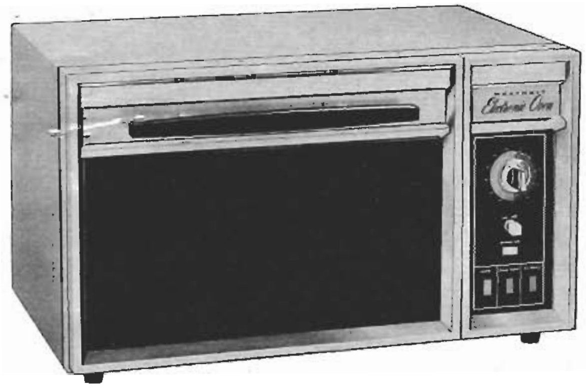


Be Cool: Cook With a MICROWAVE OVEN

By WILLIAM STOCKLIN/Editor

You can cook a frozen TV dinner in 3½ minutes or bake a potato in 4 minutes with the new Heath GD-29 microwave oven.

BUILDING *electronic* kits, particularly for the first few times, is quite a satisfying experience. But if you're looking for a change, as we were, then why not build the new *Heath* microwave oven? There isn't a printed-circuit board in the entire assembly and, except for an avalanche diode, the few solid-state devices are in the pre-built interlock assembly. The kit is basically mechanical—you have a few switches and lamps; a relay, electrolytic capacitor and transformer; and a lot of sheet-metal parts to put together. Anyone can build it, and the odds are that it will work the first time. It took us 10 hours but the average time should be 10-15 hours.

Microwave ovens are not new. The original idea was a spin-off from microwave technology utilizing magnetron design concepts, resonant cavities, and waveguide technology from radar development laboratories. The first commercial designs came out around 1947 and were used in restaurants (shortly thereafter, in vending machines too). Chances are that many who have eaten out or done much flying recently have tasted food cooked by microwaves.

It wasn't until a few years ago, though, that engineering know-how was able to develop an oven for the consumer market that featured compact size, operated off standard 120-V, 15-ampere house power lines, and could be offered for under $500. (Now, of course, we even have kits.)

Microwave ovens do cook as fast as they claim. You can boil eight ounces of water in two minutes, bake a potato in four minutes, and prepare an average beef roast in 15 minutes (5 min/lb). Frozen food can be defrosted in minutes, too (2-3 min/lb) for spur-of-the-moment meals. These ovens are ideal for vegetables, fish, and stew-meat, too, but they do not prepare all foods equally as well. Pie crusts and browning of meats, for example, would best be done in conventional gas or electric ovens.

The Microwave Spectrum

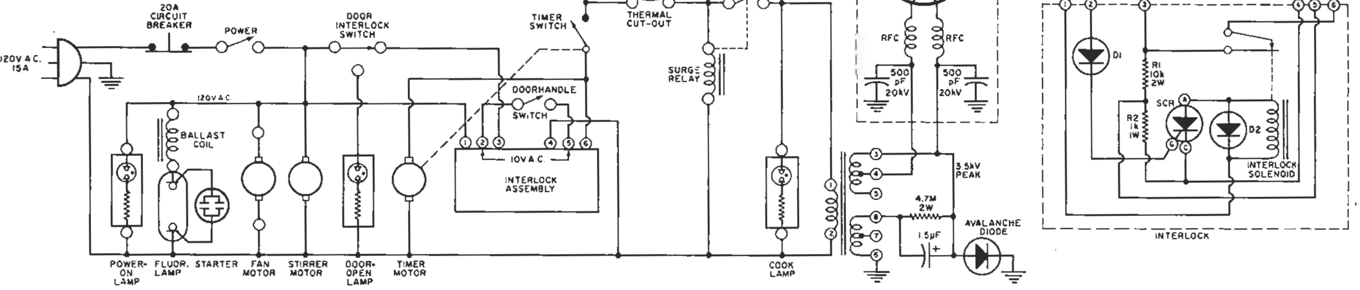
The microwave spectrum ranges from 500-10,000 MHz, falling between the u.h.f. TV and infrared bands. For the most part, these frequencies are used for radar and microwave communications. There are two exceptions, however—the 915 MHz and 2450 MHz channels allocated for industrial, scientific, and medical use. These are the operating frequencies for microwave ovens and industrial systems for food-processing, wood-drying, and other purposes. The 915 and 2450 MHz bands are ideal for microwave cooking; at lower frequencies food is heated more slowly, and at higher frequencies the food surface is heated too quickly.

The *Heath* oven operates at 2450 MHz, using a *Litton*-5201 magnetron producing 650 watts minimum r.f. output power. Power is fed into a length of S-band waveguide measuring 3.40 x 1.25 in. in cross-section, and then to the oven cavity. A "mode-stirrer" (fan) distributes energy throughout the oven.

One of the problems with microwaves is that they are easily reflected so that it is not advisable to use an empty oven or metal pans which are reflective and may cause overheating. As a precautionary measure in the *Heath* design, power is turned off when temperatures become excessive due to no-load operation, fan-motor failure, or even a dirty filter.

There are two areas of major concern to the microwave oven designer: (1) radiation leakage, and (2) finding a fool-

Fig. 1. Wiring diagram of Heath GD-29 microwave oven. The door interlock and magnetron/waveguide are supplied assembled.



proof method of eliminating the possibility of the magnetron operating while the door is open.

Minimizing Microwave Radiation

Effective July 1, 1971, the new standard of the Radiological Health Bureau, U. S. Department of Health, Education & Welfare (HEW) restricts microwave radiation from ovens at the point of manufacture to 1 mW/cm^2 at a distance of 5 cm. Actually, no one knows precisely what the danger level is, but HEW will insist that this standard be met as a safety precaution. Microwave radiation is non-ionizing—as are infrared rays, radio waves, and other low-frequency radiation—and they do not produce irreversible damage. Therefore, there is no cumulative effect. This differs considerably from x-radiation which destroys tissue that cannot be repaired; x-rays are ionizing radiation and their effects are cumulative.

