

Postscript to the Restoration of an Eddystone's 'One and Only HiFi Separate' – Model S.820 Tuner - by Gerry O'Hara, G8GUH/VE7GUH

Introduction

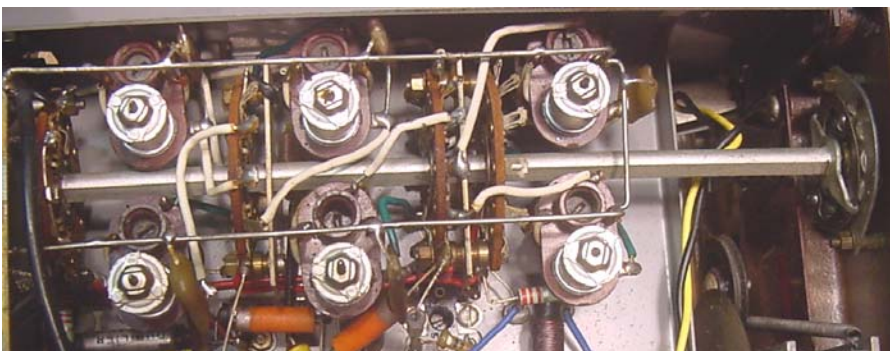
Restoration of my Eddystone S.820 was described in an earlier article posted to the EUG Website. Several weeks have now passed with the tuner being played every day during this period for several hours or even days at a time. Things went well for the first couple of weeks and then the tuner developed a dreaded 'intermittent'... resolving this issue, together with another one that developed shortly afterwards, form the basis of this postscript to the original article. I have also decided to keep the S.820 connected to my audio system as it does sound very good and I really enjoy getting that 'Eddystone' thrill when spinning the tuning knob (sadly lacking in my Akai tuner, good as it is). Who needs stereo anyway?



Staying in a room where cats sniff at things and where other folks may poke their fingers, I decided that the tuner must have a case – I thought a Perspex one similar to the one fitted to my S.750 would be ok.

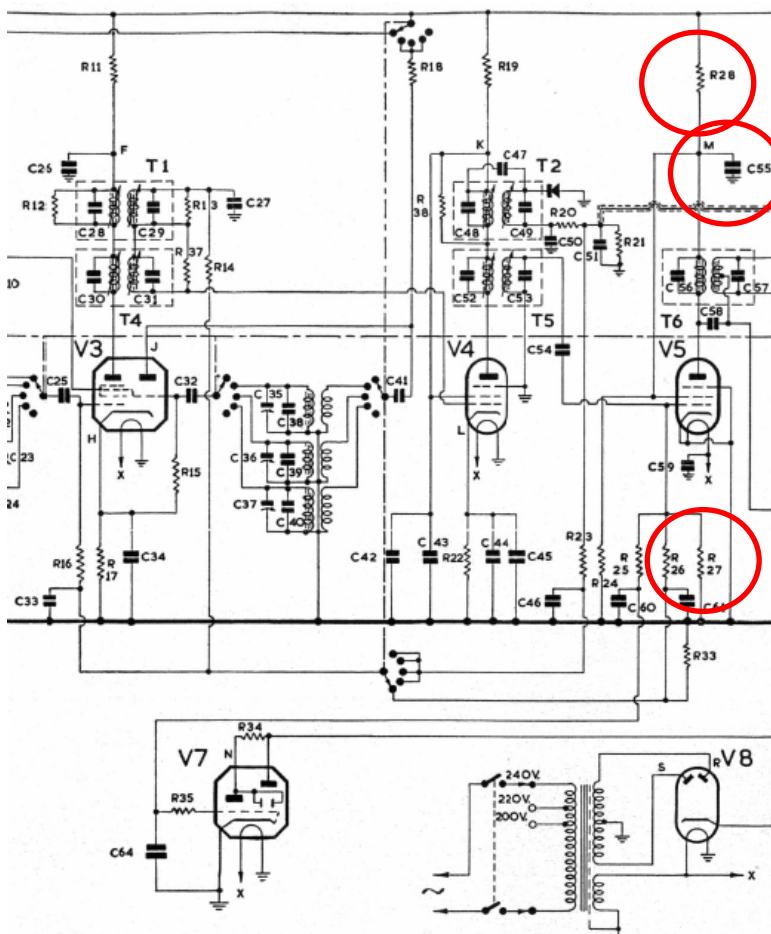
A Limiting Problem

One evening, I was listening to 'Classic Rock 101' and the audio suddenly dropped in volume and became slightly distorted. I swung the tuning knob and all stations were affected similarly. I tried switching between MW/LW/FM and it came back to normal. I re-cleaned the wavechange switch contacts with De-Oxit and inspected each of the wafers and switch contacts with a magnifying glass – all seemed ok. The set worked for another day or so and then it did the same thing. Flipping the wavechange switch did not help this time, so I tried the trusted 'on-off-on-off-on' test and the set righted itself again. Everything was ok for another couple of days and then it did the same thing. This time,



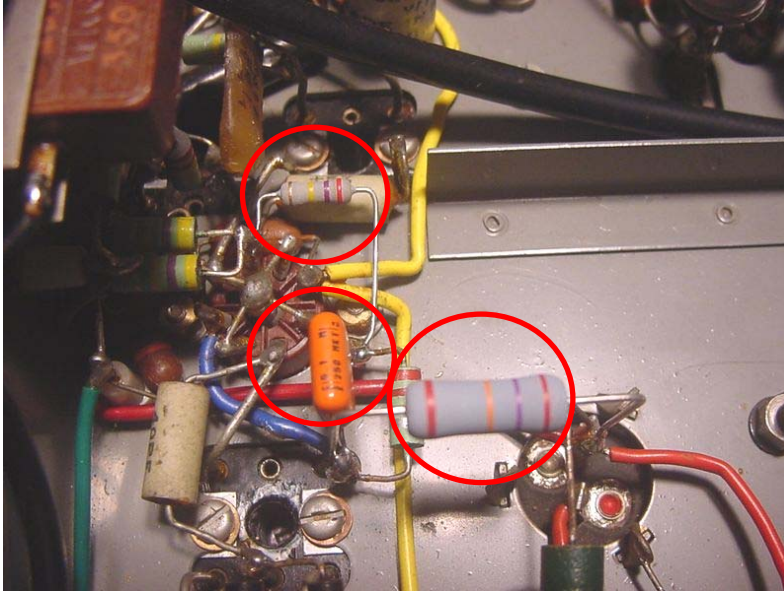
switching the set on and off did not work and neither did flipping the wavechange switch. At first I suspected a dry joint or dirty valve pins. I removed each valve and

