

Tale of an Eddystone S.990R - by Gerry O'Hara, G8GUH/VE7GUH

Introduction

Some banter on the EUG forum recently regarding being an early bird at radio rallies reminded me that I missed out on an excellent Eddystone S.990R last year - on sale for \$75 (£37) - by not being a vendor or 'helper' at a local amateur radio fleamarket. The saving grace was that the set went to a good friend (who happened to have volunteered as a 'helper' that day) and who also collects Eddystones, so at least it went to a very good home. Even better, he loaned me the set to try it out and 'explore' its physical construction. This had me thinking that a short article that discussed a little about the S.990R and showed-off the excellent internal construction details may be of some interest to EUG'ers... and probably a much better use of my time than moaning about shady practices at rallies and fleamarkets.



The Deed is Done

My friend tipped me off that there was a local radio fleamarket coming up in New Westminster (part of the Vancouver conurbation) - I tend not to keep close tabs on these things and so frequently miss them. This time I showed up a half hour before the official entry time and joined the 'throng' chatting to folks and having the usual chinwag. The doors opened, we all charged in and I did the usual quick 'reccy' to see if there was anything obviously of interest - nothing jumped out at me, so I started a slower perusal around the most likely tables: above and below - you know how it is. Of course I was on the look-out for anything Eddystone, plus a speaker/mic for a Yaesu FT-60 I had picked up recently and any other radio bits and bobs that may take my fancy. I bumped into my friend, who told me about his pre-

doors-open find - the subject of this article. What a bargain! I did find a Yaesu speaker/mic and, by way of consolation for missing out on the S.990R, I bought myself a nice Hammarlund SP600 JLX23 (photo, left) that I had my beady eye on from a previous fleamarket - hours of fun awaits me in recapping that set,



My Hammarlund Super Pro SP600 (yes I do collect non-Eddystone receivers also - there, I've admitted to it....!)

though surprisingly it works quite well with its original 'Black Beauty's' fitted.

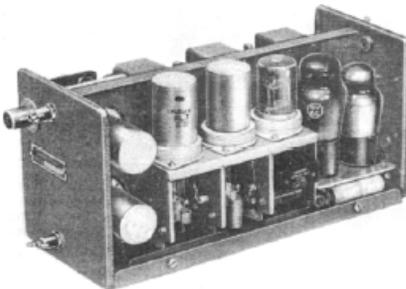
So, you win some/you lose some - no sour grapes at all from me. I reckon that if I was keener and volunteered for such things I would have been in the same position as my friend. If so, would I have bought the S.990R? – very likely! – after all, Eddystone sets are much fewer and far-between here on the west coast of Canada than they are back in Blighty and it could have gone to someone who just wanted to part it out and junk the rest. Come on folks, this is a hobby not a live or die business... for most of us at least.

Well, enough about rallies, now lets have a look at an Eddystone...

Brief Chronology of Eddystone VHF Sets Leading to the S.990R and Beyond

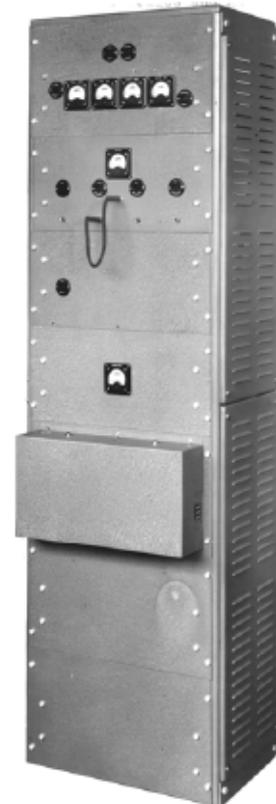


Eddystone was a pioneer in VHF receiver and transmitter technology, with the 'Cooke Report' noting work on a 60MHz tuned 'Lecher line' transmitter taking place as early as 1935 (photo, left, of George Brown, G5BJ working on this equipment). Significant effort was put into developing two-way VHF radio-telephony equipment for police and military use between 1935 and 1938. However it was only with WWII on the horizon in 1939 that this line of development came to fruition for Eddystone with the introduction of the S.214 fixed station receiver and S.215 rack-mounted 100Watt transmitter operating in the 70MHz to 100MHz range (photo, right). Later (1942-45), the S.440B 7Watt transmitter and S.450B single channel AM duplex radio-telephone receiver covering the range 50MHz to 100MHz (photo, below), were produced, these being used by the Admiralty and as part of the British Army Wireless Station No. 57 (as the R408) operating at 90MHz.

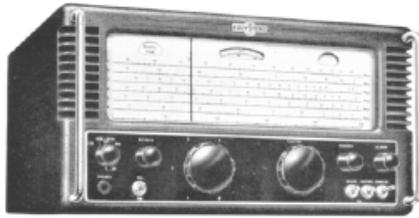


Post WWII, the company started to develop a VHF/UHF receiver around the time of the outbreak of the Korean War (1950-53), primarily for use by

UK GCHQ for aeronautic surveillance purposes. The proposed original frequency coverage for the set, the dual-conversion S.770M, was 20MHz – 250MHz. This set, using a newly-

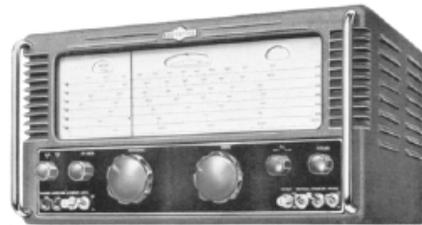


developed turret bandswitching system was shown at the 'Radiolympia' exhibition in 1951, however it never went into production due to its 3-gang tuning capacitor developing self-resonance around 200MHz.



The company then decided to limit the receiver coverage from upper HF through the VHF frequency range, in this case 19MHz to 165MHz, and thus was born the S.770R (photo, left). In addition Eddystone started developing a separate receiver for the higher frequencies – that would become the S.770U (photo,

below, right), a 16 valve, 2 semiconductor diode dual-conversion design (IFs at 50MHz and 5.2MHz) covering the high-VHF through UHF frequency spectrum from 150MHz to 500MHz.



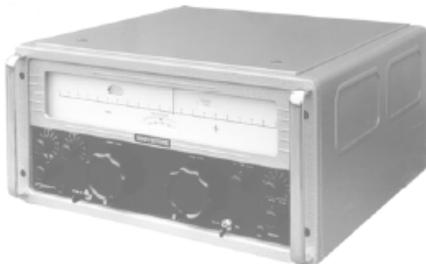
The S.770R, launched in 1953, used a 6-Band turret tuner, a 19 valve, 3 diode, single-conversion circuit (IF at 5.2MHz) and was capable of receiving AM, CW, NBFM and WBFM modes. For many years the S.770R and S.770U were the only

commercially-available receivers covering the VHF and UHF spectrum and Bill Cooke (in the 'Cooke Report') notes that the USSR ordered two hundred S.770R receivers in 1956 in preparation for the launch of Sputnik...



The S.770R and S.770U models were revamped in 1963 along with other product lines into the MkII versions (photo, left), sporting the new 'Style C' grey cabinet and front panel/knobs. However, the circuitry and mechanical features were subject only to fairly minor changes, especially in the case of the S.770R, though which now included a crystal calibrator, a linear dial bar

and a few other small improvements, with the basic receiver circuit remaining essentially unchanged. Further details of the S.770R can be found in my S.770R restoration article and of the S.770U in Ian Batty's article in 'Radio Waves' (both articles can be downloaded from the EUG website).



The frequency range 500 MHz to 1Ghz was eventually covered in the early 1960's by the very rare S.770S receiver (photo, right). This behemoth weighed in at 99lbs, used 30 valves, 18 semiconductor diodes/rectifiers and used cavity tuning in its double-conversion design: a tunable 150MHz to 170MHz first IF and a fixed second IF at 46.5MHz.