We measured radiation from the *Heath* oven with a *Narda* Model 8200 radiation survey meter. This new instrument should find wide acceptance as the standard measuring device for microwave ovens in service shops across the country. It is a much lower-priced version of its Model 8100; both give the same results. In checking all possible points of radiation from the *Heath* oven, the maximum we found was the ridiculously low figure of 0.2 mW/cm^2. This was far below what we had thought possible.

HEW has also set what might be termed a "use" standard for microwave ovens. They should never radiate more than 5 mW/cm^2 at 5 cm in their entire lifetime. It is this figure that field technicians should abide by; if radiation ever goes beyond this point, protective measures should be taken.

It is important that the builder of this kit pay particular attention to the assembly of the conductive-vinyl door seals, and care should be taken not to scratch the Teflon-coated capacitive seal plate inside the door. Any scratch on this coating may cause arcing and permit leakage.

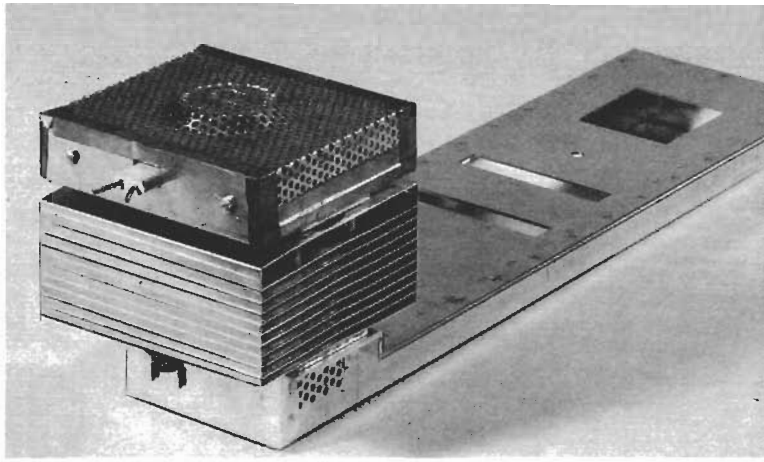
Other Safety Features

For obvious reasons, all power to the magnetron must be off prior to opening the door. The oven incorporates two interlock switches for this purpose. When a.c. power is applied between lugs 1 and 4 of the interlock assembly (Fig. 1), it is applied across the SCR through the interlock solenoid. However, the SCR will not conduct until it is triggered by a small positive voltage on the gate (G). This is supplied from a voltage divider consisting of *R*1 and *R*2 (through lugs 2 and 5) when the door handle switch is depressed. The a.c. voltage is rectified by *D*1. The SCR then conducts, energizing the interlock solenoid and releasing the door lock. At the same time, the interlock switch contacts are open; this, in turn, opens the circuits to the magnetron. (Diode *D*2 is used to short out reverse voltage surges that might be developing across the solenoid.)

When the oven door is opened, the door interlock switch is mechanically actuated to further disable the magnetron circuit. The system is foolproof. (A rather interesting situation could occur, however, in the event of electric power failure while the oven is in use. It would then be impossible for the door to be opened until power was restored.)

Heating Phenomenon

The microwave interaction is produced by what can be called "molecular friction." Molecules moving back and forth orient themselves with the electric field, causing heat, but the degree of temperature rise depends on the type of molecule. (Some move too slowly.) Water is an ideal medium for microwave heating since it has both a high dielectric constant and high loss. It is the basis of microwave cooking, in fact. All foods cooked this way must contain water. For this reason, paper plates, glass, or crockery containers absorb little energy and are heated only indirectly by the food they contain.



The magnetron and waveguide come pre-assembled and are mounted on oven with 25 nuts and bolts. Magnetron is a Litton L-5201 producing a minimum of 650 watts r.f. output.

With microwave cooking, not only is cooking time drastically cut, but so is dish-washing time. Food can be cooked in glass, ceramic, or even paper plates, and served on the same dish. Anyone using the microwave oven for the first time might as well forget all he has learned about conventional gas or electric ovens. Microwave cooking is an entirely new phenomenon and is gaining in popularity as the modern approach to home-cooking. ▲

For those interested in building their own microwave radiation tester, the U. S. Dept. of Health, Education & Welfare recently issued a booklet, "Inexpensive Readout for a Commercial Thermocouple Microwave Power Density Probe" (BRH/DEP 70-31, PB 192-377), which completely describes construction of such a unit including circuit diagrams and mechanical assembly details. The design is based on the use of Narda's *Model 8122 probe and the cost is estimated at about $50 for the parts plus $150 for the probe. For a copy of the booklet, send $3.00 to National Technical Information Service, Springfield, Virginia 22151.*

The radiation tester we used (as described in the article) is Narda's *Model 8200, which is available at $295 including probe and carrying case. For further details, see item in "New Products" Department.*

Inside door, showing vinyl seal on outer edge and the Teflon-coated capacitive seal. This Teflon seal overlaps an area of the oven front panel when the door is in the closed position. The contact width of this area is equal to ¼ wavelength of the fundamental frequency of 2450 MHz. The energy in the oven cavity sees a parallel transmission line ¼-wavelength long which is terminated in an open-circuit. Such an open-circuited line appears as a short circuit at its input end, effectively shorting the oven front panel to the door. The Teflon coating maintains a uniform separation between the door and oven front panel, acting as a dielectric between the two capacitor plates, forming the transmission line. This Teflon prevents arcing between the capacitive seal plate and oven front panel.