

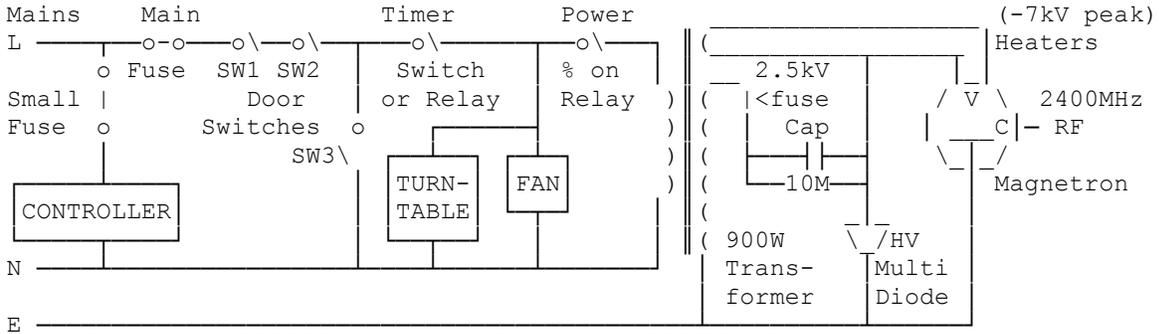
Microwave Ovens

By G8MNY

(Updated Dec 08)

(8 Bit ASCII Graphics use code page 437 or 850)

Here is the circuit that is used in most Microwave Ovens, but there are some SMPSU versions available now (HF QRM?). It is deceptively simple & masks the clever features of the circuit.



FEATURES

SAFETY. To stop misuse 3 sequenced door switches are used to stop the power SW1 & SW2, & to blow the fuse SW3!

CONTROLS. If there is a controller & clock etc, it may have separate mains transformer & fuse etc. & operate the on & on relays. Otherwise clockwork time switches may be used.

POWER LEVEL. As the power can't be varied & the valve magnetron has to warm up for a few seconds to reach full power, a simple interrupted on/off ratio timer over several seconds is used to control the mean cooking power.

RF COOKING. The turntable motor or moving RF stirrer is needed to ensure food (containing water/fats) gets evenly cooked to about 2cm deep, otherwise the 13cm standing waves would produce very strange results, & potentially dangerous to eat cooked/raw banded food!

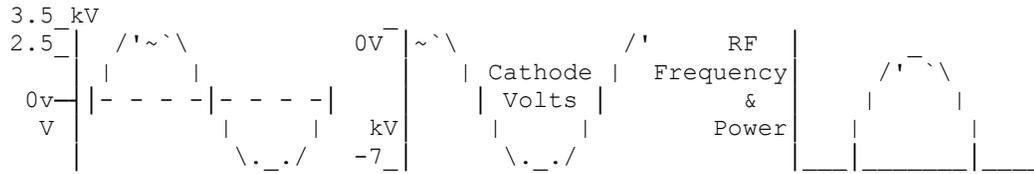
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      -----
Line of Grated Cheese>/-----7
                        /  Y  Y  /Toast
Bands of / / / / @ 45°           -^Magnetron
melted / / / / Not rotating
cheese ~~~~~
    
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Try grated cheese on a still sloping piece of toast to see the standing waves.

MAINS VOLTS. Mains Voltage variation is cunningly catered for by using a under saturated transformer in near resonance with the small Cap. As the voltage reduces the transformer L increases & partly resonates with the Cap to produce increased voltage to the magnetron exactly compensating for the mains reduction.

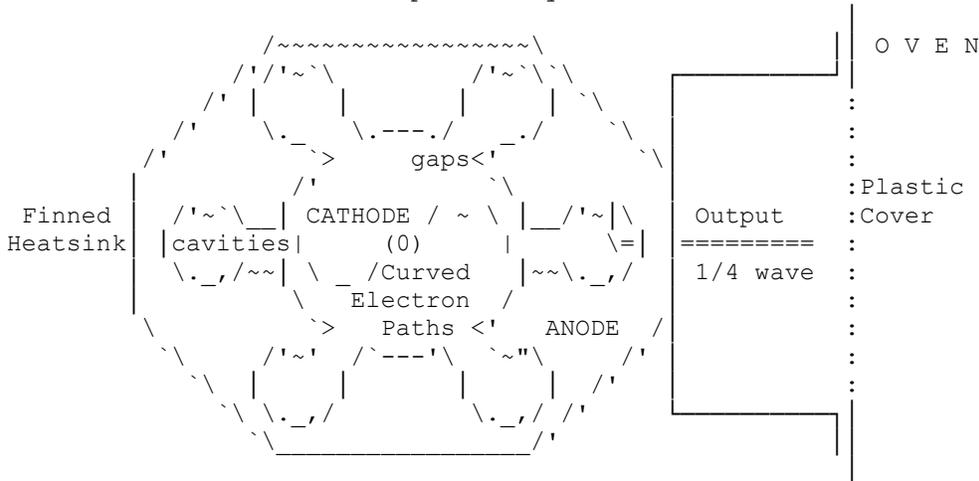
N.B. Generator users:- this effect only works at the rated mains frequency!



QRM. Energy dispersal on the 13cms band is ensured due to the raw power supply 0v to -7kV peak 50 times a second on the cathode, causing the RF oscillation to be FM & AM over a broadband. Usually 2 RF peaks cross a spot frequency per cycle e.g. @ 100Hz.