Eddystone produced several other valve VHF sets in the 1950's including the S.820 FM tuner, the S.890 microphone receiver (used by the BBC), and the S.930 'bugging' receiver (photo, right) reportedly used for



clandestine surveillance by the military. However, the first Eddystone VHF solid-state sets produced in the mid-1960's were not replacements for the S.770R MkII but were domestic or marine sets that included the VHF FM broadcast band, ie. the EB35 series produced from 1965 through 1980.



By the mid-1960's the S.770R MkII was getting decidedly long in the tooth and in line with sets covering other parts of the radio spectrum, Eddystone developed a solid-state replacement. This was the S.990R (photo, left), introduced

in 1967. It was a very successful receiver and was used in many applications such as Air Traffic Control and the Coastguard service. The



S.990S was introduced in 1968, covering the UHF spectrum (230MHz to 870MHz). There was also the (very rare) S.990T for television monitoring (photo, above).



After a very long production run for a solid state professional radio (1967 – 1981), albeit with some cosmetic changes (a later version is shown in photo, above), the S.990R and S.990S were superseded in the 1970's, with considerable production overlap, by the 1990-series (photo, right) covering 25MHz to 235MHz, 25MHz to 500MHz or 440MHz to



1000MHz, depending on the variant. This series were themselves superseded by the 1995/1 and 1995/2 receivers in the mid-1980's (photo, left), these covering the frequency ranges 20MHz to 470MHz and 20MHz to 1100MHz respectively.



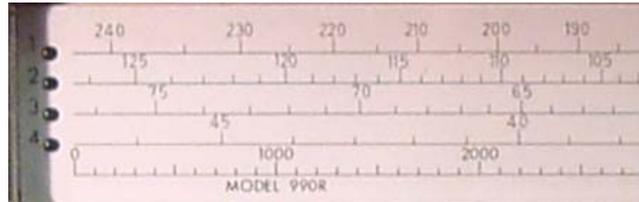
Overview of the S.990R Circuit

The S.990R circuit is comprised entirely of discrete devices: 38 bipolar transistors, 13 diodes and, rather surprisingly, one selenium bridge rectifier in the power supply. The basic design concept was a very straightforward single-conversion design that could be considered rather 'staid', even for the mid-1960's. However, the detailed circuit design was quite sophisticated and the comprehensive output facilities were obviously designed for a range of professional applications. The circuit consisted essentially of a single RF amplifier in grounded-base configuration, a variable frequency local oscillator spanning four ranges (or crystal controlled local oscillator), followed by a mixer and low-pass filter to a rather fancy 10.7MHz IF strip(s) comprising switchable IF filters, separate IF amplifier stages for AM/CW and FM, separate AGC circuits controlling the RF and IF

stages, a discriminator for FM, AM/CW detectors, BFO, a muting circuit, video/audio output circuits and a zener-stabilized 12 volt power supply.

The block diagram is shown appended to this text for reference and the full circuit description/schematic are provided in the manual, downloadable from the EUG website. The receiver tunes (in reverse) across four ranges from 27MHz to 240MHz thus:

- Range 1: 130MHz to 240MHz
- Range 2: 75MHz to 130MHz
- Range 3: 46MHz to 76MHz
- Range 4: 27MHz to 46MHz



Facilities

The S.990R can be used on a nominal 110v or 250v AC supply or from a 12v DC supply. The local oscillator arrangement permits 'normal' operation (internal VFO), selection of up to eight crystal-controlled channels, or use of an external VFO. Selectable IF bandwidths of 30KHz or 200KHz are available, the former being via a crystal bandpass filter. Two 10.7MHz IF outputs are available: a wideband one for driving a panoramic adapter unit (eg. Model EP17R using an external 5.2MHz IF converter), and one having the selected IF stage bandwidth. Video output is available in both AM and FM modes. Audio facilities are comprehensive, driving the internal/external speaker, phones and remote lines. A crystal calibrator is provided (supplying 10MHz markers across the receivers tunable range), a carrier-controlled muting system and a combined carrier-level (on AM/CW)/tuning meter (on FM).



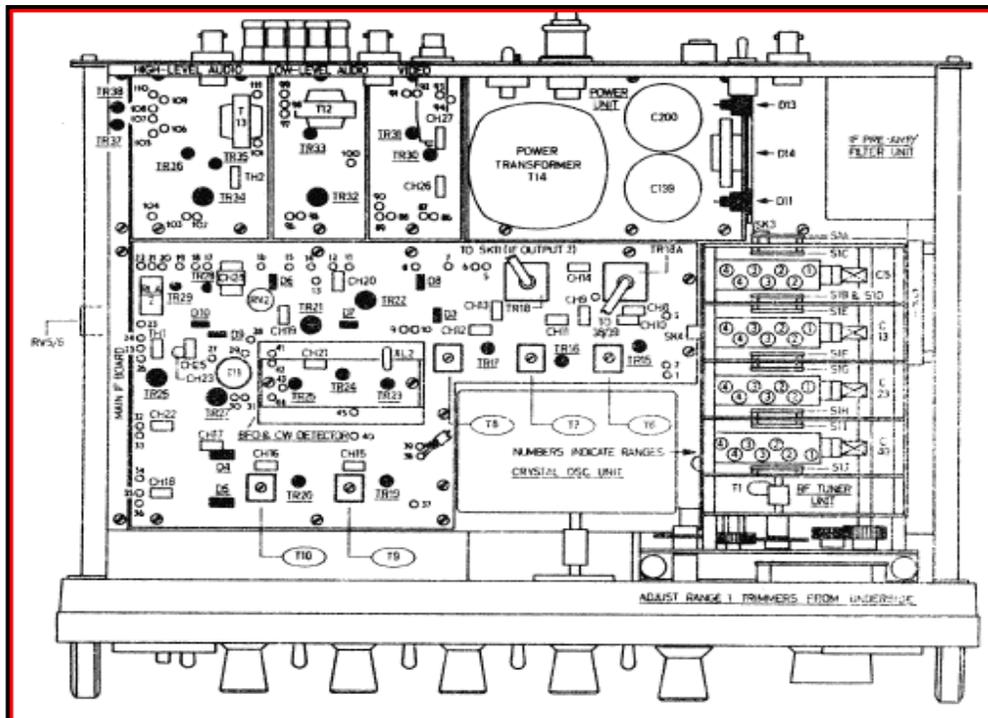
Construction Details

Externally the early versions of the S.990R, as per the one described here, has the 'MkII' or 'Style C' case look and feel of the previous generation of Eddystone (valve) receivers such as the S.770R MkII, S.770U MkII, S.940 and the S.830 series, retaining the colour scheme, the later knob style and the slide rule dial. In keeping with the 1960's 'MkII' styling, the front panel is a grey-painted aluminium casting with chrome-plated carrying handles. The case is fabricated from light-gauge sheet steel in a grey paint finish.

