"JOURNAL OF THE CONSTRUCTORS CLUB"

Hot Iron

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Editorial

Welcome to a whole host of new 'members' of The Construction Club (readers of Hot Iron) following the publicity given to Hot Iron by Bill Meara and his Solder Smoke musings. I just hope that together we can find enough good quality material to keep you all interested! That is why I say to all who have recently joined, if you can contribute an article, or even just suggest a topic that you would like given an airing, then please do not hesitate to let me know. Don't be worried about editorial style or any of that sort of detail because such trivia is easily overcome! Given that it is now over 20 years ago that I did the first one, some topics will definitely need covering again – so please tell me what you would like to read about.

Many of our newer readers are in North America and I am aware that the style of radio experimentation over there has a slightly different emphasis compared to Europe. In Europe, the price of kits, or parts for a project, have a very strong influence on decisions about what to 'build' – I suspect less so in North America where there is often more interest in good performance even if the cost increases appreciably. I am not sure of the reason for this, but it is possibly due to the lower cost of parts and there being more sales outlets for them. In putting together my kit designs, I have always tried to ensure that no one unduly expensive item dominate the cost of all the rest; so for example, I have shied away from expensive ready made IF filters, costing tens of £s over here, for use in simple circuits where the performance of the rest of the circuit does not match that of the expensive filter. This leads to a design objective of getting the best all-round performance that can be achieved for a given kit outlay – this is not designing for minimum cost always, but is about trying to balance the various aspects that go to make up the overall cost. One aspect that has always felt poor value for money in most (but certainly not all) situations to me, is the additional cost of smart enclosures - printed circuit board material can, with a little ingenuity, be used to fabricate all sorts of mechanical styles or even enclosures – its easily worked or joined with simple tools, and can be altered as and when a project develops further. I fully accept that if you are intending to use the gadget in difficult physical conditions, due to temperature, dirt or shock etc, then a case is essential but for most bench uses, they are a hindrance – especially when fault finding! I also tend to design in (too much?) 'adaptability' in the hope that builders will experiment themselves, and hence gain a better understanding of how it works! Tim G3PCJ

Christmas is imminent, so I wish you a Merry Christmas & happy New Year!

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Hot Iron is published by Tim Walford G3PCJ of Walford Electronics Ltd. for members of the Construction Club. It is a quarterly newsletter, distributed by e mail, and is free to those who have asked for it. Just let me know you would like it by e mailing me at electronics@walfords.net

Kit Developments

Where to start?! I have spent quite a while working up a paper on what we, as a hobby, ought to do to encourage newcomers when building their first radio project – needless to say, I consider that it should be an 'analogue' item as most radio fundamentals are analogue in nature. This led to a revamp of the FiveFET design – much along the lines suggested by Ian G3ULO later in this note. I laid out the PCB, wrote the first draft of the instructions and made the prototype of what has become the Rumwell two band Regen TRF receiver. The photo alongside is of that version; but using it soon showed it was too sensitive to hand capacitance effects, because the tuning parts are in the bottom right corner just underneath one's right hand! Steve G0FUV also suggested that it would be easier to build if some of the parts on the left side (the audio amplifier) could be spread over to the right hand side.

In short, it needed a complete physical re-arrangement but with the same circuit. I ended up swapping the band switch (bottom right of the photo) with the RF gain pot immediately above it and a general move of parts from left to right. I have re-written the text and will be adding it to my website soon. The Rumwell RX is now a two band Regen TRF – each band has the option of series or parallel connection of their inductors. This gives the choice of the high frequency end of what we call the medium wave in Europe (about 780 KH to 1.5 MHz) or 160m for the LF band, with either 40 or 80m possible for the other HF band. It has an RF gain pot, together with Coarse and Fine Regen controls on the left side and can drive the 15R audio load of modern stereo phones or a small loud speaker. It can copy AM, CW or SSB/DSB.

The matching simple AM transmitter is the Rimpton which would normally be mounted immediately to the right. To keep it simple for newcomers, this is normally crystal controlled but it has the option of using a ceramic resonator (adjustable with a trimmer) for 80 and 160m. It has a peak output of 1.5W on a 12 volt supply so can run an AM carrier of about 0.35W. It uses a pair of low cost MOSFETs in the final, without the hassle of a modulation transformer, with a twin pi harmonic filter that can be built for 40, 80 or 160m. The design is a derivative of earlier projects so is fundamentally proven; the prototype is built (photo right) but not fully written up. Working with short throw out aerials, these two kits are just the sort of projects for Scouts or Cadet groups, where a licensed amateur is to hand to help and supervise operation by unlicensed hopefuls, making their first contacts across playing fields etc!