lightly sanded each pin with #600 grit paper, wiped them clean and then doused them in De-Oxit before working them in and out of their respective valve sockets a few times. I switched the set on and it was fine..... for an hour or so. This time I was getting a bit frustrated and realized that some 'sleuthing' was needed. When the set was working, I tuned in a station that gave a steady reading on the 'magic-eye' (an EM80). I left the set running on my workbench and monitored it while doing other stuff in the shack. A half hour or so later the fault appeared. I noted that the 'magic-eye' was still showing the signal at the same strength. This indicated that the receiver was probably working ok up to the limiter stage as the grid of the EM80 receives its signal from the FM AGC line which is coupled to the grid of the limiter valve (V5, a 6AM6).



I re-checked the connections around the limiter valve (schematic, left) – no apparent dry joints (I thought I may have made a poor re-soldering job when I re-connected R27 after aligning the FM section of the tuner), but all appeared in order. I re-made one or two joints 'just in case' and replaced the rather tatty-looking R27 (270kohm, $\frac{1}{2}$ W) with a modern high stability type. I switched the set on and the fault appeared after another half hour or so. I re-checked the anode voltage on V5 – it was 70v with no signal and 80v with a signal tuned in. The anode load resistor, R28 was then checked (27kohm, 1W) as it did look a little discoloured (but definitely not roasted) - sure

enough, it was out of tolerance (unusually, low), so I changed it out for a high stability 2W resistor. I switched the set on again – the voltage was now around 55v with no signal, but after an hour or so the fault re-appeared. I checked the other resistors around the limiter and these appeared within tolerance, so I began to suspect that a capacitor was



either breaking down or had gone low-capacity. I tried bridging the anode decoupling capacitor (C55) - a 0.003uF tubular paper type that resembles a fat resistor (as do many of the smaller capacitors in this set) - using a 0.01uF Mylar capacitor - the fault disappeared. I removed C55 and replaced it with the 0.01uF Mylar (orange component in photo, left). I switched the set on and... thank goodness

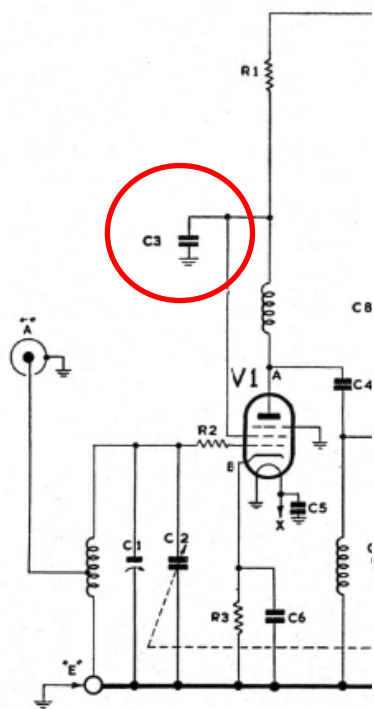
it worked fine after that, so I duly placed the tuner back into service with my audio system in my basement office.

The RF Stage Goes Ballistic

Another week went by and I was tuning about to see what I could pull in with the S.820 using a (slightly) better aerial setup than my 30" bit of scrap wire - a 'rabbits-ears' set top dipole affair I found in my junk box. On tuning through a particularly strong station around 95MHz, the tuner went quiet. I tuned away from the strong station and it behaved normally again. The fault was mostly repeatable, but sometimes it did not occur when that station was tuned in and I could listen to it for some time before it would suddenly go completely quiet again. During these 'quiet events', I noted that the 'magic-eye' was full on (as it was when the strong station was being received ok). Back to the workbench...

I upended the S.820, tuned in the strong station and started to probe about with a plastic knitting needle (I bought a job lot of these at a local Salvation Army 'Thrift Store' some time back to make some alignment tools and have a few left over - they come in handy for such things). I suspected that this new fault was in the front end, though the probing indicated that it was probably not a mechanical issue.

I decided to take a closer look at what was going on with the AGC as it intrigued me as to why the 'magic-eye' was fully on when there was almost no audio (apart from a little hum and a bit of quiet 'static'-like noise, plus a very slight 'click' just as the set went quiet). I connected my trusty EICO valve-voltmeter to the AGC line and noted that when tuning through most strong(ish) stations the AGC voltage reached a maximum of -4v or so, but on the really strong station (when it went eerily quiet) it suddenly jumped to just over -11 volts as the set went silent. I first suspected that the hexode section of V3 (ECH42) may be acting strangely with such a high negative bias applied. This valve acts as the first IF amplifier in FM mode - I recalled it did not test that brilliantly when I first



checked the valves on my valve tester. I changed it out for another – no difference. Hmm... I now suspected that the sudden jump in AGC voltage was being caused by some instability in the front-end, ie. a spurious signal generated by self-oscillation of the RF amplifier, V1 (a 6AM6), stimulated by the presence of a very strong signal. The first suspect for such instability was the anode decoupling capacitor on V1 (C3 – schematic, left), a 500pf tubular paper type that also resembles a fat resistor. I bypassed this with a 1000pf Mylar when the strong station was tuned in and the AGC line was reading -10v and it immediately cured the fault condition. I removed C3 and checked it out with my capacitance meter – it was reading only around 17pf (not much use as a by-pass capacitor!). I replaced it with a ‘near-enough’ 680pf Mylar

(blue component on the photo, right) and the fault was fixed – no problem receiving that very strong station now at all (around -7v on the AGC line when tuned on the nose) and not a hint of any instability. Now, back to easy listening... I hope.



