# Hot Iron

Issue 26 | "Journal of the Constructors Club" | Winter 1999

## Contents



## *Editorial*

Happy Christmas and may you have a happy, healthy and prosperous new year! May you all keep your soldering irons working hard! As we enter the next century, and millennium, it is a timely moment to reflect on the state of amateur radio. The pace of development has been startling throughout this century in most technological fields and radio is no exception. Even into the middle of this century many scientific matters could be studied with relatively simple apparatus, however that is changing as the quest for better value for money makes even small improvements in any aspect of performance worth chasing. Inevitably this leads to increasing sophistication where the string and sealing wax or brass metalwork and mahogany wood of earlier scientific instruments are inadequate. Amateur radio enthusiasts were right at the forefront of several major radio developments in the first half of this century using equipment made with very simple facilities. Apart from valves which required metallurgical and lamp bulb making skills, nearly everything else of the very early radios could be fashioned within a home workshop. Frequently, new radio technologies were pioneered by enthusiasts prior to take up on a commercial basis but, with the sole exception of computer software (whether related to radio or not), it is now the case that we follow the large organisations trying to use devices and ideas as spin-offs from commercially developed projects, often by multinational companies with huge development budgets. Unusually, software can still be written for quite impressive applications using little more than a home type personal computer costing around a £1K or so. For much of the rest of radio related projects we are the followers of others - this is not a situation that I would have chosen but it does present an interesting challenge! I see my task as a kit designer to be that of adapting the technology (and particularly the devices) of others in a manner which allows us to experiment and enjoy ourselves. I get my kicks out of the design work and hardly ever use a rig once its completed - I leave it to others to extol the virtues of operating matters, where I am not fit to make any judgements! Some would argue that operating skills have gone down hill in the last couple of decades - I hope that one of you will write me a letter (for publication) refuting this and tell us what the operating challenges are for the next century! However the hobby develops, the important thing is to have some fun and not take life too seriously - its just too short! I hope you have as much fun in 2000 experimenting as I intend to have with my pencil, paper, (waste bin), soldering iron, scope and PCB layout tools!