MAGNETRON

Electrically they are a just valve diode, but have resonant cavities in the anode & a powerful magnet (hence name) with pole pieces above & below the cathode, which makes the electrons curve passed the cavity capacity gaps. Each cavity works like a whistle & oscillates. Link wires may be used to RF couple all the cavities to the output cavity.



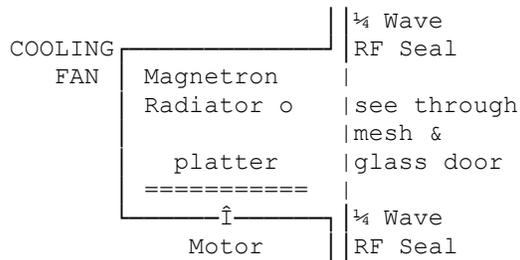
The outer anode case is at earth potential & has finned area for the fan to cool, this waste heat is ducted through the cooking chamber.

FAULTING (dangerous DEADLY voltages, definitely 1 hand behind your back!)
 Always leave tumbler of water in the oven during test! NEVER DISABLE THE SAFETY SWITCHES! R.F. B U R N S.

Harry, M1BYT says he can run his unit for testing with mains removed from the Magnetron transformer to find lamp, motor, fan or controller faults without the danger from the uWaves or lethal HT.

- 1/ Does the mains transformer hum? If not check fuses, door switches, & relay.
- 2/ Using a high voltage probe (10x 10M in series in old pen case to a scope.)
 - a) see if 2.5kV AC is present from transformer. If not DC check pri & sec.
 - b) see if 0-7kV is present on diode/cathode. If not disconnect cathode & retest. If still no voltage, disconnect diode, if AC appears suspect the multi section diode. Do a cap test otherwise (. 1uF 3kV).
 - c) if all OK except when cathode connected, replace magnetron/scrap.

- d) if all OK, but no RF. Test heater circuit, no heaters replace magnetron/scrap. Heater OK, test secondary circuit & repair connectors or broken wire etc.
- 3/ If arcing noises or thumping are noticed, try checking in the dark, if there is light from any connections/insulation take remedial action. If from magnetron replace it. If radiator arc (RF O/P of magnetron), check the 1/4 wave cover is making good connection to valve pin if it is a separately connected type.
- 4/ RF leakage. The RF is radiated into a fully welded box with 1/4 wave overlaps door choke coupling. It should not leak much! But U can see the 100Hz FM bands on a 13cms CCTV Rx.



I use a commercial microwave RF sniffer to make sure. It is crude thing with a 10GHz diode & a meter.

MICROWAVE OVENS - PWR CALC. From: DAVID G4EBT @ GB7HUL

A magnetron's output power can be measured by checking the temperature rise in °C of one litre of water during an 87 second period @ full output power. A magnetron usually reaches full power about 4 seconds after the clock button has been pressed, so the timer needs to be set for a 91 seconds test period.

If it's desired to determine the time lag from switch on to full power, use a small neon with its wires cut off close to the pinch seal & insert it into the oven cavity with the pot of water. It will glow brightly at full power & shouldn't be left in after it starts to glow, or it may shatter.

The power output is given by the temp rise in degrees C x 50. Thus if there's a 14° rise in temp of 1 litre of water over an 87 second period after the oven has attained full power, the output power is 50 x 14 = 700W.

Another method, claimed to be more accurate, is to place two 500mL beakers of water at equal temp in the oven, run the oven at full power for thirty seconds, then check the temp rise in each beaker. Take an average of the two readings & multiply this by 70 to get the output power figure.

The formula for this is given as: $P = (4.187 \times V \times \text{temp rise}) / t$

Where: P = Power in Watts.
 V = Volume of water
 t = Time of full magnetron power.

This test conforms to IEC 705 (1988). This info is given in good faith (& at your risk!), from an article in April 1998 Television magazine, copyright of which is acknowledged. - G4EBT

HAM USE

I have seen a design for a 13cm ATV Tx based on a magnetron. A highly dangerous project!

Many hams think the small but powerful 900W mains transformer could be useful for valve linears. It can be done, but the trouble is one side of the 2.5kV AC is wired to the transformer's case earth & even if that end was lifted off earth, to feed a bridge rectifier to give a 3.5kV HT, the insulation to earth of that end of the winding is poor & will not readily handle the 3.5kV peak! If done a single 900W transformer should make a 800W continuous PSU or 1600W peak CW/SSB mode PSU OK provided it is fan cooled as in the oven.

Another approach is to use a half wave rectification for 3.5kV DC PSU. But this will DC saturate the transformer & reduces the rating by about a factor of 3, making a 900W transformer only safely give 300W continuous with this amount of core saturation & the much reduced inductance on the mains. So 2x identical 900W transformers wired in antiphase will be OK for QRO CW/SSB use. e.g. 600W continuous load or 1.2kW intermittent.

OTHER DANGERS

WATER HOTTER THAN BOILING!

Note with RF heating it is possible to get water & some drinks actually hotter than 100°C without boiling! This can occasionally happen if very clean container & water are used, so clean that there are no crevices/particles for the steam bubbles to form. Result is a cup of scalding liquid the boils over at the slightest knock!

EXPLODING OVENS

If you are stupid enough to put a sealed container like an egg in the microwave, it will explode causing a mess inside the oven.

If you are as stupid as those on a certain TV programme who put a new bottle of champagne in one, it demolished the oven the table & the room, & certainly might have killed anyone nearby!

Why Don't U send an interesting bul?

73 De John, G8MNY @ GB7CIP