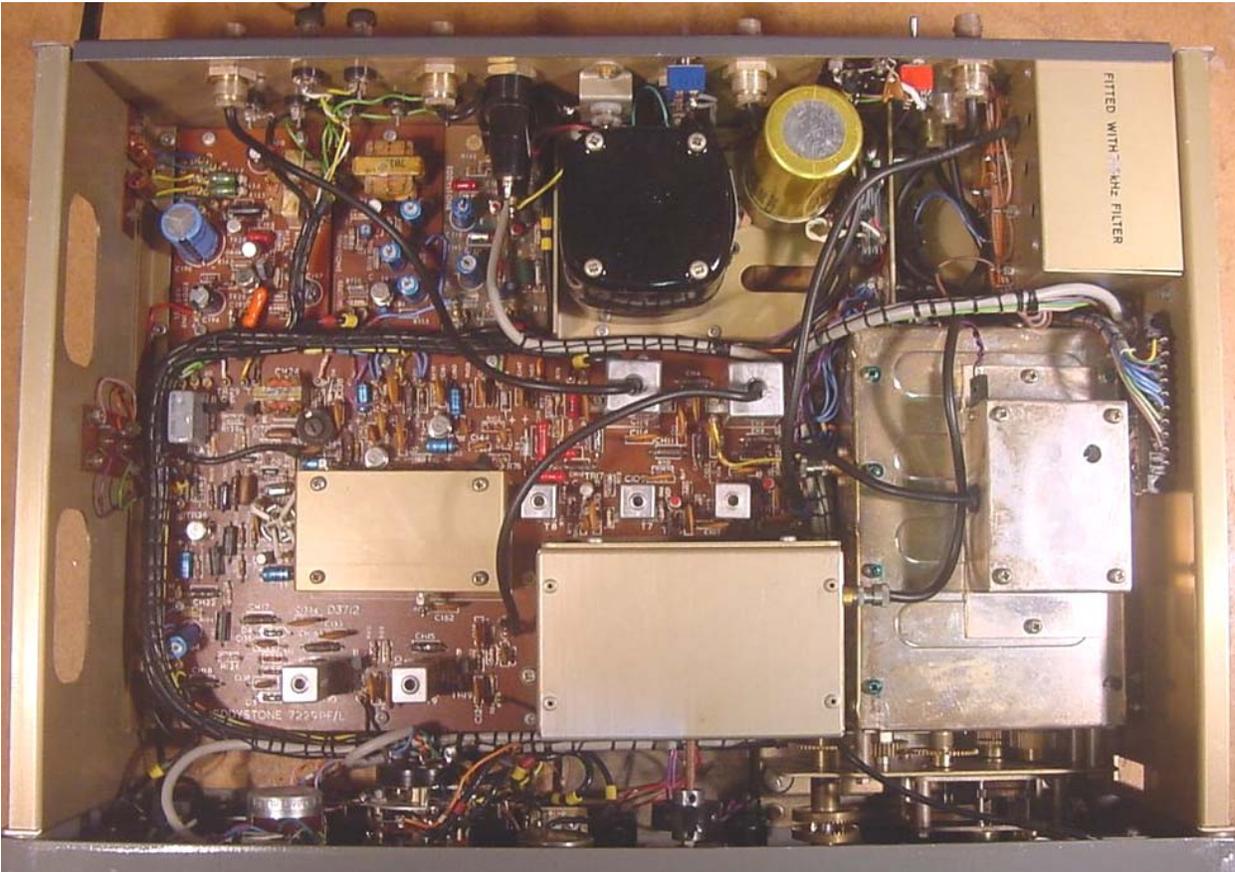


Internally however, all construction, with the exception of the power supply, is on printed circuit boards, bolted to the steel chassis, and could almost be described as modular (but not quite in the same league as the EC958). The separate units comprised:

- RF Tuner
- Crystal Oscillator
- Crystal Calibrator (mounted above the RF Tuner unit)
- IF Pre-Amp/Filter
- Main IF Board (includes two emitter followers units and the BFO/CW detector unit mounted above it)
- Video Amplifier
- Low-level Audio Amplifier
- High-level Audio Amplifier
- Power Supply

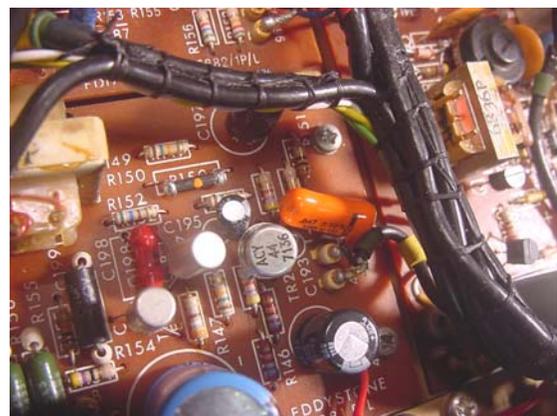


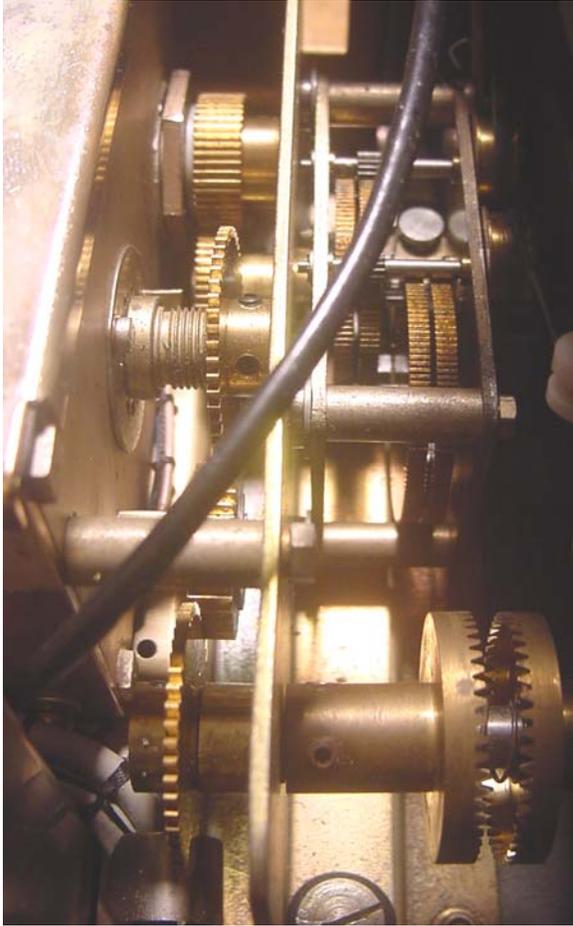
A plan view of the internal construction is shown at the base of the previous page and is reproduced full-size at the end of this text for reference and comparison with the photographs. The internal 'above chassis' construction is shown in the photo below. The L-shaped IF board is the largest unit and is mounted in the centre of the set, and this has the two emitter followers units and the BFO/CW detector unit mounted above it. This is flanked to the rear by the video and audio boards, together with the power supply sub-chassis. The crystal oscillator unit is mounted in the cutout formed by the L-shape of the IF board, and the RF Unit/calibrator is next to this with the IF Pre-amp/Filter unit behind.



The tuning mechanism, mounted between the front panel casting and the RF tuner unit (photo on next page), shows its Eddystone heritage, sporting a flywheel for that legendary smooth tuning, here with a 100:1 backlash-free reduction gearing to the tuning capacitor in the RF Tuner unit. This mechanism drives the dial pointer via cord/pulleys over a 9" scale length. The tuning mechanism in this particular set worked very well and showed no signs of wear.

On close inspection of the sets innards, I spotted a replacement transistor (TR34, replacing a GET880 with an ACY44 – photo, right), and





Above: The gearbox layout. The front panel is to the right and the tuning unit to the left. The contrate gear 'clutch' in the foreground is used to disengage the range switch (I thought it was broken until I realized this!)

receiver with a decent VHF antenna, but did try it out on 2 meters using both a 5/8 vertical and a small Yagi. It performed very well, picking up several local repeaters and a couple of simplex contacts. I also tried it out on the FM broadcast band using a 'rabbit ears' TV antenna and it pulled in stations across the band to full quieting and the audio quality through an external speaker was good (the internal speaker was ok for speech).