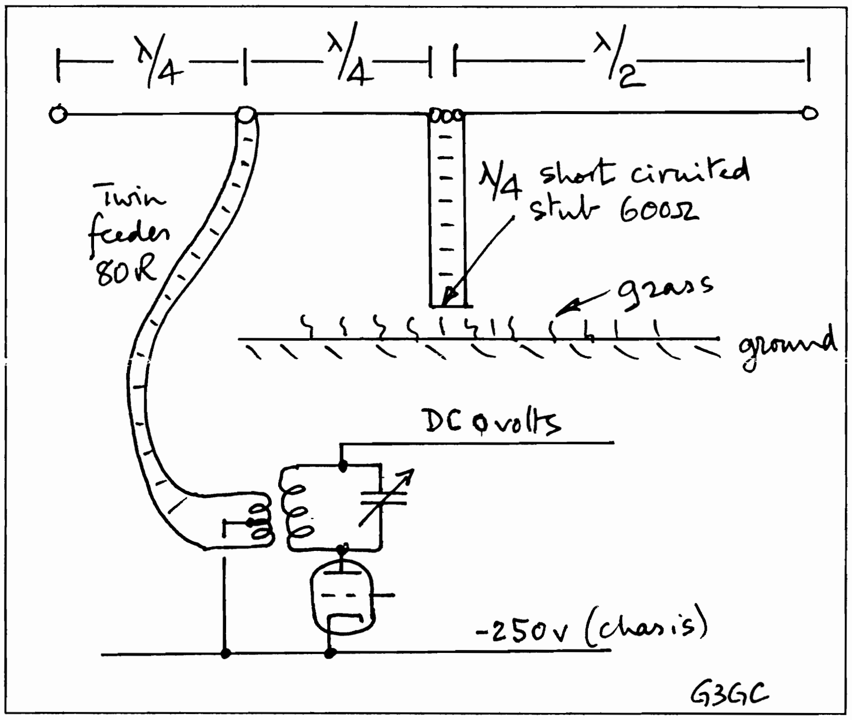
## *Kit Developments*

Early experience with the **Minehead** (DC CW TCVR up to 20m) is encouraging; John Gardner GW4KVJ, has been using his mobile and has been working successfully around Europe. As noted last time, I have been working on an update to my **Antenna Matching Unit** but it is proving very tiresome largely due to the non-availability of air spaced variable capacitors. They are being removed from the Maplin catalogue but I need a reputable and repeatable source which tends to exclude many of the options available to you. I thought I had this solved with switched fixed high voltage capacitors only to find that the tolerance of those I chose was far too wide! I also thought at one stage that the new design was very lossy only to find that harmonics were causing spurious readings - a low pass filter quickly cured that! It will include a *high* pass filter to remove medium wave BCI which is often a cause of interference. Progress is being made! Tim Walford G3PCJ Editor

## ***Worms and Mains earthing - part 2!*** by Eric Godfrey G3GC

As one of the recalcitrant consultants who refrained contributing to the article on 'Earthing for 50 Hz and RF' I must say I think I made the correct decision! Tim's article is excellent and although I would have been happy to contribute something on the RF side, I did not think I was competent to write about mains problems, particularly PME. The article has confirmed this and I must say that I now have a much better understanding of what PME is and why it is used.

However it seems to me that in some ways PME is nothing more than a reversion to the old days of the two wire system. Before the war I lived in Finchley where the electricity supply was 250 Volts DC generated by the Finchley Electricity Company. The Company's main feeder running down the road was a three wire system, +250 / 0 (Earth) / -250 Volts. The houses were supplied with two wires which were 0 (Earth) and 250 (Live) Volts, with alternate houses being either plus or minus 250 Volts. This mean that if one was on a +250 line coming into the house then the supply positive was live and the negative at 'earth' potential. However if one had the -250 Volt supply, then the supply positive was at 'earth' and the negative was of course at -250 Volts. This -250 Volts was usually tied to all the equipment metal work because most valve circuits usually had their negative supply connected to the chassis and also to the centre taps of transmitter aerial link coupling networks. This was a potentially dangerous situation and you can guess which supply we had, yes -250 Volts live! I will now tell you as little true story to illustrate the possible dangers of mixing PME and RF earthing.




At one time I while at Finchley I had an aerial system which was two collinear half waves fed in phase. One of the half waves was fed at its centre by a low impedance balanced feeder connected to a centre tapped link coupling on the transmitter. The phasing of the second half wave was achieved by using a short circuited quarter wave pair line stub joining the two half waves together as shown in the diagram. One rainy day I looked out of the window to see steam rising from the lawn below the quarter wave stub. On closer investigation I found the aerial had sagged a bit and the stub was touching wet grass. Because the aerial was tied to the transmitter chassis by the link coupling, the whole aerial was at -250 Volts and now had a short circuit back to 0 volts by means of the connection to the wet grass and thus warming it up. What was interesting was apart from the steam all the worms were wriggling their way to the surface. I do not know whether they were just getting warm or were getting an electric shock from having their heads and tails at different potentials. Perhaps I should have patented this de-wormer! More seriously this illustrates that there was a potentially lethal situation which was similar to that of bringing 'RF (ground) earth' into a shack which is protected by PME. Some years after the war, the Finchley supply was changed to 240 Volts AC but the two wire system in the house remained with neutral connected to earth. The voltage on the neutral was not supposed to deviate by more than 30 volts from earth. (I think the current figure is nearer 10 volts - G3PCJ.)

**Lightning** - The mention of a potential gradient across the ground, reminds me that this is a serious risk if you are near a lightning strike. It leads to the advice that if you are out in an electrical storm, you should stand crouching (to minimise the chance of a direct strike) on one foot so that there is no potential difference from a nearby strike if both feet are on the ground; this might otherwise allow current to pass through your sensitive regions! Do not rely on the insulating properties of wet wellington boots! You should go home while still crouching and hopping on one foot! G3PCJ

## *Powdered Iron Toroidal Cores*

While exploring alternative approaches for the revised Antenna Matching Unit, I needed a wide range of 'thickish wire' inductances for the potentially high currents in a matching circuit. Comments from Paul Tuton had suggested that the low cost ready wound high current RF chokes, available in a useful range of inductance values from TOKO but using ferrite cores, were prone to saturation (and hence heating) so I decided to investigate powdered iron toroids. The design idea needed multi-tapped inductors to minimise the total number of cores. I tend to use the red powdered iron T68-2 core as a standard since it is suitable for use over the HF range and had checked that the $A_L$ factor in the ARRL Handbook for this core is 57 nano-Henries per turn squared. Then, using the formula on the right, I worked the required number of turns and wound the cores with 22 gauge wire so it wound not burn out in the QRP AMU role. No success! I found that the actual inductance values were way off what was intended! Why?