A Case at Last

So, having decided to keep the S.820 as part of my office audio kit setup (just so I am never too far from an Eddystone tuning knob – I also keep my S.750 on my home office desk, just in case I get withdrawal symptoms when I am playing with my DX-394), I figured that I needed a case for safety and to keep the dust and my very inquisitive cats out.

After some thought as to whether a metal case would be best, I came around to thinking that as the Perspex case I had made for the S.750 was providing good service I could make a smaller version for the S.820.

‘TECHNICAL SHORTS’

by Gerry O'Hara, G8GUH

‘TECHNICAL SHORTS’ is a series of (fairly) short articles prepared for the Eddystone User Group (EUG) website, each focussing on a technical issue of relevance in repairing, restoring or using Eddystone valve radios. However, much of the content is also applicable to non-Eddystone valve receivers. The articles are the author's personal opinion, based on his experience and are meant to be of interest or help to the novice or hobbyist – they are not meant to be a definitive or exhaustive treatise on the topic under discussion... References are provided for those wishing to explore the subjects discussed in more depth. The author encourages feedback and discussion on any topic covered through the EUG forum.

No Case For Your Eddystone? Well, As Monty Python Said, “...Now For Something Completely Different...”

Having completed the restoration of my S.750, the remaining niggle was that it did not come with a case (it was sold as a ‘parts set’ on eBay and the seller, a knowledgeable radio amateur, confirmed that it was from an estate sale in the Okanagan Valley, British Columbia, and that he had indeed checked the various sale lots to see if the case was anywhere, but to no avail...). I would hazard a guess that the radio was probably fitted into a ‘console’ or rack at some point in its working life and the case was removed at that time and either discarded or stored in a ‘safe’ (and long-forgotten) place – it is probably now home to a family of mice...

I figured the chances of coming across a spare S.750-style metal case in British Columbia, or anywhere come to that, were at best a bit slim (but see Postscript!). The radio is a neat size for the desk in my office (currently sporting a Radio Shack DX-394 that I picked up new in a sale a couple of years ago for 100 bucks) and as the S.750 now works really well (and the tuning feels soooo good), I decided I wanted to put it into everyday use while I work or ‘play’ at my desk.



My naked S.750, post-restoration



The materials and techniques used are as described in Technical Short #4, downloadable from the EUG website – so I will not repeat it here save to include a few photos during and after construction and fitting at the end of this postscript article. It works

a treat and I think looks pretty good too (as well as keeping the dust and my two prying cats out).

Another Channel Anyone?

So, Eddystone never got around to making a multiplex decoder? – on the face of it, not that difficult to do these days: it's a single-chip solution, and I wondered if I could build one to work with the S.820 (no irreversible mods mind you, only something 'bolt-on' that could be removed without trace would be considered). All that is required of the S.820 is to provide a suitable signal take-off from the discriminator stage to feed to the decoder's input. The sidebar, right, provides an outline of 'what, when and how' in relation to multiplexed stereo technology.

On browsing various old magazines and web-based articles for something suitable, I came across quite a few circuits that would likely work. Some of the circuits in 1970's Practical Wireless looked very promising, eg. The 'IC of the Month' article in the August, 1970 issue featured the Motorola MC1304 stereo decoder chip. This is a 14 pin DIL that needs only a handful of parts to make it work, complete with stereo indicator lamp, stereo/mono switch and audio mute (the article is appended) – but could I still buy the chip? The short answer is no – at least not yet - I am still looking for the chip and after a few false starts I am now exploring other options... but too late for inclusion in this postscript anyway (if anyone knows of a readily-available stereo

Multiplex FM Stereo – Its History and How its Done

In the late-1950's, several systems to add stereo to FM radio were under development and evaluation. Included were systems from 14 companies, including Crosley, Halstead, Zenith Electronics Corporation and General Electric (GE) in the USA. The individual systems were evaluated by regulatory bodies and broadcasters for their strengths and weaknesses. The Crosley system was rejected by the FCC because it degraded the signal to noise ratio of the main channel, did not perform well under multipath RF conditions and had an excessively wide FM subcarrier bandwidth that prevented the use of Subsidiary Communications Authorized transmissions (SCA). The Halstead system was rejected due to lack of high frequency stereo separation and reduction in the main channel signal to noise ratio. The GE and Zenith systems were so close that they were combined and became the standard stereo FM broadcasting method in the USA, the UK and most other countries.

It is important that stereo broadcasts should be compatible with mono receivers. For this reason, the left (L) and right (R) channels are algebraically encoded into sum (L+R) and difference (L-R) signals. A mono receiver will use just the L+R signal so the listener will hear both channels in the single loudspeaker. A stereo receiver will add the L+R and L-R signals to recover the Left channel, and subtract the L+R and L-R signals to recover the Right channel.

The GE-Zenith method of encoding stereo information on a composite carrier results in L+R signal having a bandwidth of 30Hz-15kHz, a L-R sideband signal having a bandwidth of 23-53kHz and a 19kHz pilot carrier. Each of these components is separated from the composite signal by an appropriate filter and then fed to a matrix. The L+R signal is fed directly to a matrix, whereas the L-R signal is applied to an AM detector, as is the pilot carrier after it is doubled in frequency to 38kHz. The detector mixes the sidebands and the carrier to produce the original L-R audio signal, which is then applied to the matrix. The matrix then combines the L+R and the L-R signals to recover the left and right audio channels.

decoder chip or kit, please let me know). When I eventually track a suitable chip down I will take the input to the decoder directly from the junction of R29 and R30 in the S.820 to provide the best frequency bandwidth (check out the Leak Trough-Line circuit attached to the S.820 restoration article for an example of how they did it).

