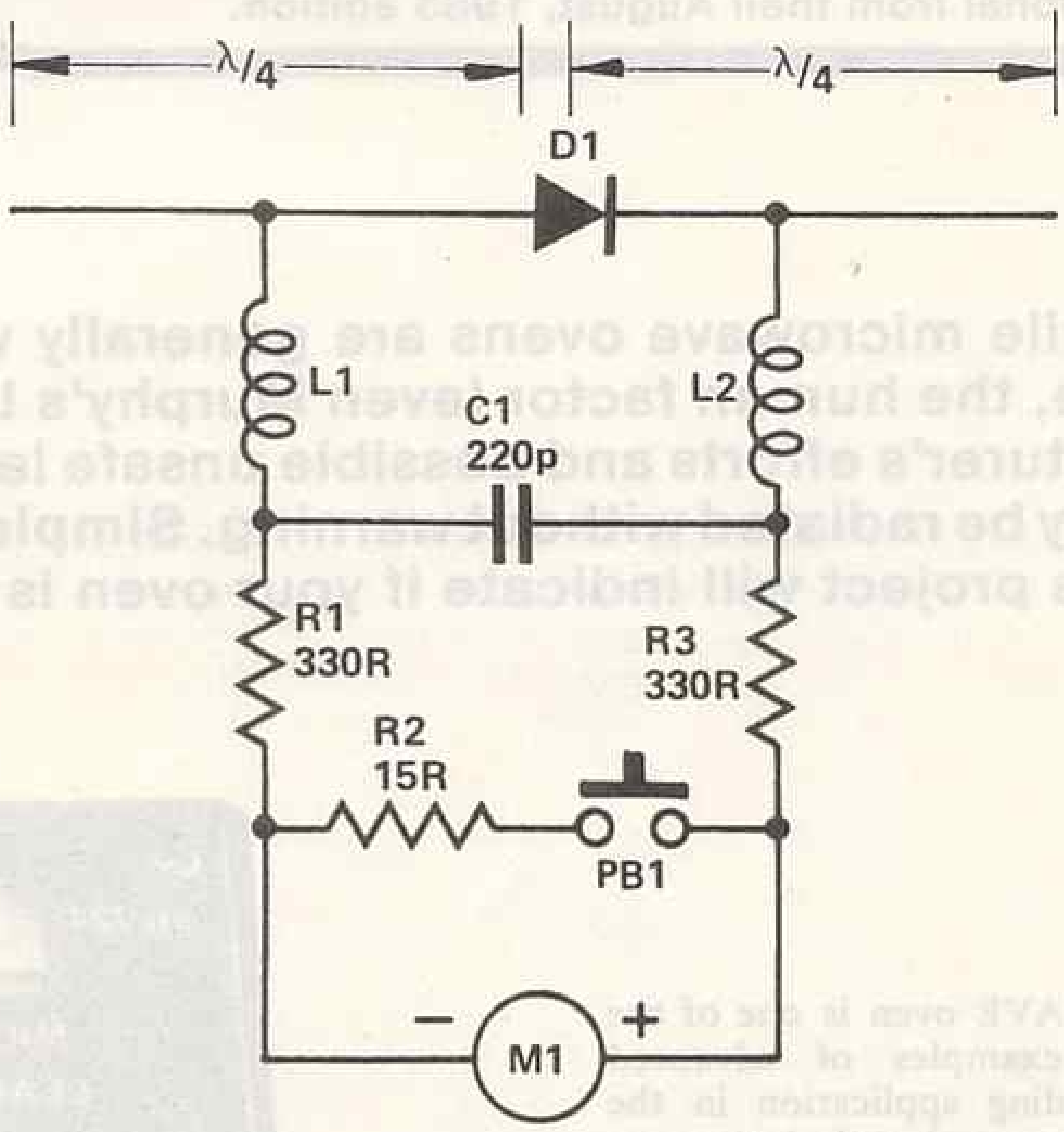
Our design does not suffer from these drawbacks. The output is an analogue meter. This is set to read full-scale deflection (FSD) for a signal of approximately 5 mw/cm^2 in the 'test' mode. Hence, as little as 10% of the danger level can be read.

When the test button is released, the sensitivity increases by about an order of magnitude. In this condition the unit acts like a signal strength meter, and should show some deflection with the normal residual leakage of an oven. This confirms that it is working.