Conclusion

All in all, I really liked the receiver – it is beautifully constructed and is a testament to Eddystone workmanship. However, I doubt it would get much use in the VE7GUH shack (probably use it to listen to 'Rock 101' on the FM broadcast band on a bit of wet string while fixing other radios...). Even so, it felt good in use, sounded as good as it looks and seemed remarkably stable. Most of all I loved the tuning for 'cruising' on VHF and the set certainly looked 'the part' next to my S.830/4, S.940 and EC958/3.

some replacement electrolytics on the High-Level audio board (C189, C193, C195, and C197). The coupling capacitor (C189, specified as a 5uF electrolytic) had been replaced by a 0.047uF Mylar film type (see photo at bottom of previous page). All other components looked original and there was no sign of any other re-worked solder joints beneath the circuit boards. The video board may have been replaced at some time as the printed circuit board coating colour (green) differed from the other boards in the set (red). The paint seals on the RF board screws were still intact so I did not open it up to take a look inside (after all it was not my set!). Everything else looked to be in very good condition and almost 'Bath Tub' fresh.

Performance

The claimed performance figures for the S.990R includes a sensitivity of 5uV for 10dB signal to noise ratio with 50mW output in AM mode with 30kHz selectivity. Spurious responses are noted to be 50dB down and frequency stability is stated as 1 part in 10^5 per degree change in ambient temperature for the VFO and 1 part in 10^6 per degree with crystal control.

I did not have opportunity to use the

So, yes my friend, I am as jealous as hell, but glad you managed to snap it up! Enjoy it... and if you ever think about selling it don't take it to a damn rally – give me a call instead!

73's

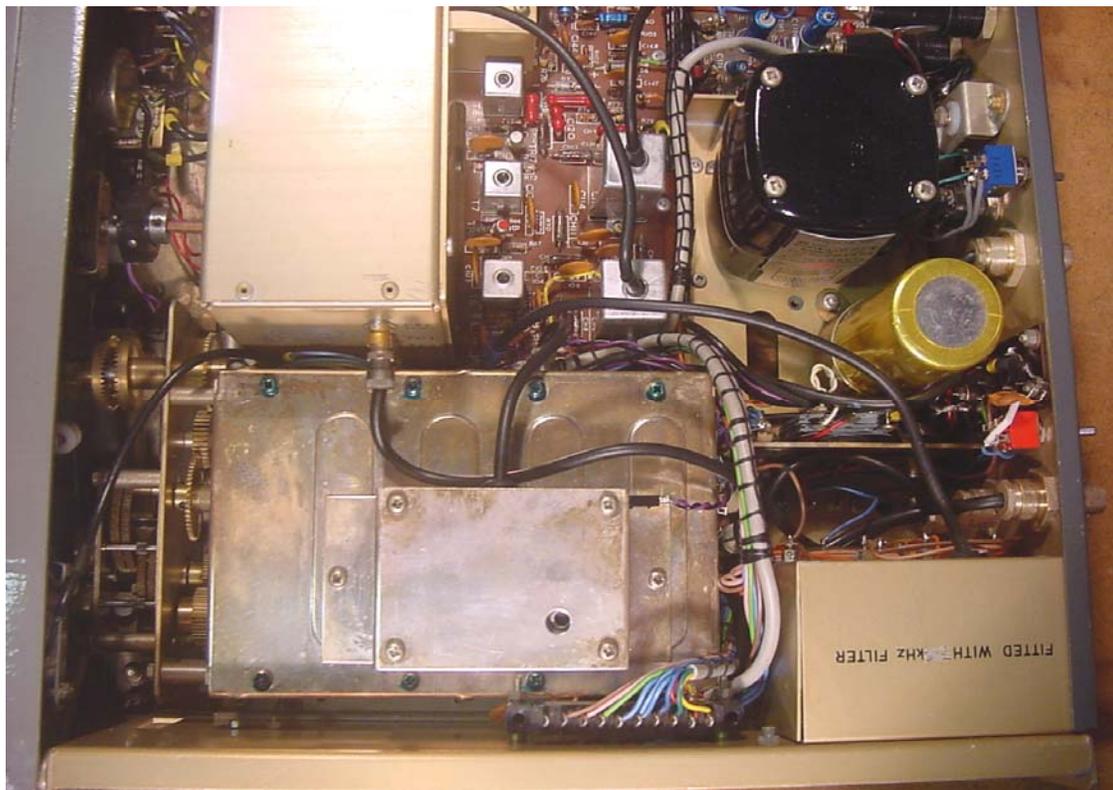
© Gerry O'Hara, G8GUH/VE7GUH (gerryohara@telus.net), Vancouver, BC, Canada, November, 2008

References:

- 'The Ultimate Quick Reference Guide' (QRG) 2nd Ed. Graeme Wormald, G3GGL, 2002
- 'The Cooke Report', Bill Cooke, GW0ION, 1998/9
- Manuals for S.770R, S.770U, S.990R and S.990S
- 'Tale of an Eddystone S.770R', Gerry O'Hara, G8GUH, July, 2006
- 'The Eddystone S.770U MkI/II', Ian Batty, Radio Waves April, 2008
- 'Restoration of Eddystone's One and Only HiFi Separate – Model S.820 Tuner', Gerry O'Hara, G8GUH, October, 2007 (and Postscript, November, 2007)

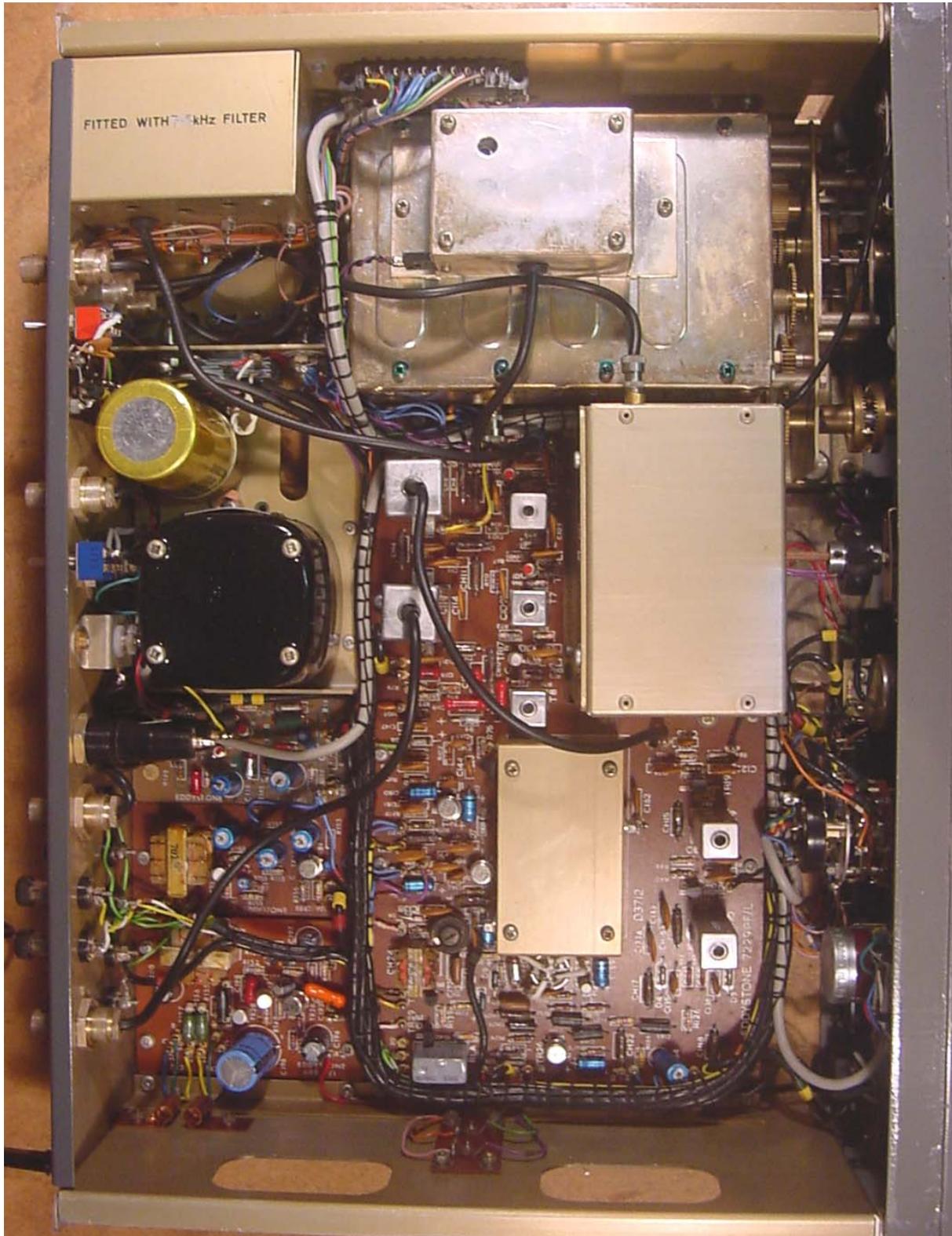
All the above can be downloaded from the EUG website,