I have also spent quite a while considering even simpler RX projects – the photo on the top of the next page might become such a kit - more details next time!

I am sorry I cannot tell you more about it yet, but it does demonstrate a perfectly viable building technique for one off projects!

Meanwhile some of the other more complex kits under development have had to take second place. Doing the design and laying out a PCB is the easy bit – writing the instructions, testing and then polishing them is what takes the time! G3PCJ

REGEN EXTRA by Ian Spencer DJ0HF/G3ULO

I suppose in these days of large scale integrated circuits and SDR we should ask ourselves why we would want to build a receiver who's circuit was basically invented way back in the 1920's and 1930's. Well for me when I switch on an SDR I know how complicated it actually is and expect it to perform but when I switch on a Regen using just 1 valve or a couple of transistors then I feel that's it's a minor miracle when it works. I built my first Regen in 1962 so more than 50 years ago and am still building them because when a good Regen is operated properly not only is it very sensitive but also pretty selective. I never cease to get a thrill when that single valve or couple of transistors allows me to listen to signals coming from the other side of the world and listen to not only AM but also SSB and CW over a wide frequency range with no problems of IF image etc. Just amazing.

All Regens have at least two controls and some perhaps three. Something to tune to the required frequency with a Regeneration control to get that all important performance and in the luxury version an AF gain control for the volume from the loudspeaker or headphones.

But that said the simple Regen is very touchy to adjust and not easy to get working at optimal efficiency, so that simplicity has a price and I was wondering if it could be improved without adding significantly to the complexity. In reality, moving just one component and adding two others can work wonders.

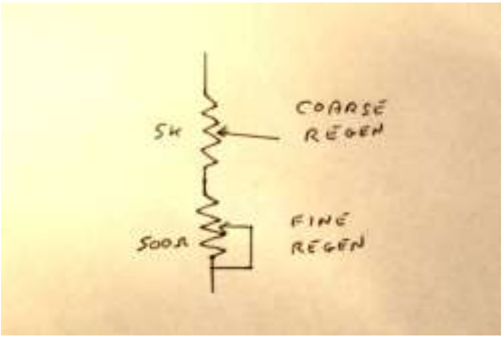
The three main problems seem to me to be that the tuning capacitor or varactor diode covers quite a wide frequency range so tuning in a signal perfectly isn't easy, especially when that signal is amateur band SSB which requires very exact tuning.

The Regen control is very sensitive, a few degrees too far and the set is oscillating, a few degrees back and the receiver loses sensitivity. A tricky adjustment.

And the last problem is the volume control if the set has one. Now the standard thinking is to put an AF volume control into most sets just before the final AF amplifier so that you can adjust the volume of audio but this is in my opinion the wrong place for the volume control. The reason being that Regen receivers work best with weak signals and very strong signals can easily cause overloading of the Regen detector leading to distortion and pulling of the oscillator frequency. This is especially evident where strong SSB is being received.

To get perfect audio from SSB the oscillation of the Regen has to be just strong enough to replace the missing carrier signal. Too much oscillation and it swamps the audio, too little and it sounds like an over modulated, distorted AM signal. Now if you put a 1k to 5K pot (it's not critical) between the antenna and ground and take the input to the receiver from the slider then you can vary the strength of any signal from zero to maximum and by turning back the pot on strong signals this not only makes life easier for the Regen detector but also automatically lowers the volume in the headphones or loudspeaker. In my opinion a much better solution. So just moving 1 pot from the AF section to the RF input can make a vast improvement in the quality of reception.

To get greater control of the regeneration just requires an extra fine adjustment potentiometer, so if the main Regen is a 5K variable resistor then adding a 500 ohm or 1K variable in series with it gives a very effective fine control. For the cost of one potentiometer you get effectively a 10:1 reduction drive (see photo 1). You set the fine control to mid position, tune to the place on the band where you want to listen and then advance the course Regen pot until oscillation just starts. Now you can back off the fine Regen pot for maximum sensitivity and selectivity on AM signals and advance the fine control a bit to get the set oscillating for perfect CW and SSB reception and the adjustment is so much smoother than with the coarse regeneration adjustment. But remember the old saying you can't make a silk purse out of a sows ear. If you advance the Regen control and it starts to oscillate but when you back it off it continues to oscillate then you've got that sows ear and the fine Regen control isn't going to help. Entering and exiting oscillation should in any well built Regen be nice and smooth.