Parts list

- ☐ R2 . . . . 15R (brn-grn-blk)
- ☐ R1, 3. . . . . . 330R (org-org-brn)
- ☐ C1 . . . . 220pF ceramic cap
- ☐ D1 . . . . HP5082 diode
- ☐ PB1 . . . . Push on switch
- ☐ M1. . . . . 250uA panel meter
- ☐ 1x . . . . PCB
- ☐ 1x . . . . Zippy box

Solder, front panel



The two coils (L1 and L2) have been etched onto the PCB as tracks. So you don't have to worry about them at all. The same applies to the aerial.

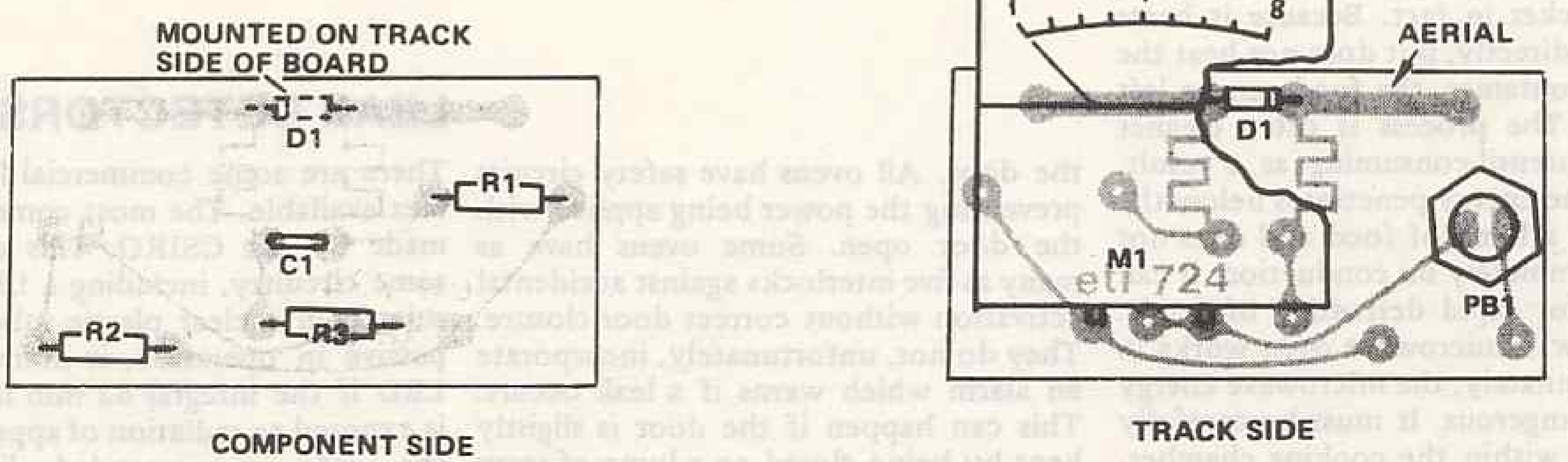
CONSTRUCTION

☐ Construction of the Microwave Oven Leakage Detector is pretty straight forward. However, unless you are very experienced with high frequency work already, it is very important that you adhere to the component overlay and the constructional details given herein.

☐ Commence assembly by soldering the three resistors (R1, 2 and 3) and the capacitor (C1). Once the capacitor has been soldered in, bend it over so that it lies flat on the PCB.

☐ Now turn the PCB over and solder the diode (D1) in place flat against the board in the centre of the dipole. Ensure that the diode is soldered in the right way round. Note that there has not been any holes drilled for the diode. It is simply soldered acress the two pads.

☐ Now turn your attention to the front panel. Firstly lay the front panel label on



Component overlays of both sides of the PC board. Note that the diode is mounted on the COPPER SIDE of the board. It is strongly recommended that the device is constructed using the PC board design shown so that results are consistant with the calibrated prototype.

top of the aluminium lid from the zippy box. Then mark out the four corners for the meter cut-out as well as the centre for the test switch hole. Use a sharp instrument like a centre punch.

☐ After having done that, drill the switch hole to approximately 7mm diameter. The meter cut-out is rectangular and will have to be cut out using a nibbling tool. If you haven't got a nibbling tool, you will have to resort to a more tedious method. This involves drilling a row of small holes - then, with a flat needle file, filing the edges down to a smooth finish, just large enough to let the meter face through.