<http://eddystoneusergroup.org.uk/>

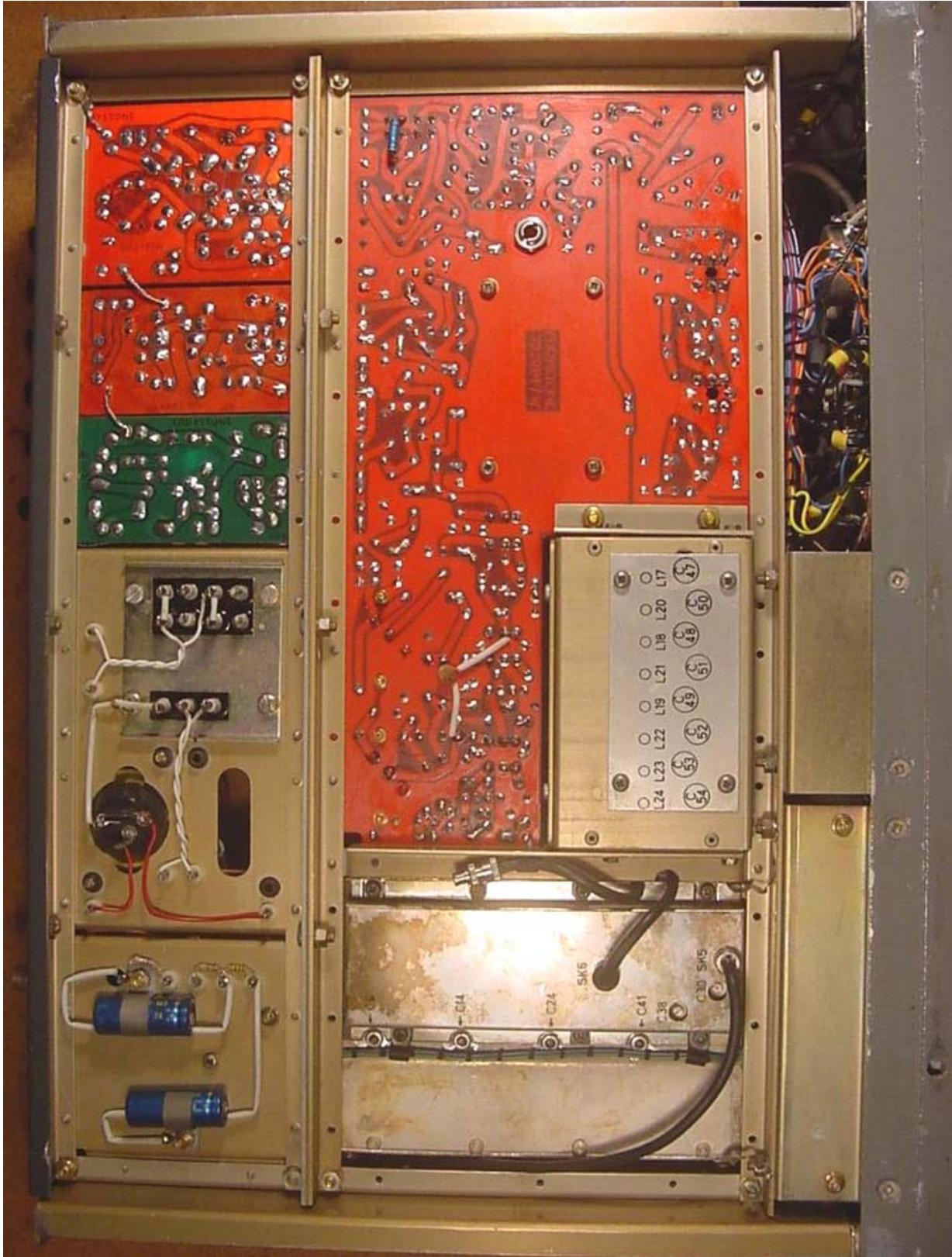


Above: An 'above-chassis' view of the power supply (upper right), IF Pre-amp/filter (lower right), RF tuner with crystal calibrator unit above (lower left) and crystal oscillator unit (upper left)

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Above: Entire 'above-chassis' view of the set, front panel to the right. The power supply sub-chassis is centre-left and 10.7MHz IF pre-amp/filter unit upper left, video and two audio boards lower-left, the main IF board is lower-right/centre, the crystal oscillator unit centre-right, and the tuner upper-right, with the crystal calibrator above. The box located on the IF board is the CW detector/BFO unit and the two 'IF cans' with cables emerging from them are emitter follower units