No of turns $N$

$$= 100\sqrt{\frac{L(\mu H)}{A_L}}$$

or

$$L_{\mu H} = A_L\left(\frac{N}{100}\right)^2$$

G3PCJ

Fearing that I had poor $A_L$ information I checked on the Amidon web site at www.bytemark.com/amidon which has some very useful information on the suitability of cores for different frequencies etc.; there is also a full $A_L$ table from which I have extracted the data on the right for the more common cores. In addition there are tables of inductance for a given number of turns for each core type and size. These confirmed my maths but did not explain the unexpected results! Thinking that my winding technique must be the trouble I wound several different coils on the same core and resonated them with a capacitor to obtain their resonant frequency with a grid dipper. (This required a separate 1 turn link on the core connected to a couple of turns over the coil of my ancient GDO. It actually uses a valve - it is a Heathkit that I built while at school!) Then using the standard formula for parallel resonance I could work out the inductance. Changing the wire size made no appreciable difference but putting the turns on the core close together, instead of around the whole circumference, reduced the inductance by roughly one third! See actual figures right. All had 12 turns on the same T68-2 core resonated with a nominal 68 pF. From theory the inductance should have been 0.82 μH but tolerances of the toroid and my test capacitor are sufficient to explain the discrepancy from the 'wide' figures. I repeated this experiment with another core and different capacitors but the result was similar. This shows that the windings of such inductances must be *spaced around the core* if you wish to obtain the correct value. This is particularly so for small numbers of turns on a given core. (It also explains why builders quite often say they add or remove more turns than suggested for TX output matching circuits!) Closing the turns up can add up to 50% to the value! G3PCJ

| Size | Mix 2 Red | Mix 6 Yellow | Mix 10 Black |
|---|---|---|---|
| T50 | 49 | 40 | 31 |
| T68 | 57 | 47 | 32 |
| T200 | 120 | 100 | Not Av |

| Gauge | Spacing | Freq | Ind μH |
|---|---|---|---|
| 22 | close | 15M8 | 1.5 |
| 22 | wide | 19M8 | 0.95 |
| 24 | close | 15M5 | 1.5 |
| 24 | wide | 19M6 | 0.97 |

## *Bandwidth extender and DDS kits*

I floated the possibility last time of a kit to accept analogue signals, maybe to 30 MHz, convert them into digital signals with a high speed A to D converter, store them, and then read them out at a somewhat slower frequency into a low cost oscilloscope. Three members kindly expressed interest but I have decided against it for two main reasons; firstly complexity and risk. It would have to operate with internal digital clock signals in excess of 60 MHz and although there are plenty of suitable devices they are all surface mount! It might need several such chips and I fear that the risk of builders wrongly assembling (and hence damaging) them is too large apart from the difficulty of testing. The second is price. With an input analogue gain and attenuator stage, for reasonable convenience, the cost for a single channel looked as though it might rise towards £100 or so; bearing in mind that a good new 20 MHz analogue *two* channel scope (which will often give usable readings to 30 MHz) is now about £250 they represent a better buy. (More useful than a black box anyway!)

The second possibility was a combined signal generator or digitally controlled VFO to replace that in a rig. This looks much more promising and I have obtained a suitable DDS chip which is controlled by a serial interface. I shall report progress later. I would like 'spin-wheel' frequency control but they cost many times the main chip. Ideas welcome! Perhaps a potentiometer arranged to provide no change at its central position but with an up or down action on each side of centre? G3PCJ

## ***Hints for Tin Bashers*** by John Teague G3GTJ

If you fancy making a metal case for your Taunton or whatever, some tips, a consequence of a lifetime restoring vintage cars - a hobby with much in common with amateur radio - maybe helpful.