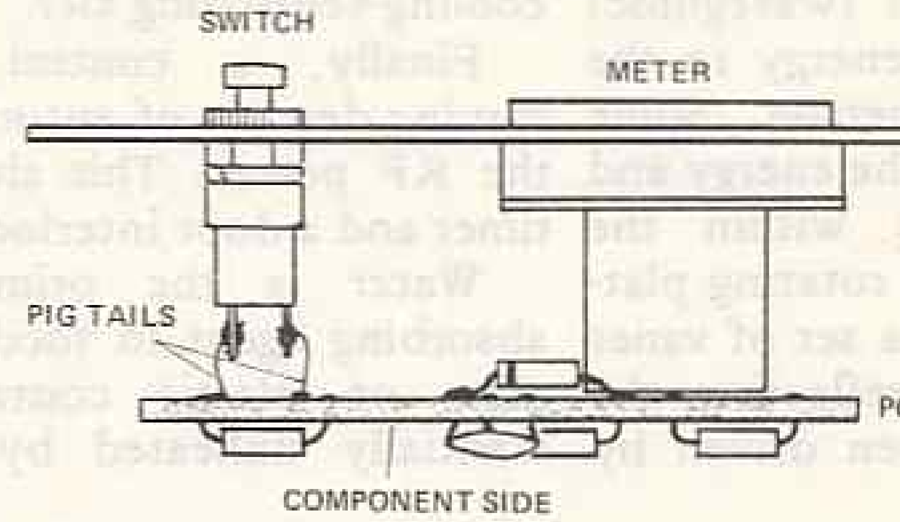
☐ Once you have done the holes peel the backing paper off the front panel label and carefully attach it to the lid, smoothing out any air bubbles as you go along. Now trim the label off where the holes are and your front panel is ready to use.

☐ Next solder the meter to the PCB. The two meter terminals should be bent back so that they protrude from the edge of the meter and lie flat on the pads where they are soldered. Ensure that the meter is soldered as close to the PCB as possible. If it isn't you may find it hard to fit the assembled board in the zippy box. Also make sure that the meter terminals are not shorting to other tracks on the board.

☐ Mount the test switch on the front panel next. Orientate it so that the lugs line up with the pads on the PCB, then tighten the nut. Since the switch is slightly short of reaching the PCB you will have to solder two wire pigtails between the lugs and the pads on the board. Solder the pigtails to the switch terminals first, then feed them through the holes in the PCB as you line up the meter. When all is positioned correctly solder and cut off any excess leads.

☐ Now slide the PCB/meter assembly into the zippy box. You will find that the PCB is very close to the bottom of the zippy box when the front panel is pushed flush with the top of the box. This also helps keep the meter in place.

☐ Your Micorwave Oven Leakage Detector is now ready for testing.



USING IT

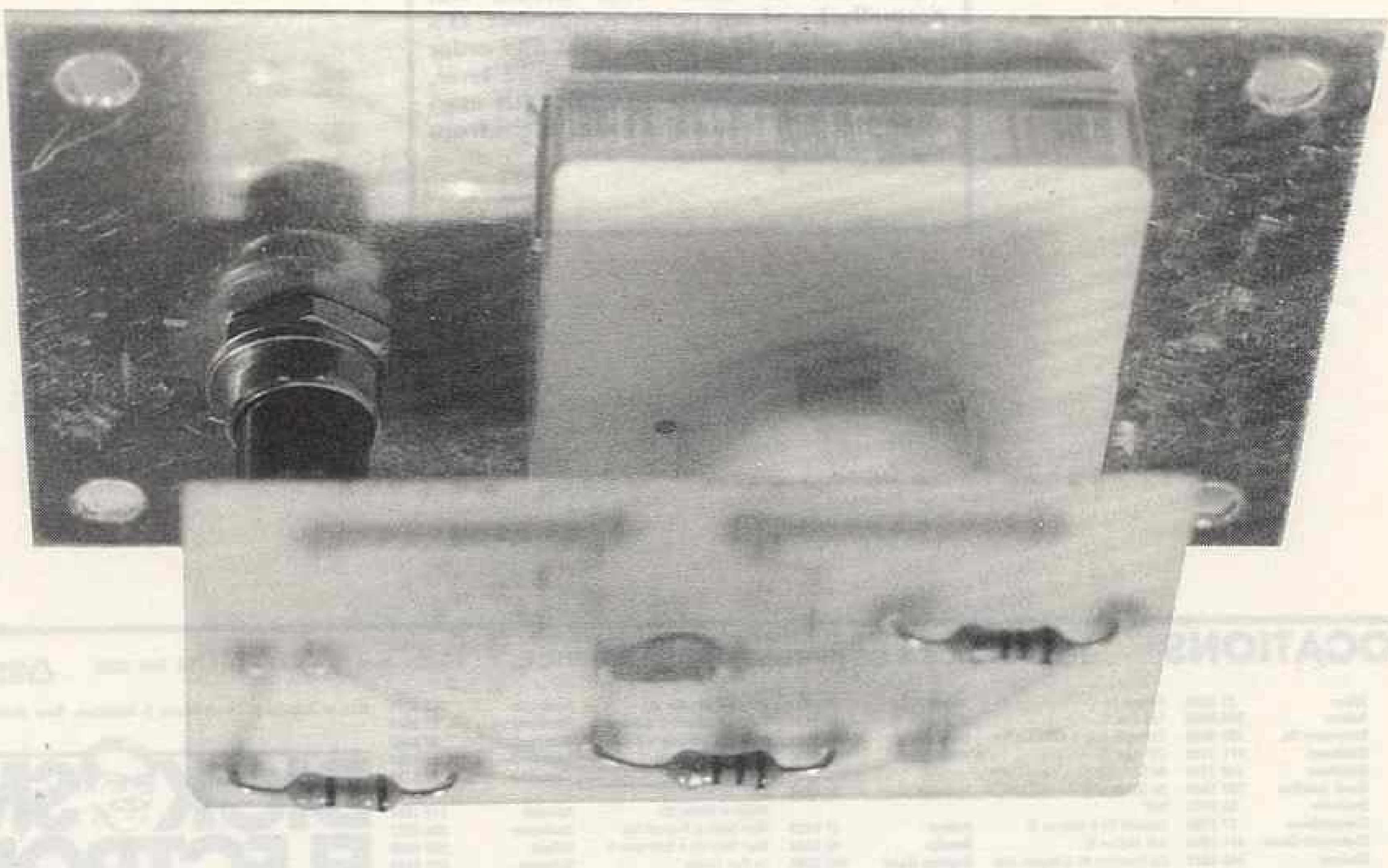
The meter is moved around the door rim with the oven operating, meter facing away, button depressed, the back parallel to the door and spaced approximately 40 mm from the surface.