And finally to get that perfect frequency control if the tuning is done with a capacitor then just fit a small perhaps 10pf variable capacitor in parallel or if your Regen uses varactor tuning then as for the Regen Pot a small value pot in series allows very smooth and accurate fine adjustment of frequency making those SSB signals much easier to tune in, almost like having that expensive reduction drive. Maybe better as you can still use the main tuning control to quickly make large frequency changes.

If you've never done it before try these changes to your Regen and see just how much easier the handling of your receiver becomes. Never mind the SDR's, feel that Regen performance.

Here is my Regen derived from the Walford Electronics FiveFET. On the front panel you can see the main tuning control with to the left the fine tuning and to the right a band switch for 80/60/40/30/20 Metres. On either side of the headphone socket are the fine and course Regen controls; to the right is the RF gain control.

Aerial locations

This is not a speciality of mine but my good friend Eric G3GC, who died many years ago, drummed into me that one should get as much wire out as you can, up high, and ideally in a balanced configuration! Sounds easy like that but for people with small, or even no garden at all, it's a bit challenging. On the farm I am spoilt for space out in the fields but surprisingly, finding a suitable aerial location is not that easy, due to the proximity of other buildings near to the house and my electronics bench. One should try and avoid long feeder runs if possible.

The first thing is to try and get the radiating elements, usually wire for HF aerials, in the 'open' – this is a vague term but really it means getting them (especially that part of the wire carrying a high current) away from other conducting materials – such as the house power, or 'comms' wiring, metal water pipes, or even bulk conductors such as earth! Another hidden nuisance is metallic foil on the black of some modern plaster boards, whose purpose is to prevent it burning! If mobile coverage is appreciably better outside the building than inside it, then don't put your aerial inside it! Reinforced concrete structures (especially flats) can be difficult due to the structural steelwork. Many people are forced to consider their attic spaces, but these are best avoided if possible because the external roof material is a conductor when it is raining! And that is apart from any wiring or pipes that are conveniently hidden overhead! So get the wire out in the garden if you can. Run it from the eaves guttering, or even the chimney if you can do that safely, away from the house to some convenient sky hook at the far end of the garden. If there are not any trees then run to the tallest pole you can manage, with a supporting stay(s) to keep it upright. It is advisable to keep the aerial wire out of reach of humans (young or old) so that any high voltages are avoided – for high power work, it is wise to use egg type insulators but modern 'poly' rope is a reasonable short term (insulating) expedient, until it perishes in the ultra violet light after a few years!.

Feeding RF into such a wire is not always easy because it is often 'end fed' and that tends to be a high impedance point with consequent high voltages – with a good antenna matching unit this need not be a problem - but what completes the RF current path on the earthy side of the tuning unit? Where is the RF earth? And I don't mean the mains power safety electrical earth! While that safety earth should be connected to real ground somewhere, it can be quite a long way off (many wavelengths) and is definitely NOT recommended as an RF earth. In fact one should NEVER connect your RF earth (which might be metalwork in the real ground) direct to the main safety earth, especially if you have PME (protective multiple earthing) just in case that goes wrong and all the 50/60 Hz mains return current (maybe 100 Amps or more) tries to zim down your thin RF earth wire – not good! So how should you obtain an RF earth? Ideally, by a thick wire to lots of well bonded metalwork buried in the ground over an extended wet area! That maybe impractical if you live in a flat several floors up so the next best thing is to provide the missing half of the ideally balanced aerial in the form of a counterpoise; this needs to be a quarter wave long at the operating frequency. If that is difficult then consider a magnetic loop aerial, it wont be as good as a large outside aerial but they do allow you to get on air - even with a thing like my 'radiator' on the right, complete with its own gamma match!! G3PCJ

Analysis of the Crystal set's Detector

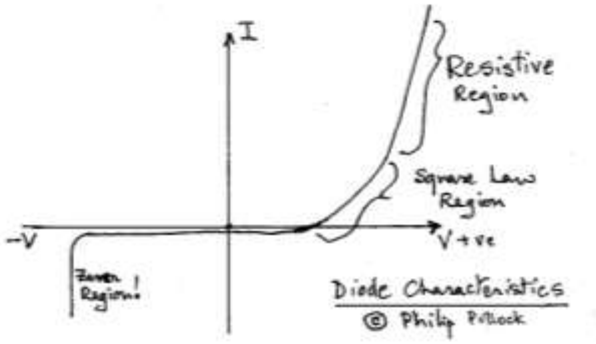
It is said that, "You don't understand something until you try to teach it". I have recently come to appreciate the truth of this as I teach a course at the South Dublin Radio Club.