Aluminium is the obvious material: it is readily available, does not corrode and while easy to work it is also easily scratched and damaged. A good way to avoid this is to cover the surface before you start with packaging tape - the very cheap mud coloured stuff. For marking out don't use a scriber. Once you have decided where the holes have to be, stick on patches of white masking tape and mark the centres in pencil on the masking tape.

Surprising, perhaps, but for cases and panels thick metal - within limits - always looks better than thin. From an appearance point of view 1.5 mm is the minimum. Hard metal is easier to drill and cut than soft because much less burring occurs. However both hard and thick means it is difficult to bend. The answer is to anneal the aluminium and the best way to determine the annealing temperature is to rub a stub of ordinary toilet soap onto the surface. Then heat the metal sheet over a camping gaz flame all over but only to the point where the soap lines char and turn black. Go any further and you will have an unplanned hole! Let the metal cool without plunging; it should end up soft and malleable.

These methods do not apply if you happen to have one of the aircraft type aluminium alloys which are far harder than commercial aluminium sheet. However, they are delightful to work, easy to drill absolutely cleanly and make ideal flat panels. Bending without cracking is difficult. Whatever the material, holes bigger than 6 mm are a problem. Any drilling is ten times easier with a pillar drill if you have one. Whatever you use, clamp the workpiece down, don't hold it. I lacerated my hand quite badly once when a piece of thin metal (the worst) rotated with the drill.

For holes of 8 to 25 mm diameter, by far the best tool is an appropriate flat blade bit sold for woodworking. Buy a fine file at the same time as the bit so that the cutting edges can be kept keen. Put an undrilled block of wood beneath the work, use a smidgen of oil and cut right through in a single pass. The pointed tip will wander off centre if you lift it and then attempt to reengage in the hole: for the same reason don't try and cut through from both sides to avoid the burr as the bit exits the surface. These burrs, by the way can be removed with a pen knife or with the excellent tool sold by Maplin for that purpose.

Now for meter and irregular holes. There are several possibilities and I have tried them all. I assume that professional engineering cutters are not available. You can use a jigsaw fitted with a fine tooth pitch blade or you may open out a smaller hole with a file. The best way, I believe, is the most tedious. This is by the time honoured method of drilling a row of small linking holes just inside the edge of the aperture and filing to final shape and size. Again, much easier with a vertical bench drill. I have done tests: it is always quicker to mark out and centre punch the points at which the line of holes will be drilled. Mark out carefully say ten points 4 mm apart, then use a pair of school compasses as dividers set as required to mark the other points. Drill the holes with a 4 mm drill, knock out the centre. If you insist on drilling freehand then you will be left with bridges to cut away. A good tool for this purpose is an old jig saw blade ground to a point at the machine end (jigsaws cut on the rising stroke). This can be tapped through two adjacent holes to cut the first bridge.

Much has been written about techniques for panel finishing. If you fancy bare metal, then try one of the variety which can be produced by using various grades of abrasive paper in an ordinary wood orbital sander. Good bashing!

## ***Somerset Homebrew Contest***

To quote the GQRP Club contest organiser, Peter Barville G3XJS - who has the tough job of deciding who wins - 'This deserves to be one of the most popular events in the QRP calendar, with the chance of winning a £50 voucher to be exchanged towards any current Walford Electronics product. It is one of the few which actively promotes the use of homebrew equipment. The rules are very similar to previous years with a couple of small changes.' Please see the next issue of Sprat for the full details but essentially it is open to any single operator QRP station using homebrew RX or TX (or both). Any mode on 40 and or 80m near the QRP frequencies between 0900z and 1200z on Sunday March 26th in 2000. Exchange RST, Somerset Contest serial number starting from any random number over 100. Scoring is 5 points for a QRP contact both ways and 1 point for QRP/QRO contacts. Deduct 25 points if you did not build either the RX or TX yourself! Entries to G3XJS by April 30th with claimed score, details of equipment and antennas used etc..

There is still time to build a rig and avoid that penalty! It can be any make or home designed. No particular kit stable has a better track record than others! Mark it in your diary now!

## ***Working with Surface Mount Devices***

I have extracted the following from e mails from Andy Howgate who has taken the plunge and provides an inspiration for all of us! Next time I hope to include some of his ideas on boxing kits.