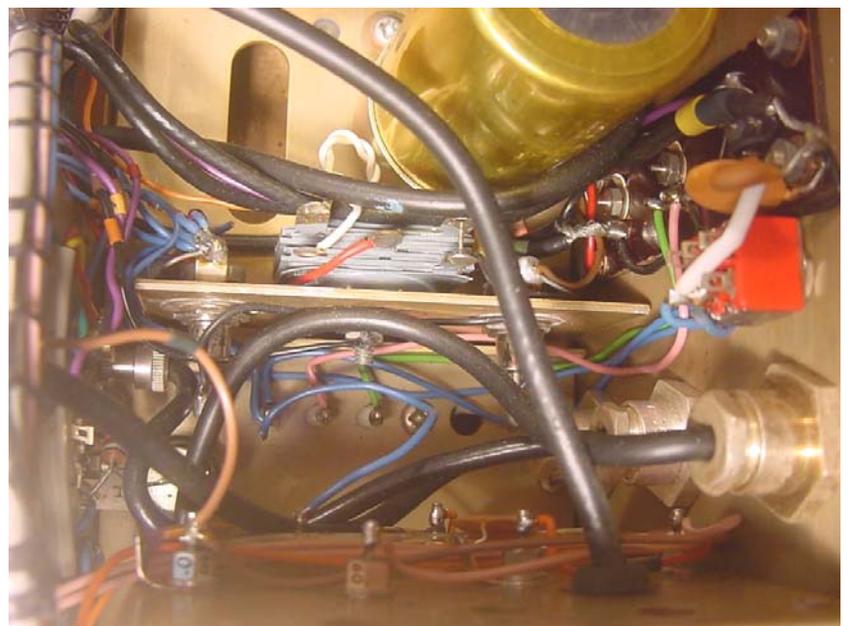


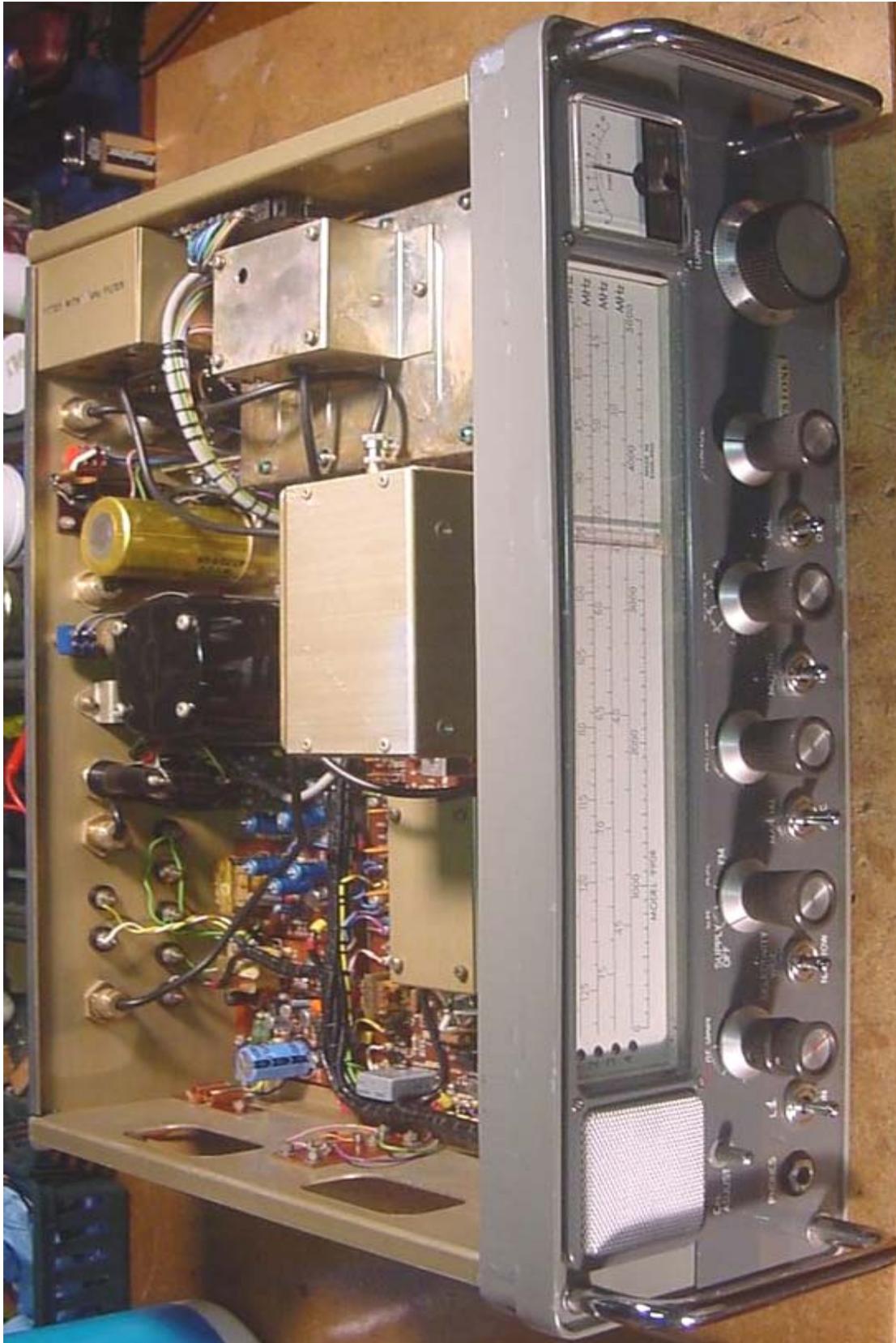
Above: 'Below-chassis' view of the set, front panel to the right. The power supply sub-chassis and 10.7MHz pre-amp/IF filter unit is located centre/lower-left, video (green finish) and two audio boards to the upper-left, the main IF board is upper-right/centre, the crystal oscillator unit is centre-right and the tuner unit is lower-right/centre.



Left: The power supply sub-chassis showing the ‘bombproof’ Parmeko mains transformer and physically large (by modern standards) dual 6,400uF 16v smoothing capacitor

Right: Surely an oddity for the late-1960's? – the power supply sports a lowly selenium rectifier. Hey, I thought those gizmos were unreliable (I have encountered my fair share of the fishy-smelling finned beasts when they do fail) – but here's one still working ok after 40 years! – low voltage though





Above: Internal layout of the S.990R – easy access to most of the set (except the RF sections – probably a good thing! I don't think anyone had 'fiddled' with this one as a consequence)



Left: Rear panel layout. Note the miniature toggle switch addition for AC/DC operation, thus avoiding having to have a link inserted in the 12v DC supply Bulgin plug. Note the extensive array of outputs: audio, video, IF and local oscillator, as well as provision for feeding an external oscillator (VFO) to the set.

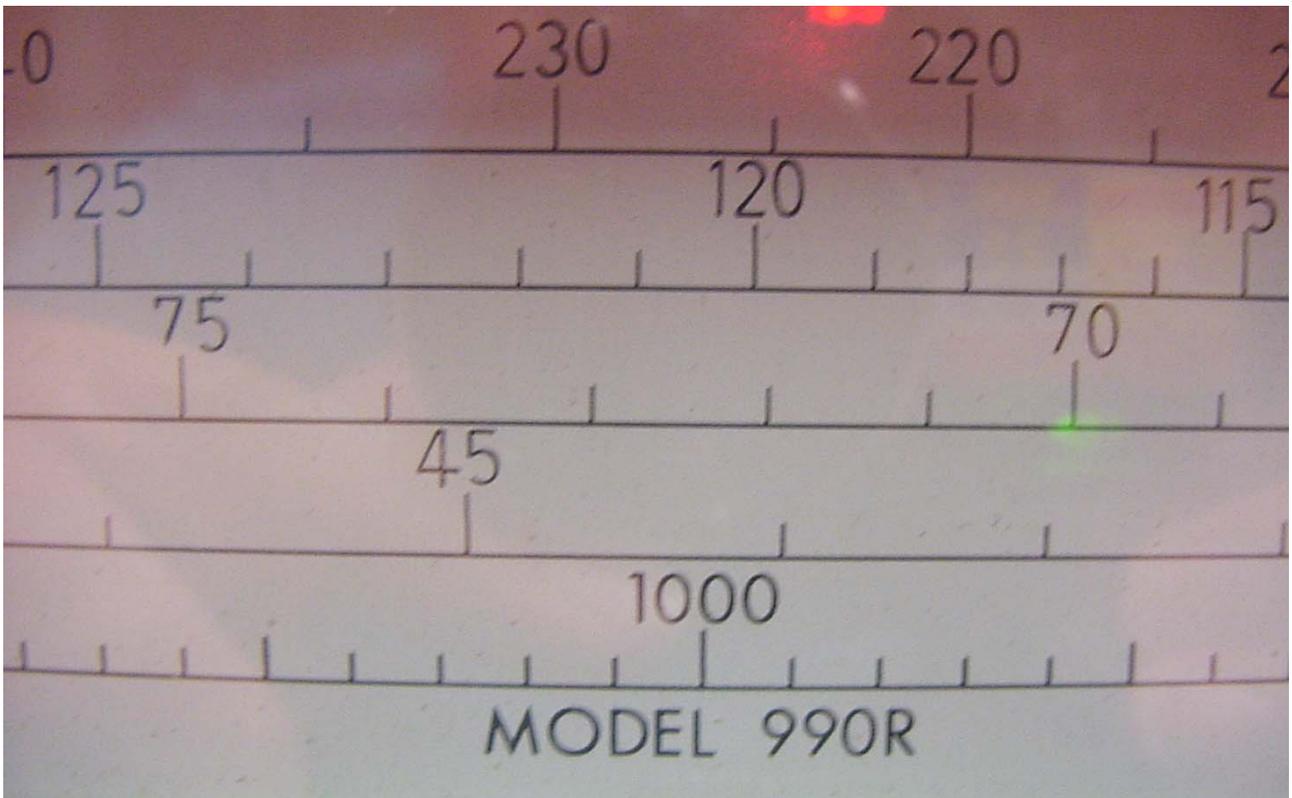
The original 'kettle connector' mains plug is still in place here, and the mains cable still has the correct connector in place, which is in very good condition (photo, below)