Nothing shakes one's confidence more than examining the fundamentals of a subject. How much of my knowledge is incorrect 'Ham Lore' or glossed over principles taught to me at University? Explaining the fundamentals, raises the question, "do I really understand it myself?" Lets take the crystal set for example, as I heard on Solder Smoke of the Michigan Mite," There's a lot of electronics going on there". The tuned circuit was easy enough to explain, as was the crystal ear piece. But the detector or demodulator - or is it a rectifier? That, gave me problems.

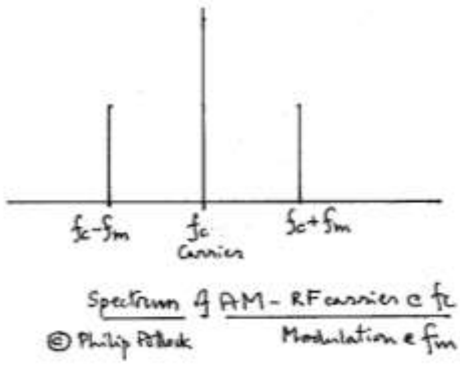
Read the simplified explanations and one could think that there is a carrier wave whose amplitude varies with the modulating waveform. This is then rectified by a diode and the radio frequency component is filtered off, leaving the audio. Much is made of selecting the appropriate CR time constant for best output as it follows the modulating waveform. Other sources such as The ARRL Handbook, most emphatically state that the audio is demodulated from the carrier using the diode as a demodulating mixer. The audio being one of the mixer products. (ARRL Handbook 2013 10.9) That a diode demodulates an AM signal by allowing it's carrier to multiply with it's side bands may jar those long accustomed to seeing diode detection ascribed merely to "rectification".

What should I tell my students? To decide, it was back to the fundamentals. The diode detector is so called because it was used to detect the presence of a signal. It can work in two ways: as a frequency translator for low voltage levels as in the diode modulator. Here the transfer characteristic of the diode is like a square law device. For large signals the transfer curve becomes resistive and the diode behaves as a rectifier.

Here is a diode transfer characteristic. Here we can see the two regions of operation - Square Law and Resistive. For the small signal, multiplication occurs due to the square law diode transfer properties and the modulating signal is converted back down to audio frequencies. The two input frequencies are the carrier which multiplies with each side band frequency to produce the modulating audio as one of the products. The audio can be filtered out from the other products which are usually outside the range of hearing anyway.



Here is an AM signal with one audio frequency.



What is going on? The square law device has this characteristic:

$V_{out} = kv_1 + k_2v^2 + k_3v^3 + k_nv^n$

The k is a constant & depends on the diode curve's shape. For $V_{in} = V_c(1 + m \sin \omega_M t) \sin^2 \omega_C t$ where m is the modulating index, ω_C the carrier and ω_M the modulating frequency. Apply it to the diode and the k_2v^2 term produces:

$k_2V_C^2 \div (2m^2 \sin^2 \omega_M t)$ which gives us the modulating signal.

The other terms give us other frequencies which can be filtered out.

As a rectifier: In this case the diode rectifies the signal when it is large and the voltage across the capacitor follows the shape of the envelope waveform. The shape is the waveform of the modulation and therefore the detector output is the modulating signal. Some use the description envelope detector for this detector.

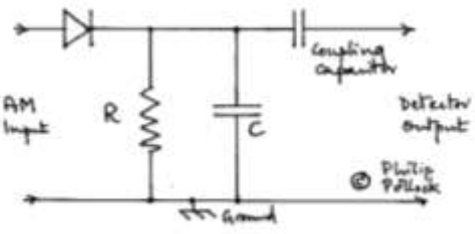
I find this simple explanation hard to understand. If we are talking of a carrier with one audio tone, I can understand how a capacitor will charge up to the peak value of the tone amplitude. Many different amplitudes as found in a voice signal does not make sense. All information should be lost in the integration process occurring in the capacitor. A combined voltage pulse should be the output. The usual text book explanation of the envelope / rectifier demodulator confuses me.