Knob Clean-up

One little cosmetic job not described in the S.820 restoration article was the clean-up of the three knobs. One of these was quite badly scored, the others only had light soiling and minor scratches present. Having just bought a set of three 'Novus' plastic cleaner fluids from Antique Radio Supplies, I was keen to give these products a go (rather than my usual



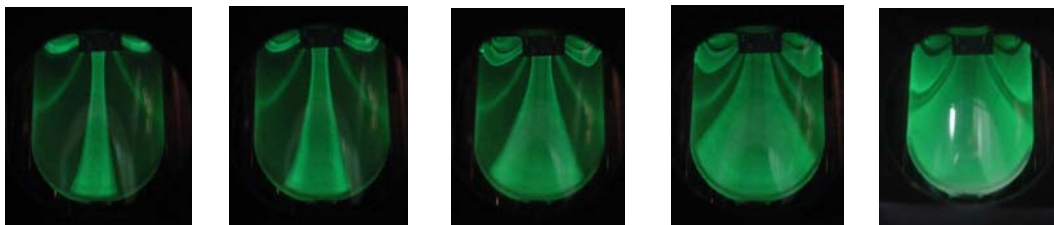
soapy water/ toothbrush wash, followed by a clean with rubbing alcohol and Brasso to remove any scratches). The set comprises bottles of #1, #2 and #3. #1 'Plastic Clean and Shine' is touted to be suitable for cleaning, shining and protecting plastics, #2 is used to remove fine scratches and #3 is for the removal of heavy scratches. I must say that they work well and the knobs now have a great luster that contrasts well with the reddish-coloured fingerplate (see photos).

Conclusion

So, a couple of months after receiving the S.820, it is now probably the most listened-to Eddystone in my collection – only because I listen to music and some talk-radio a lot while I work and do other, non-radio things (yes, most of what I do has not a jot to do with radio!). I am sure that more faults will eventually develop over time as there are plenty more of the tubular paper capacitors in there to go wrong – actually about 20 more - and I do not intend to simply replace them all at one just for the sake of it as many are quite difficult to reach and others I have tested are working ok. Never mind, its more 'fun' this way anyhow...

73's

© Gerry O'Hara, G8GUH/VE7GUH (gerryohara@telus.net), Vancouver, BC, Canada, November, 2007 (yes, I finally got around to taking my Canadian amateur radio exam...)



Above: The EM80 'Magic-Eye' at work: weaker signals to the left, stronger to the right

Postscript to my Postscript

I have been asked how I did the repairs to the valve bases (two of the B7G bases in the S.820 had damage to the shield retaining collar: in one case, on (V1) it had completely detached from the base and on another (V5) only one side was still holding). I mentioned a type of epoxy adhesive 'JB-Weld' that I had been recommended



by someone at the SPARC radio museum over here in Coquitlam, BC. I am not sure if you can buy this goop in the UK, but here is a photo of the packaging so you may be able to find it locally. It is a steel-filled, grey-coloured epoxy that seems to bond metals particularly well. I have also included some photos of how its done (yes, I don't do anything these days without a camera at hand – not even a glue-job!).



Above: The VHF RF amplifier valve base (V1) before and after 'JB Welding'



Above: The limiter stage valve base (V5) before and during 'JB Welding' (clamped)



(according to the packaging, an outfit in Texas repaired a Cat engine block with this stuff and saved \$4,000...). Anyway, its definitely strong enough to hold a valve shield retaining collar in place! (and certainly beats replacing the valve bases – a rotten job on any receiver).

Simply clean both surfaces to be ‘welded’ (their term, not mine) – I used a small, stiff wire brush that I use for cleaning-up soldered joints. Mix the goop up (like mixing Araldite-type epoxy) and apply with a small tool (screwdriver). It takes about 6 hours to harden to a point where it can be handled, 15 hours for ‘full’ curing, ie. when the part can be put into service



Above left: Clamping during JB ‘welding. Above right: The limiter stage valve (V5) with the valve shield back in place after JB ‘welding’ – the repair is almost ‘invisible’

Postscript 2 to my Postscript

So, just as I was wrapping things up for this postscript, I popped down to the local radio museum (SPARC) and while standing talking in the ‘vintage audio’ section, I happened to glance upwards and guess what was sitting on the top shelf? – nothing other than a rather dusty Leak Trough-Line Mk1 that’s what! So, I checked it out pronto for a possible restoration job and took the opportunity to take a few comparative photos. Actually, the only ‘flimsy’ thing about the Leak when examined ‘in the flesh’ is the dial drive mechanism and the plastic ‘facia’ – the chassis is otherwise pretty robust, though I must say, not quite in the same league as the S.820. It will be interesting to compare the two for performance on FM (the Leak does not have the AM bands that the S.820 does but has a more sophisticated circuit as described in my S.820 article) – that will be some time off though as I have a bit of a backlog developing in my little workshop.

In the meantime, I’ll just keep listening to my little S.820...

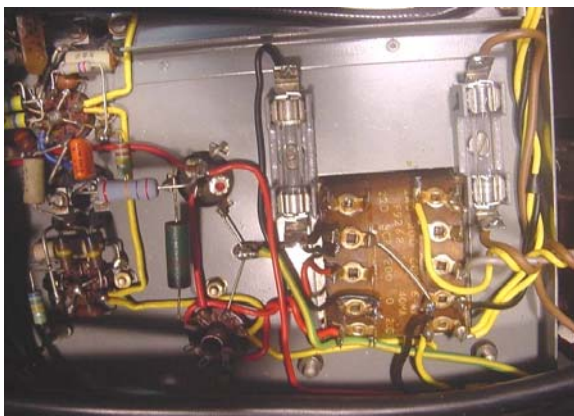
Some Useful References

Various documents downloaded from the EUG website including:

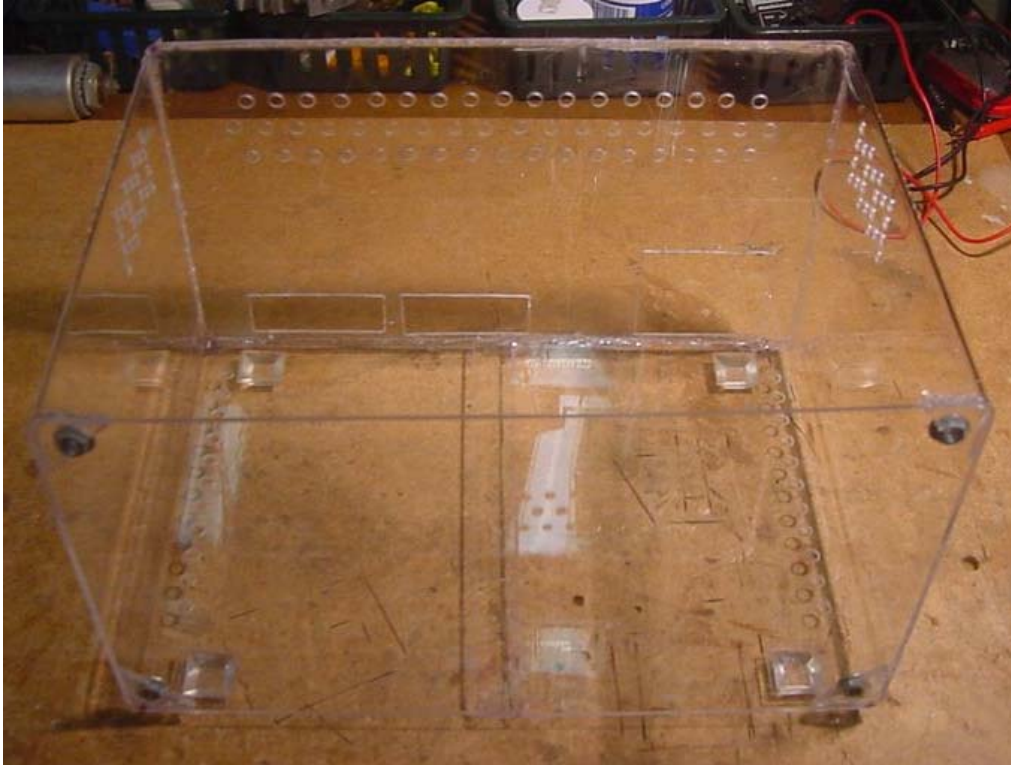
- S.820 Manual
- Eddystone S.820 Restoration
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And, of course various articles and snippets from Lighthouse (I forgot to include these in the original article – sorry folks):

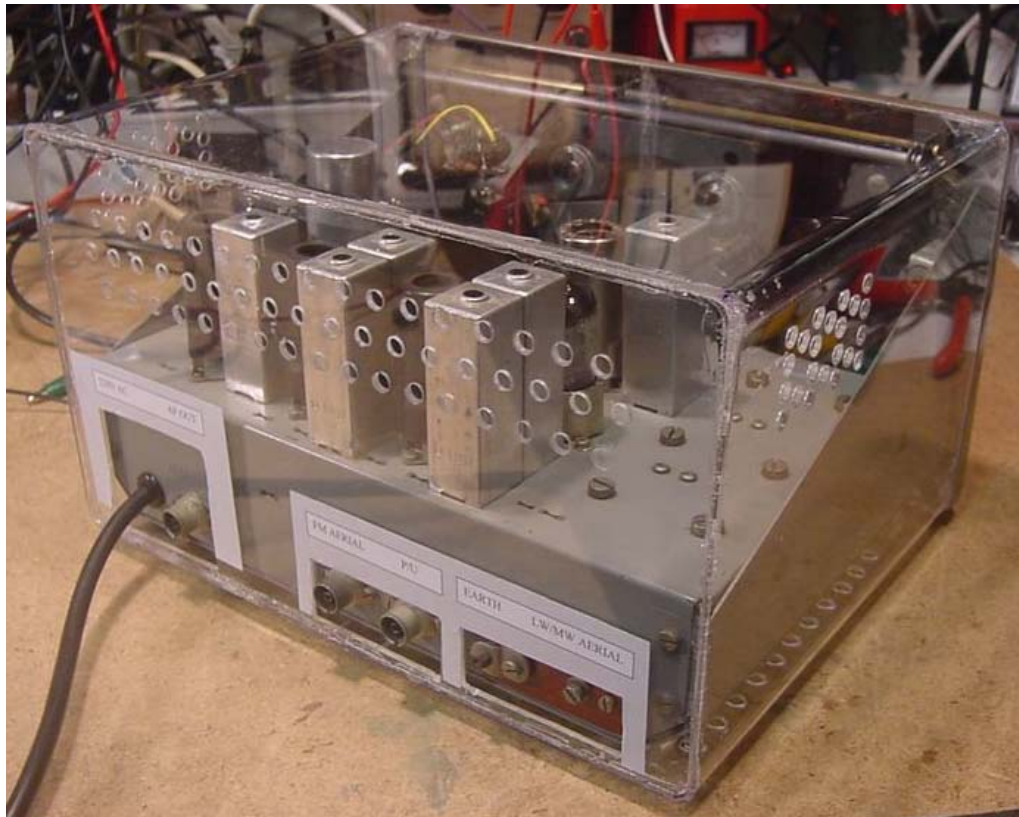
Details	Issue	Page
acquisition & case	20.....	3
advert, Stratton & Co.....	51.....	35
case	16.....	3
.....	67.....	5
co-ax sockets.....	29.....	13
condenser omitted from circuit	67.....	5
documentation, original	34.....	17
dry joint	73.....	8
fault repaired.....	59.....	6
featured model	66.....	12
frequency coverage, query as to.....	56.....	12
gain, low	22.....	7
.....	22.....	20
featured receiver	20.....	3
H.T. circuit repair	79.....	16
in use	28.....	16
photo	66.....	1
reliability	27.....	14
repairs	46.....	4
.....	48.....	27
.....	53.....	5
.....	63.....	20
.....	65.....	6
stereo version query.....	21.....	2
transformer failure	72.....	16
tuning problem.....	51.....	4
valves		
V5 low operating voltage	28.....	30
problem cured	74.....	16
upgrades	61.....	7



Left: After reading through some of the above Lighthouse articles, I decided to fit a second fuse – this time a 100mA in the transformer HT center-tap to ground (the fuseholder for this is the one located on the left)