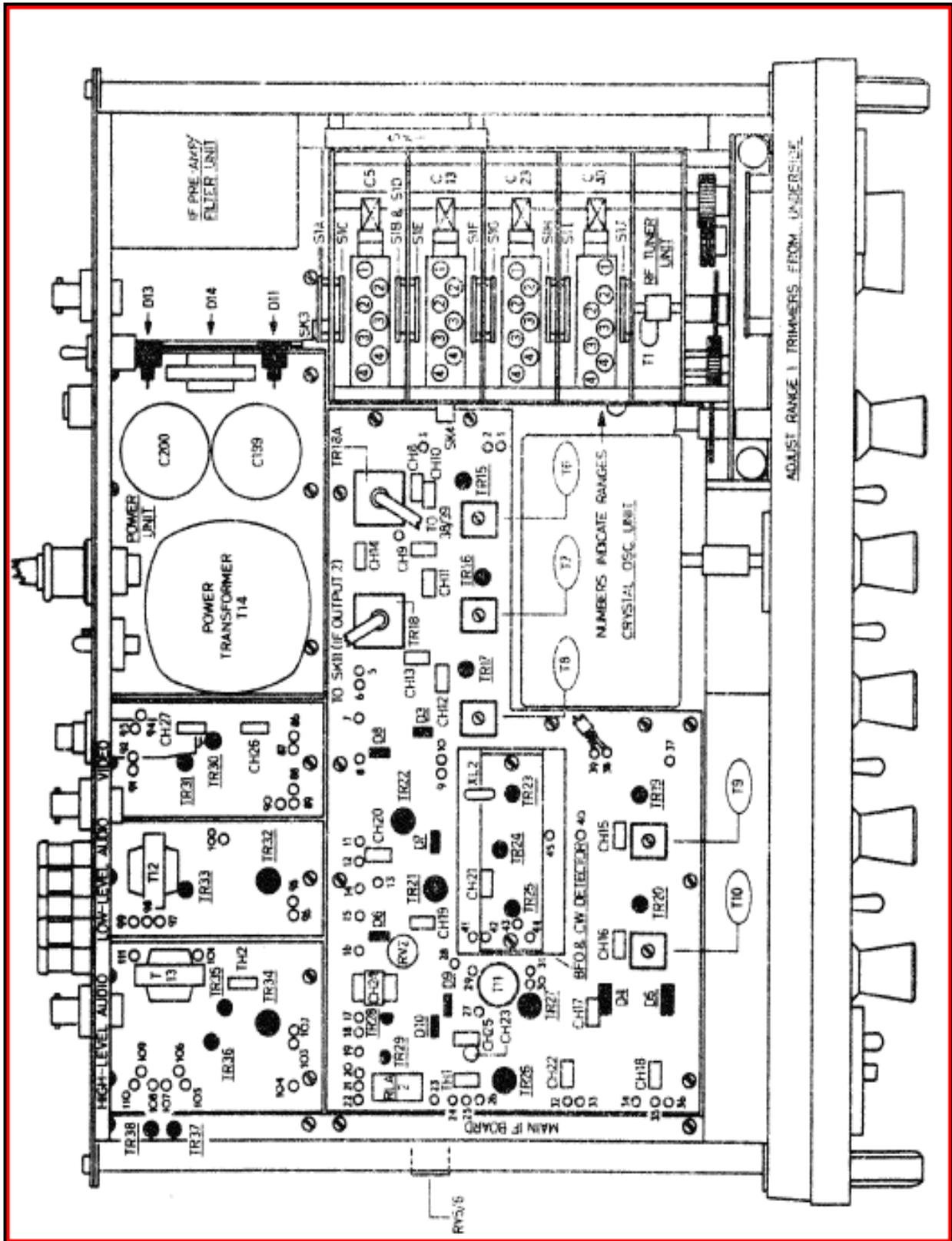


Above: The subject of this article is set S/N 1475 – probably dating from around 1969

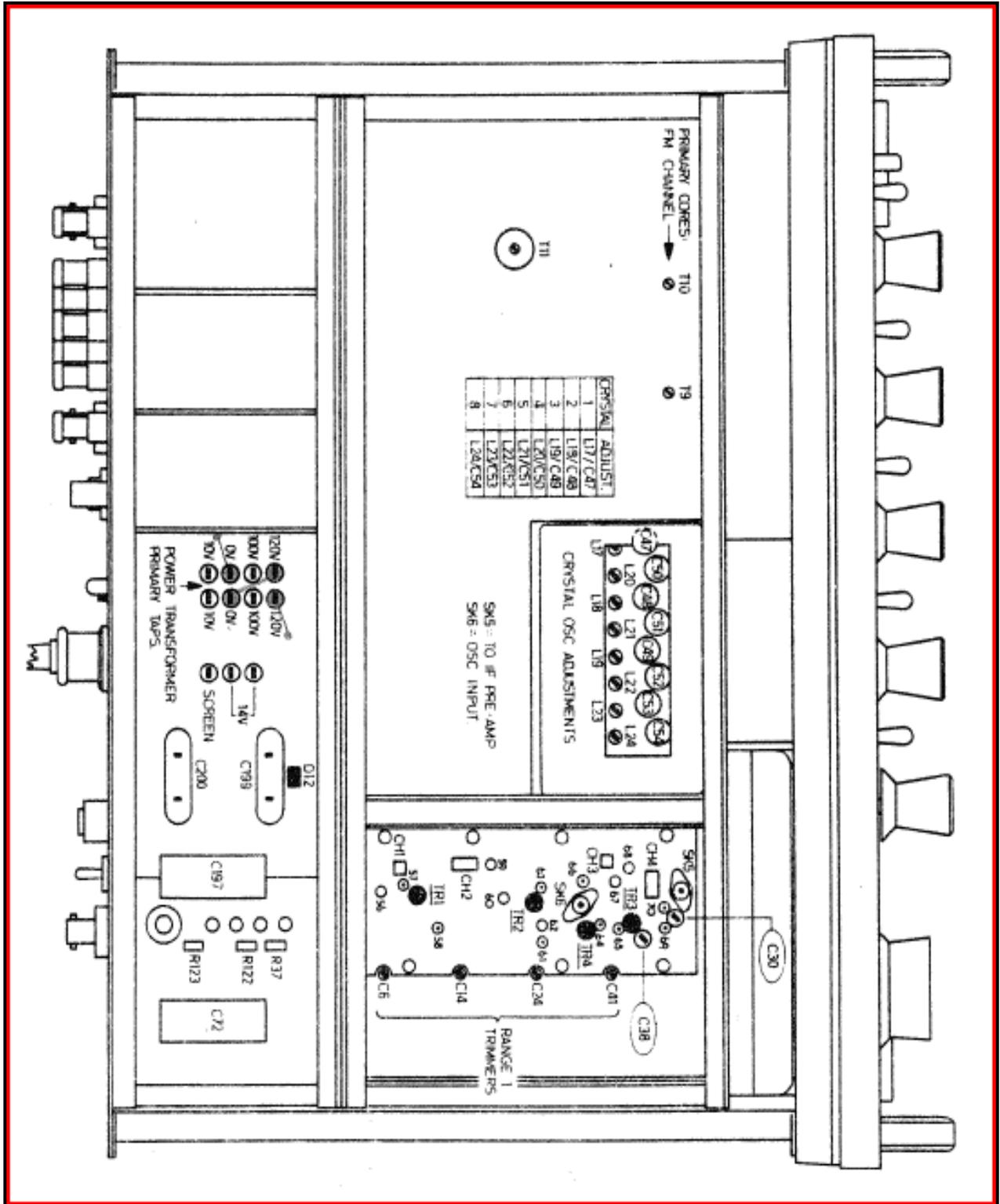
Left: The combined carrier level (CW/AM) and tuning meter (FM)