So back to the mathematics! The rectified diode output developed across the resistor should be half sine waves of the carrier and the side-bands. Fourier Analysis of a half sine wave gives a series of:

$v = 1/\pi + \frac{1}{2} \sin \omega_C t - 2/\pi\ (1/3 \cos 2\omega_C + 1/15 \cos 4\omega_C t$ _+.etc.)

Multiplying the signal to the diode by $V_{in} = V_c(1 + m \sin \omega_M t) \sin^2 \omega_C t$ by the series gives these terms:

$V_{OUT} = V_C / \pi + V_M\, m \sin \omega_M t / \pi$ + etc.



Simple diode detector

I am happy with V_C / π which corresponds to the rectified carrier, a DC voltage, and $V_M\, m \sin \omega_M t / \pi$ which gives the modulation, free from it's carrier.

I have describe both methods. Both occur depending on the applied signal levels. I am not happy with loose talk regarding AM. I think it creates much confusion; there are internet forums with arguments over which way a diode receiver works. All the controversy seems to derive from a lack of mathematical understanding and loose terminology. The carrier frequency carries nothing. Each side-band frequency is a modulated carrier frequency. Not everyone can do the maths but they can understand that the diode rectifier demodulator works as a consequence of rectification and multiplication of a signal's Fourier components. A simplified explanation causes confusion.

Note from G3PCJ! I include this thought provoking note above from Phillip to see what any Members think is happening. I must admit to finding it a little hard to use this analysis when designing a crystal detector. I apply the principle that the detector’s CR time constant must be long compared to the period of the RF carrier frequency and short compared to that of the upper modulation frequency. Apart from ensuring the detector has enough forward bias to be operating in at least the square law region, I am not sure what else you should do! Comments or suggestions please!

Derek Alexander G4GVM

Bob Bowden G3IXZ tells me of the sad death on 22nd November of an important person in the history of my kit business. Derek was a great QRP devotee and Chairman of the Yeovil Amateur Radio Club during the formative years of the 1980s when it became a centre of excellence in this branch of our hobby. Together we designed the Yeovil transceiver, as a derivative of an earlier 80m phone superhet TCVR called Tiny Tim. The Yeovil was a great success and was an important early project in my kit business; Derek regularly used his Yeovil until quite recently. On moving to Hereford about 22 years ago, he joined the Hereford ARS and greatly boosted the construction activity by designing a simple direct conversion QRP CW transceiver, many of which were constructed by club members at the time. I think I am right in saying this became known as the Fox Mk 3. His enthusiasm never waned and he was still designing and building innovative items right up to the end.

He will be greatly missed by all who knew him, Tim G3PCJ

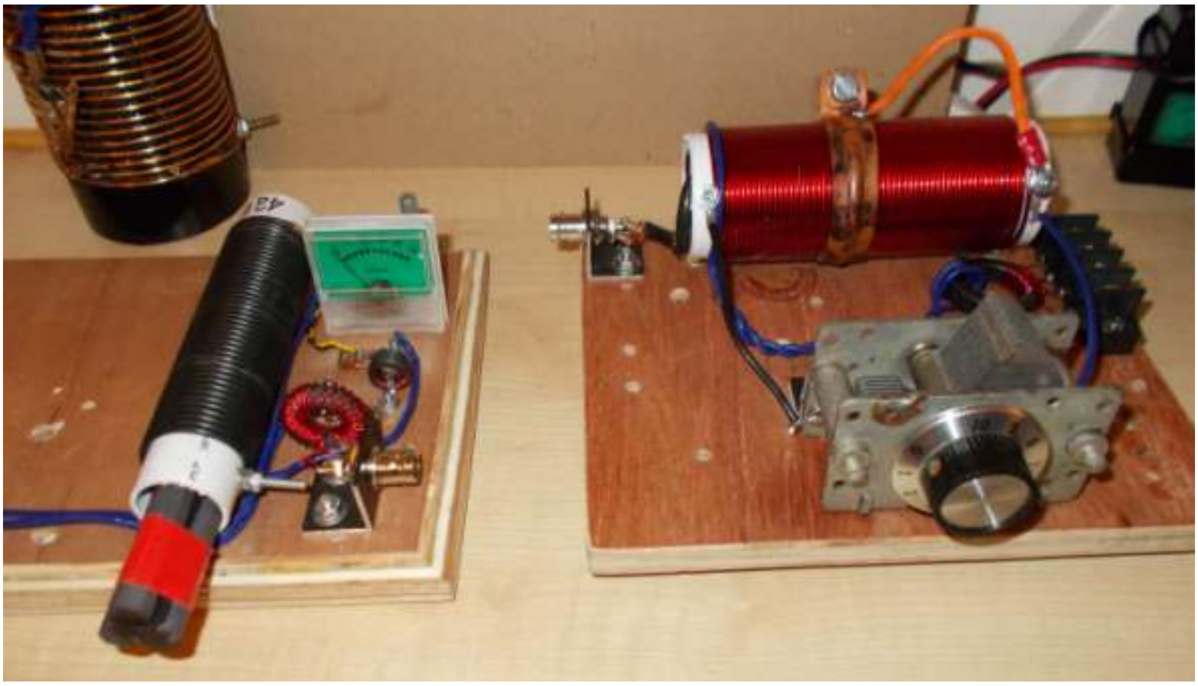
Les Moxon, Random Wires, Counterpoises… by Peter Thornton