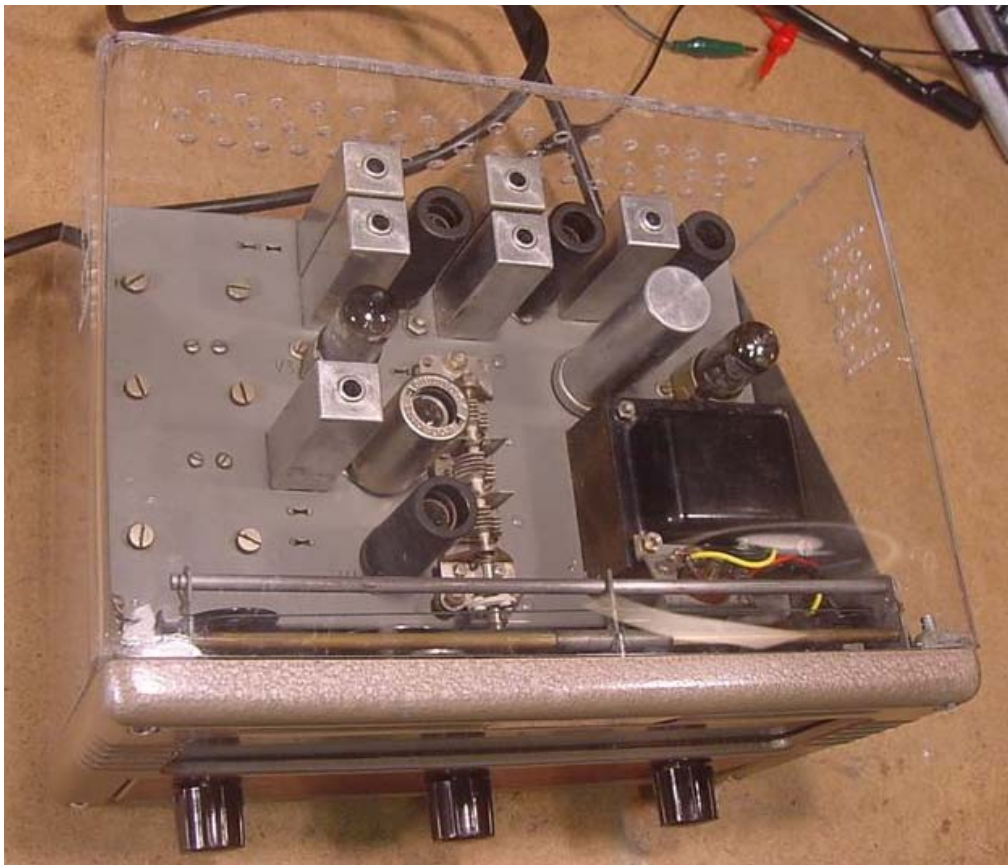


Above: The Perspex case under construction – plenty of ventilation holes and cut-outs for the rear panel sockets and power cable. Below: The finished case fitted to the S.820. I made some labels for the connectors as the chassis stampings are hard to read when looking over the top trying to make the connections





Above: A case at last – looking smart and ready for a move into my home office. Below: Top of chassis viewed through the newly-fitted Perspex case

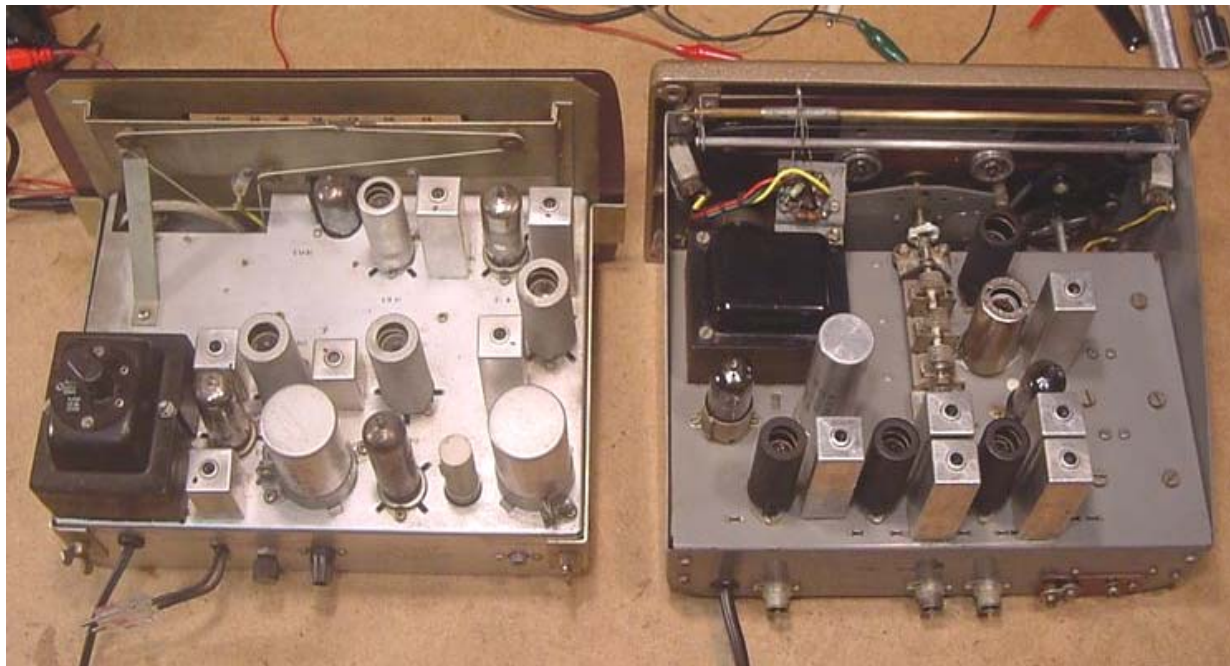




Above: Playing away quite merrily and running nice and cool too (the tuner only takes 40mA HT current, so the EZ41 runs cool, as does the power transformer)

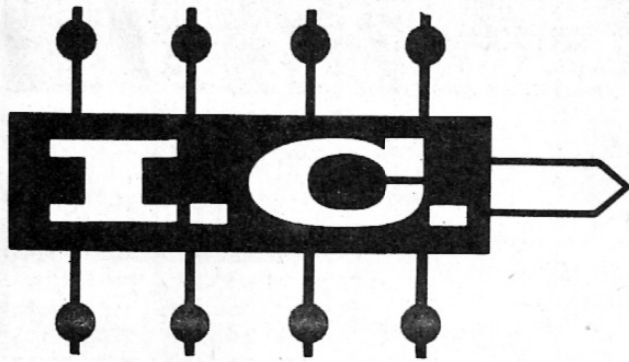


Above: The 'terrible twins' from below (Leak Trough-Line Mk I on the left, the S.820 on the right). Below: Same, but top of chassis views



Below: S.820 – “Stop looking gormless – your next mate...”