When testing, it should be moved over the oven in each polarisation, just to be sure. To check if it is working, simply repeat the procedure without depressing the test button. Some erratic flicker of the needle should be evident, indicating correct operation. It can be left on top of the oven when not specifically being used, so that some drastic leak will cause deflection should that occur.

HOW A MICROWAVE OVEN WORKS

There are several separate sections to a microwave oven. Firstly, there is a Magnetron, which is the heart of the system. This is a thermionic device incorporating a resonant cavity. It is an oscillator and will deliver power at super high frequencies (microwave ovens operate on 2.45 GHz). The oven has a power supply incorporating a number of safety interlocks preventing activation in unsafe circumstances.

There is a cooling system for the electronics, usually a fan. The cooking chamber has metal walls and some system of ventilation to remove steam, etc. The one fan is often used to cool



Internal view of the microwave oven leak detector shows the simplicity of construction.

the electronics as well as ventilate the cooking chamber. A duct (waveguide) transfers the microwave energy to the chamber from the magnetron. Some form of disperser spreads the energy and prevents standing waves within the chamber. This is either a rotating platform moving the food or a set of vanes in the chamber ceiling reflecting the beam about. (This is often driven by the fan motor or even the stream of cooling-ventilating air).

Finally, a control panel allows varying degrees of automatic control of the RF power. This always includes a timer and a door interlock.

Water is the primary microwave absorbing agent in food. Dry food and glass or plastic containers are substantially unheated by the radiation. The energy can penetrate to a depth of about 20 mm effectively, though this varies markedly with the food.

Domestic ovens consume about 1200 watts altogether, of which about half appears as microwave power in the food chamber. This, considering the mode of absorption, is considerably more efficient than an ordinary oven which is why the cooking speed is so rapid. ●

HOW IT WORKS – ETI 724

Operation is very simple. The device is completely passive and requires no batteries. It uses the radiated energy from the oven to deflect a meter directly.

The pc board dipole, when exposed to microwave radiation of about 2.5 GHz, develops an ac voltage across D1. When the diode is positively biased the diode conducts, shorting the dipole. When reverse biased it isolates, thus leaving a net voltage on the diode. This DC component is filtered by L1, L2 and C1.

The amplitude of the dc component varies somewhat with the type of radiation from the oven – CW or pulsed, depending upon the supply rectification and filtering used with the magnetron. It will also vary with distance, of course. The Australian safety limit is 5 mW/cm^2 at a distance of 5 cm from the oven. R1, R2 and R3 define the sensitivity, the values chosen being suitable to produce FSD for 5 mW/cm^2 CW at the pc board plane with PB1 closed.

Some variation should be expected from unit to unit. This should not normally be of any concern, however, as a healthy oven will emit at least one order of magnitude less than the 5 mW level, and so the readout is unambiguous even when the unit is not the exact 5 cm from the oven surface.

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