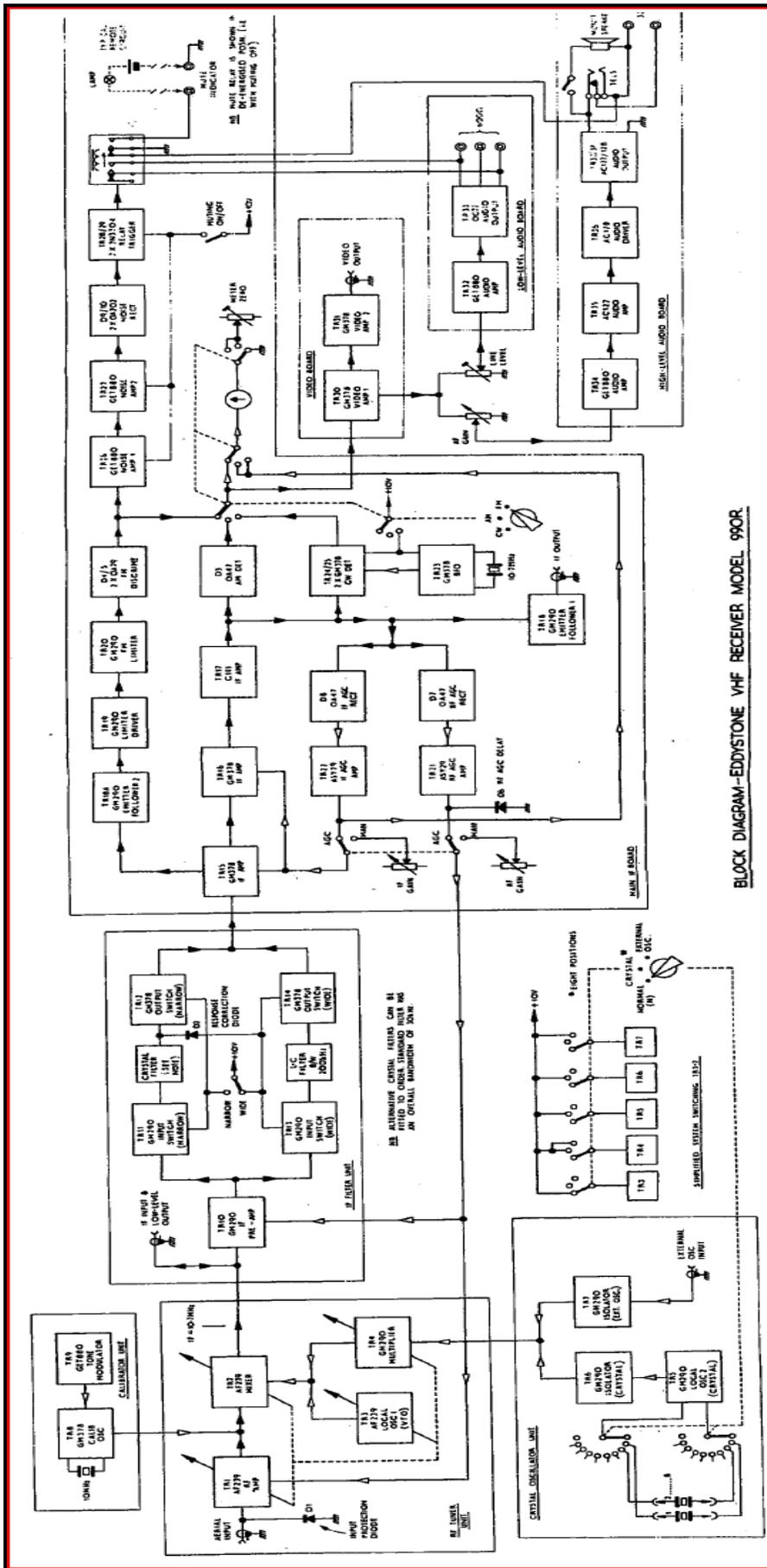




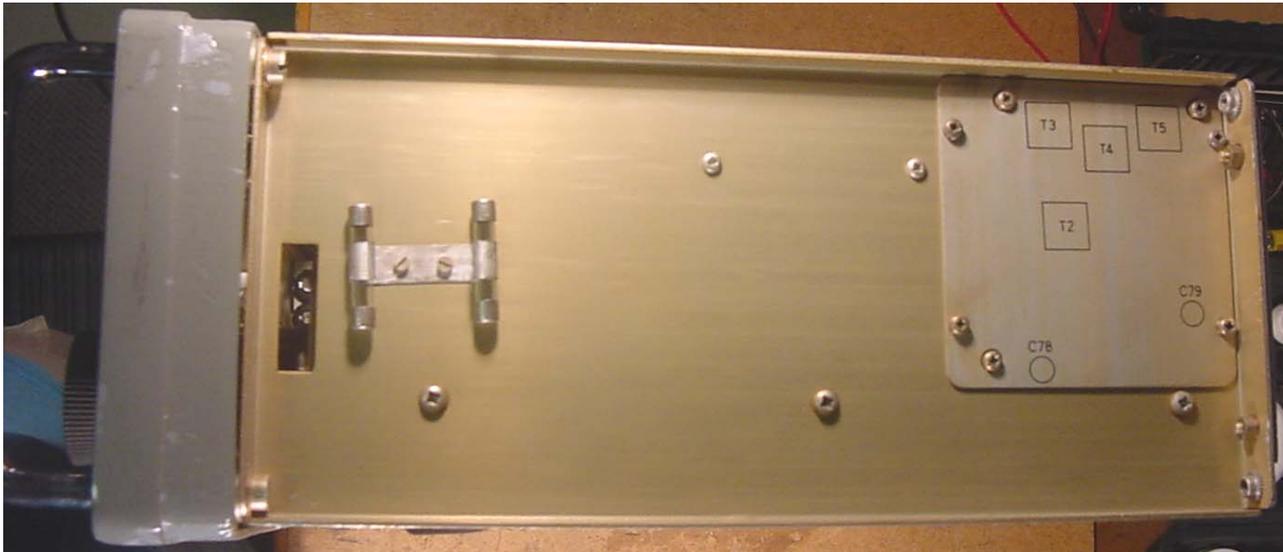
Above: 'Above-chassis' layout



Above: 'Below-chassis' layout



Left: Block diagram of the S.990R (sorry it's a bit fuzzy but the Adobe file of the manual scan on the EUG site is locked, preventing direct extraction of the diagram that would improve resolution - however, you can of course download the manual for yourself!)



Top and middle: chassis side panels, complete with RF and IF AGC pre-sets and spare fuses.

Left: Well, have I made my case....?