OF THE MONTH

L.A.J. IRELAND

Number 10

MC1303 Stereo Preamp/Decoder

As long ago as December 1967 "P.W." carried a report, with full assembly details, on an f.m. tuner incorporating a special-purpose linear integrated circuit, the R.C.A. type CA3014, as the i.f. amplifier stage. Since then other manufacturers have introduced competing f.m. i.f. amplifier i.c.s, and now there are also available units to perform the other functions required in a hi-fi audio system. This month two of them are considered, a stereo decoder and the audio preamplifier to follow it.

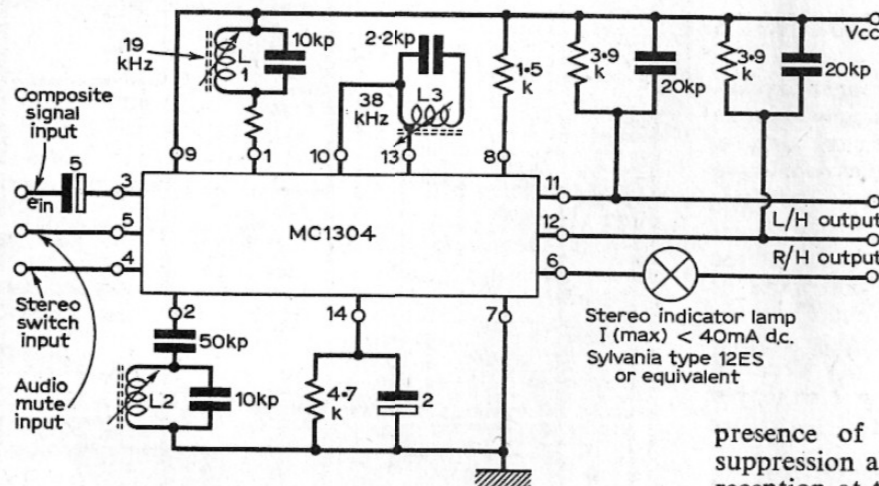
MC1304 Stereo Decoder

First, the stereo decoder, a Motorola unit type MC1304. With a handful of resistors, capacitors and coils this unit takes a "pilot tone" type multiplex stereo signal from the discriminator stage of an f.m. tuner and sorts out the separate right and left

channels to the extent to which right and left channels differ at any given moment.

The difference is actually transmitted in the form of an amplitude modulation of a subcarrier at 38kHz, and therefore a decoder is analogous to a t.r.f. receiver tuned to this frequency, followed by a matrix which produces the separate channels from the now known sum and difference signals. There is one final complicating factor; to conserve bandwidth the sidebands only of the 38kHz a.m. subcarrier are allowed to contribute to the frequency modulation. The "suppressed carrier" must be provided if a conventional a.m. detector is to function, and this is in fact produced in the decoder with the assistance of a 19kHz "pilot tone" accompanying the sum signal.

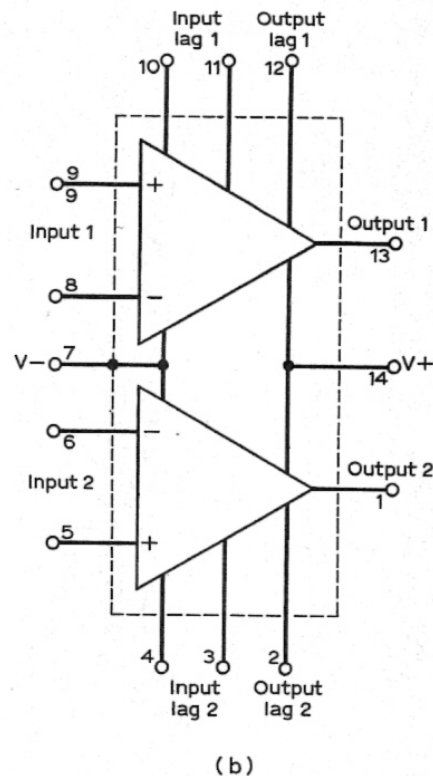
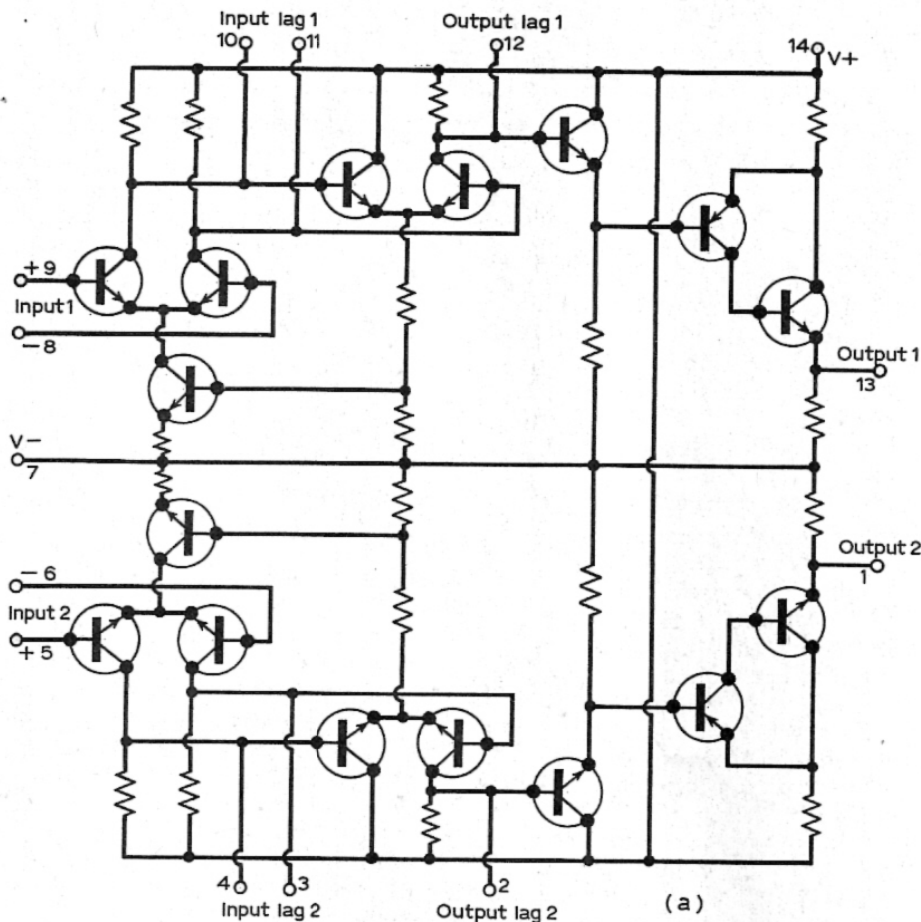
To these essential functions the MC1304 adds a few "optional extras" in the form of a lamp driver output activated by the pilot tone to indicate the