'I have recently repaired one of my VHF PMR converted rigs which had a fault. I was able to deduce that a 14 pin surface mount chip was acting up; I managed to find a replacement from RS and thought I had little to loose by having a go. I understand that a lot of SM component removals are accomplished by the use of a high temperature blowing device a bit like a paint stripping gun. The chip or device is heated using this hot air so that the solder becomes fluid and then chip removal is possible. Another process which I have employed is to cut the legs of the device with a sharp Stanley knife, remove the chip and then the remaining fragments (mainly legs) with a fine iron; next clean the area and check for damaged PCB tracks. Apply a small dab of flux to each track pad. Rest the replacement chip in position and solder one corner leg only, you can then apply slight movement to the chip to get it into exactly the correct position. Then solder another leg to the PCB on the opposite side and again check that all other legs are in the correct places. Solder them down in turn. It is fiddly but it can be done quite easily with patience!

Transistors and passive components I find harder to do because they usually do not have legs; the edges of the component are the often the connection points. The trick is to move quickly between the connection points with a fine iron and to gradually heat them all up or ease an edge up so that they have less restraining effect on the rest. Take care not to lift the PCB tracks with too much force on the device! (Practice on a scrap PCB is highly recommended first!) Always have some fine hook up wire for track repair and a good magnifier with plenty of illumination. I have changed 60 lead processor type devices in this way.'

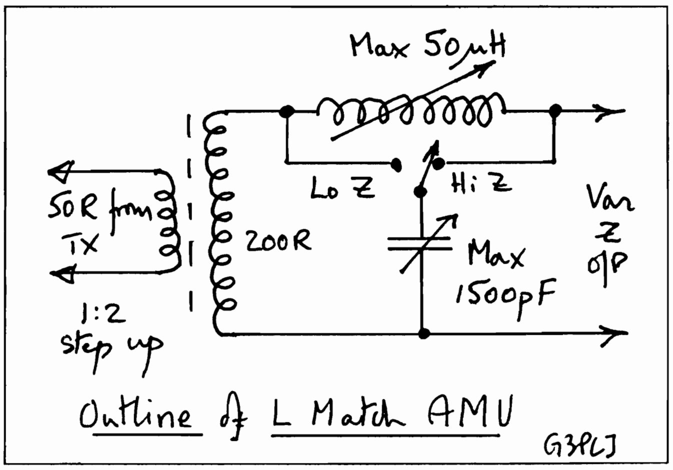
As a helpful comment to those of us laying PCB boards, Andy suggests making the pads for the surface mount devices slightly longer than usual so that the tip of a fine iron can heat the track and flux and allow the solder to flow up the track to form the joint with the leg. Note that Andy is suggesting the use of flux paste separate from that in multi-core solder; this can be obtained from any good electronics component supplier - you must not use plumber's flux - it is usually highly corrosive because it is acid based. Andy often finds that stripping off any PCB surface protection is sensible prior to soldering and to then apply a final lacquer after soldering is completed.

## ***Surplus PCBs***

I have several boards which I do not intend to make into kits; tell me if you can use them:-
One good Yeovil RX board and two good TX boards; Coxley regen TRF and Adjustable CW filter boards with minor defects and several PCBs for the Five digit counter having minor track defects.

## ***Antenna Matching Unit***

It is important not to waste power (either way) through an AMU which is why the simple L network is often chosen. It has the disadvantage that the Q is fixed for any particular set of input and output impedances. The larger the impedance transformation, the higher the Q which can lead to high circulating currents and tender tuning. One scheme suggested by several designers is to transform the output of the TX from a nominal 50R down to 12.5R in a 2:1 (for voltage) transformer, which also provides DC isolation and permits an ungrounded RF load, and to then use a wide range L matching network to transform up to whatever the transmission line load presents - typically in the range 25R up to maybe a few Kohms. This latter condition leads to the undesirably high Q = 10. An alternative approach which seems to work well is to reverse the 2:1 transformer so it steps up to 200R and the L network then transforms from 200R either up to a high Z load or down to low Z coax etc.. This restricts the maximum Q to about 3 for the largest transformation (up or down) and leads to a worst case inductance of about 50 µH or maximum capacity of 1500 pF for the extreme 160m load impedances. The basic circuit is shown right. G3PCJ