An all band HF antenna that fits an awkward and pinched space - my back garden - is a W3EDP, but couldn't get RF "up the spout" on all HF bands despite all the usual tweaks. Time for another look at my "Bible": Les Moxon's (G6XN) "HF Antennas for all Locations". Les reckons an end fed wire is a Zepp fed, scant half doublet - with all the usual problems, and plenty!

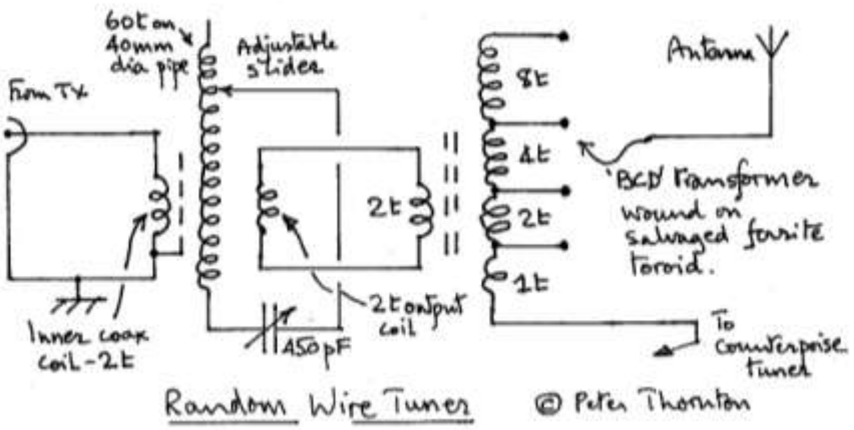
Les shows some ways to feed random wires; I added Faraday screens and an output isolating transformer. The 'EDP's counterpoise, usually 17' long, I found better at 9m, chucked wherever the cat allowed, and tuned this as per Les' advice. The counterpoise tuner is 2m away from the ATU; I found close together wasn't as effective - the wire between them playing a part. Individual circumstances being so variable, you'll need to try a few options to get the counterpoise series resonant. MFJ make "artificial earths", and this is what you're after with a counterpoise.