Left: The external circuitry required for full stereo decoder facilities using the MC1304. The righthand side of the indicator lamp goes to the 12V supply. Lefthand channel output is between pin 11 and earth and righthand channel output between pin 12 and earth. With a supply voltage of 12V the resistor at pin 8 should be changed to 2.7k Ω .

channels to feed the audio stages of the receiver system. As many readers will know, the pilot tone system of stereo f.m. transmission was chosen by the broadcasting networks since it is "compatible," i.e. can be received as a mono signal on a standard f.m. receiver. This is because the primary signal is the average of the two stereo channels. However, the demodulated stereo signal also contains components at a frequency beyond the limits of aural sensitivity which carry the difference information, determining

presence of a stereo signal, together with stereo suppression allowing comparison of stereo and mono reception at the touch of a switch. A similar system allows complete audio muting, switching the receiver into a stand-by mode. Like the stereo preamp type MC1303, described below, the MC1304 is supplied in a standard 14 lead dual in-line epoxy package, and the circuit and application diagrams should enable the experienced constructor to achieve success with this unit. Layout of the decoder system is not critical, as the highest frequency occurring is the upper sideband of the 38kHz suppressed carrier a.m. signal. In regard to matching this unit to the circuitry of the f.m. tuner, the input impedance is typically 12k Ω ,



Left: Circuit of MC1303, stereo preamplifier unit. Right: Simplified diagram of the preamplifier.

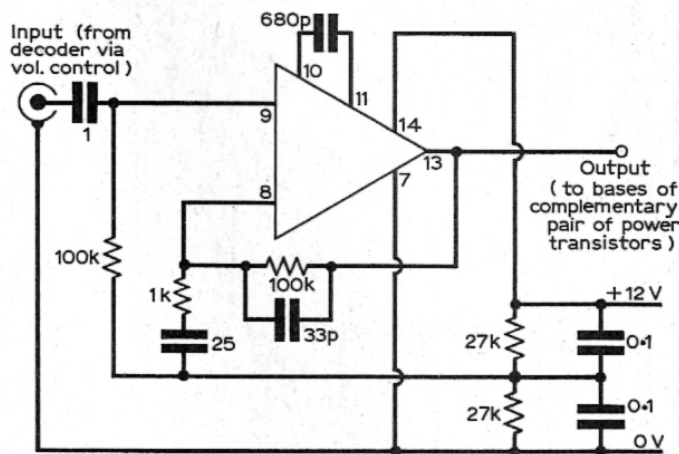
and with this light loading of the discriminator stage of the tuner, no difficulty should be experienced. (One point, however, the satisfactory operation of a stereo decoder presupposes that the tuner had the specified bandwidth for f.m. reception, which must allow for a 75kHz frequency deviation. This is assured in conventional circuits with 10.7MHz i.f. and discriminator circuits, but may not be available in pulse-counting type tuners, with their very low i.f. frequencies, even though a particular specimen appears fully satisfactory in its mono performance.)

The output for each channel of the decoder is taken from the collector of a common emitter transistor stage, so that the only constraint on the audio amplifier following it is that its input impedance should not be too low. However, any standard stereo preamp will have an input impedance of 50kΩ or greater, so again no difficulty in matching should be experienced. For standard applications elegant and effective output stages to follow the decoder, with power levels in the range of 0.5 to 2 watts per channel, can be provided with i.c.s already mentioned in the pages of this magazine, such as the R.C.A. CA3020 or the General Electric (USA) PA237.

MC1303 Stereo Preamplifier

Motorola intend their MC1303 preamp to drive an output stage using discrete power transistors to a level of ten watts per channel or greater. The circuit is a development of an industrial dual operational amplifier, the MC1535, and as such provision is made for operation from a dual power supply, which gives both positive and negative inputs to the unit as well as an earth reference. For single source

operation, as would be provided in the amateur circuit and for compatibility with the decoder, the base bias to the input transistors is drawn from a potential divider. The output level will then also be approximately one-half of the supply voltage, and correct for direct coupling to the bases of a complementary output transistor pair of the appropriate power rating.



Typical circuit of one channel of a stereo preamplifier built around the MC1303.

The power supply unit will be a standard system chosen with regard to the requirements of the output stage, with suitable decoupling for the preamp and decoder. Neither this nor the tone control circuits, also conventional, should provide any difficulty for the competent constructor. ■