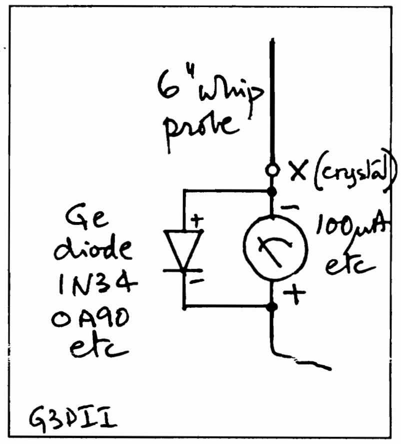
## *More practical tips from Joseph Bell G3DII*

*Salvaging components*: Defunct old computers and other electronic equipment can yield masses of useful parts for those wishing to augment their junk box stores. A drastic but effective way of removing the parts is to cut the PCB into progressively smaller sections with a pair of sharp diagonal side cutting pliers. Cut the PCB into smaller sections until only a single part is left on it and then cut through one side of each lead hole so that the PCB remnants can be almost broken off - perhaps with a short application of the soldering iron. This process will obviate the damaging prolonged heat which is often necessary to extract each lead from its mounting hole. Use safety glasses as boards can shatter.

*Winding coils*: In spite of the growing use of toroids, the conventional solenoidal coil has its place. When winding coils, especially with thin wire, it often becomes difficult to maintain the desired spacing between turns and still have a neat coil. To avoid the problem, first wrap the coil form with cellophane tape that has adhesive on both sides. Then when the coil is wound, the turns can be placed exactly where required and will stay put. The completed coil can then be protected with a coat of lacquer or varnish. The modern type of enamelling can be burnt off with a chunky hot iron.

*Base for CW key*: If you are fed up with your key moving around when using it, then use the sole from an old electric iron. The old ones are made of cast iron but even the modern aluminium ones will do. Three rubber feet should be mounted underneath the sole and the requisite number of insulated terminals mounted at the pointed end.

*Xtal calibrator and RF indicator:* This device can be made in a few minutes and has many uses. As shown in the circuit, a germanium diode shunts a meter connected to probe wires. The more sensitive the meter the better, 100 µAmps is ideal but even a 1 mAmp device will do. The markings on the scale do not matter since it only has to show a response. The short length of wire on the meter positive (which provides a return path for the wanted RF input to the other 6 inch probe wire) can be held in the hand or, for extra sensitivity, connected to the earthed metalwork of whatever is being investigated. If the probe wire is placed near one of the feeders in a balanced antenna line, it will give an indication of the amount of RF flowing up the line enabling proper adjustment of the antenna matching unit. Other uses are the detection of RF on power lines or for checking for parasitic oscillations.




If a crystal is inserted at the point X, it then forms a highly selective detector at the crystal's frequency. For example it allows you to check the frequency calibration of a GDO by placing the probe wire near the coil of the instrument. Say you wanted to check the resonant frequency of a 40m loop, which is likely to have a very high Q and hence need careful setting to get in band, with a poorly calibrated GDO covering 5 to 10 MHz. Using any known crystal(s) within this range will allow you to check its calibration and hence obtain the 7 MHz setting more accurately. The calibration of signal generators can also be checked by linking the probe to the output of the generator and then tuning it across the crystal's known frequency. Depending on its actual output you may need to couple it rather more directly to the generator's output. Connect the meter positive directly to the generator's ground terminal; with a similar short antenna wire on the generator's hot output, couple the two together, initially without the crystal so as decide how much coupling is required. (If the generator output is low they can be directly coupled with a small value capacitor.) Having obtained a suitable broadband reading, insert the crystal and then adjust the tuning to find an output at the crystal's frequency. Repeat with other crystals if you have them. With a 100 µAmp meter, even 30 milliVolts will give the meter a healthy kick!

## *Excess capacitors!*

Being forced to buy 800 off 105 pF adjustable film rotary trimmers when I only wanted 100, I have plenty to spare! Their body size is the same as the common yellow bodied 65 pF variety but a different footprint. If you could use some their cost is one and a half first class stamps each - no cheques please - plus two extra stamps for P & P; e.g. 6 trimmers for eleven first class stamps. G3PCJ

Finally

# *Happy Christmas, good health and fun in 2000!*