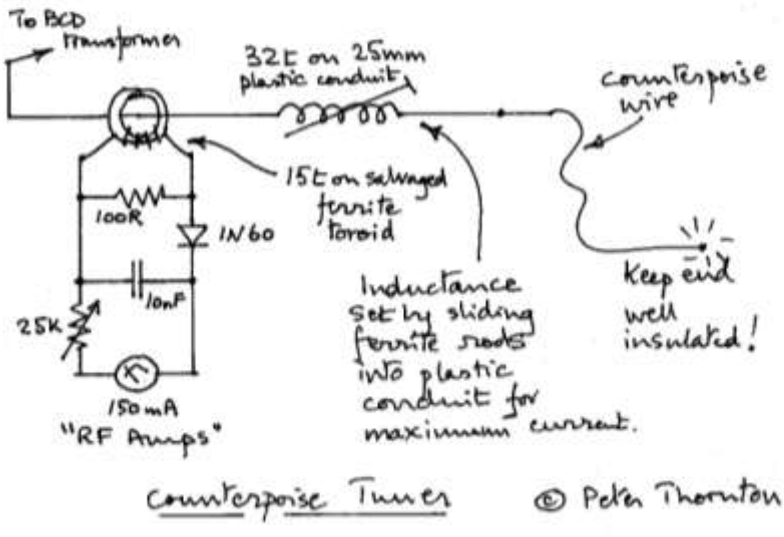
I have a penchant for salvaging ferrites from scrap switch mode power supplies; and here's where I used a few. I've found suitable ferrite rings quickly and easily, these ferrites are chunky rascals, easily able to handle my QRP 5 watts. The 2 turn driver coil fits *inside* the resonator coil, made from co-ax with the core soldered to the screen through a hole in the sheath for a Faraday shield. Directly above the driver coil, on the *outside* of the resonator coil, is the 2 turn output coil: this is Faraday screened from the driver coil by the close wound resonator coil. The output coil link feeds the BCD transformer which allows a choice of ratios to get the best match. The resonator coil has a sliding copper collar, made from a 54mm copper pipe "U" clip, bent into a circle to clamp around the resonator coil. I soldered the shorting wire to the collar as the clamp screw can't be used for connection - it can't be too tight or you can't slide the collar along the coil. I removed enough enamel from each turn of the resonator coil for the collar to contact wherever it was set - about 1/5th of each turn. With 60 turns on 40mm waste pipe I can tune and match 0.9MHz to 30MHz.

The BCD transformer gives a wide range of load impedances. The multiple isolation and screening eliminate stray RF, and the tuned counterpoise, though an extra "faff", gives far better results; what's more I can see the results in the RF ammeter - very useful, in circuit permanently and no lossy SWR meter. I run AM on a local net (3615kHz & 7158kHz) and the results are much improved; the tuner runs with "room to spare" Top Band to 10m, so I can experiment on any HF band, without risking the transmitter P.A.



Counterpoise tuner on left and main AMU on right in photo above.





Snippets

602 Input levels Philip Lock reports further on experiments to improve the Minster TCVR LO mixing (when adding band cards) by altering the SA602 mixer input levels to reduce unwelcome mixer products that caused birdies. He found that the screened PCB interconnecting leads were best grounded at both ends, especially the coax for the point 7 connection. He also removed R211, and replaced C208A and B to 140 pF, and changed R210 to 5K6. After this the signal on pin 6 of IC210 was about 250 mV p-p and triangular. He would have preferred a sine wave input to the LO mixer (to reduce the harmonic content) but this is not easy to achieve without considerable complications in a multi-band rig!

Valve HT supply I have laid out the PCB for the circuit (to obtain 250v DC from a nominal 12v DC input), that I outlined in the last Hot Iron. It is not yet tried out but if anybody is particular interested, let me know and I will get on with it!

Collecting parts One member, new to electronic construction, asks what 'parts' he should obtain to support his future electronic projects. Most of us who have been dabbling for years instinctively know what might be useful, and hence buy it when we see it for sale cheaply! It is difficult to make a definitive list but I would always include almost any small or medium sized hand tools, perhaps next followed by items of simpler test equipment such as multi-meters, digital counters, signal generators, or even oscilloscopes. Obtain these and you will not need much else! After that the more obscure/expensive parts are worth bagging when the opportunity arises. I would put single or multi gang air spaced variable capacitors top of the list, especially those with slow motion drives! After that mains transformers with low voltage secondaries that might be suitable for power supplies (with care), and even rarer items such as IF filters with CW or phone bandwidths, based on commonly used actual Intermediate Frequencies. Most other parts are now so cheap that, when you have not got what you need, you should order 100 of them – often the delivery costs alone will make that sensible!! G3PCJ

Data storage etc

There has been a lot written recently about scammers obtaining personal records in order to perform identity theft etc. So I now explain my approach! Generally, I do not keep records of any Hot Iron reader's personal information apart from your name and e address – because I am not usually told it! I do keep the addresses of most people ordering kits, but when I get that data from Paypal etc, they are usually kept here in paper form. I am never told credit or debit card numbers because I have no need for it, nor any means of using that information! The name and address information that I do store electronically (in an Outlook address book) is not encrypted and I try to avoid that information being available to other readers when sending Hot Iron out. However, if anybody is unhappy about your information being vulnerable to hacking, then please let me know and I will delete your data. Tim G3PCJ

Finally Happy Christmas to you all and may your electronic experiments all work first time next year!