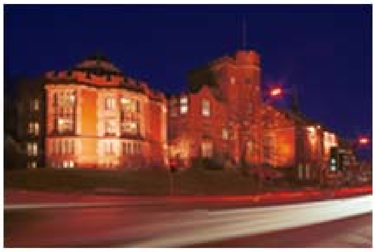
Restoration of an Eddystone EC10 MkI Solid-State Receiver (Part 1) - by Gerry O'Hara, G8GUH/VE7GUH

Background

In my Eddystone S.740 restoration article, I recounted that a long time ago (1971 or thereabouts I think) I owned a Murphy B40 ex-Admiralty communications receiver (available cheap on the surplus market at the time) bought out of my hard-earned wages working in the repair workshop of a local TV and radio store in Carlisle. At that time, one of my radio amateur friends, Gordon, G3MNL (now SK) owned an Eddystone S.640 and an S.770R and I was so impressed with those Eddystone receivers I decided to sell my B40 and buy the only Eddystone I could afford – a secondhand EC10 Mk1 for £40 or so ($80). There was also another consideration for me though - I was planning on going to university in Sheffield (photo, right) and there was no way the B40 could have gone with me – it weighed 1cwt!



Although I liked the quality construction and 'feel' of the EC10 – especially the smooth tuning - to be honest, I was a bit disappointed with its performance compared to the old (valve) B40. Also, it did not have a 'certain something' that Gordon's valved Eddystone sets had. So, in my youthful enthusiasm (and now with much regret and shame) I 'butchered' it – installing a Q-multiplier, crystal calibrator, S-meter, fine tuning, NBFM detector, squelch, product detector for SSB, 'hot' FET front-end, regulated psu, 2-meter converter, etc. Amazingly it still worked – and very well as I recall! I still have that EC10 – though it is residing far away in my mother-in-laws garage in the UK (I now live on the west coast of Canada). However, as noted in the S.740 article, one day I intend to rescue that EC10 and will try to undo the butchering…

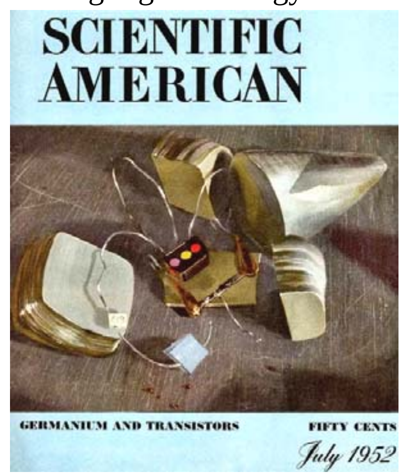
Well, I wrote the S.740 article back in June 2006 and almost 2 years later no rescue mission for that poor EC10 has been launched from the O'Hara QTH in Canada. Having 're-taken the plunge' into solid-state Eddystones with the purchase of an EC958/3 last fall from a radio amateur located in Winnipeg (an article will be written on that set sometime, though I have not even had its case off yet!), and not having bought an Eddystone receiver for some time, I was getting rather itchy for a 'fix' and a change from restoring domestic US & Canadian 'tube' radios. Back in February, 2008 I noticed an EC10 MkI in the 'For Sale' section of the EUG site – this one stood out in that it was located in Canada (much easier on the shipping costs for me). From the photos sent to me by the seller, it looked in generally sound condition, but had several cosmetic imperfections evident that suggested to me that it was likely in the 'suitable for restoration' class. Also, the seller reported that he had heard a hiss and 'a couple of

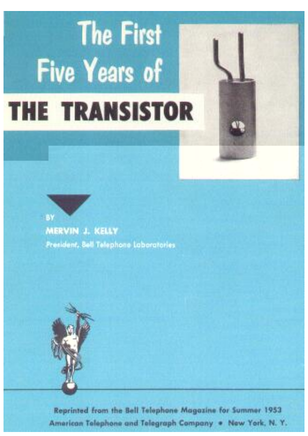
stations' on it when switched on, but that these were 'quite faint'. As the EC10 is a very popular set, I decided to go for it with a view of restoring the set and preparing an article for the EUG site that may be of some use to others, but also for a self-indulgent trip down memory lane. Some negotiation later I forked out a small 'fistful of dollars' and became the owner of my second EC10 MkI. This article details some aspects of my restoration of that set, but first I think a little context-setting would be useful – at least for the uninitiated in the land of radios containing three (or four)-legged semiconductor beasties.

Context of the EC10 MkI

'C'mon man, stop hogging that damn' microscope!'

Following the development of the first transistor devices in the late-1940's (when real engineers all wore ties - photo, left), the first commercial application of this fledgling technology were in hearing aid amplifiers around 1950. A short article from the December 1953 issue of *Radio-Electronics* is attached to provide some insight into this particular application. The first actual 'trannie' radio was reportedly developed by *Intermetall* in 1952, which they showed-off at the Dusseldorf Radio Show that year. This was followed by the first commercial transistor radio set in 1954, the 'Regency TR1', developed in the US as a joint project between the Regency Division of *Industrial Development Engineering Associates* and *Texas Instruments* (Texas Instruments manufactured the transistors and Regency designed and built the radio). This desirable gadget (bearing a remarkable likeness to the modern-day iPod) was marketed under the catchy slogan "*See it! Hear it! Get it!* – those that did get it though coughed up $49.95, around £200 ($400) in 2008 lucre. Meanwhile, over in Japan, the *Tokyo Tsushin Kogyo Company* (soon to be re-born under the moniker '*Sony*' for obvious reasons) followed close behind with their 'TR55' model, launched into the market in August 1955 (hey, that's when I was produced also! - though I was made in the UK). Speaking of which, the first UK-made portable trannie was the 'Pam 710', manufactured by *Pam (Radio & Television Ltd)* of Regent (not Regency) Street, London and launched in March, 1956 for about £33. The rest as the saying goes, even including the Sinclair matchbox radio, is history…

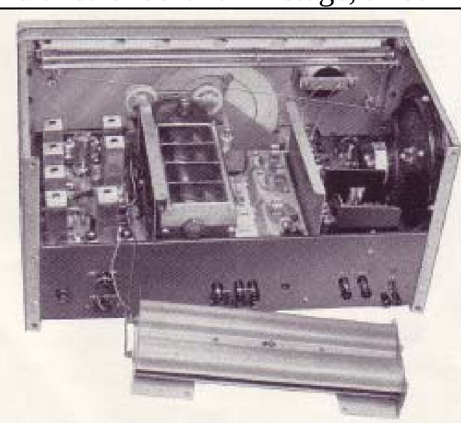




Eddystone first experimented with transistors around 1960 (see the *Cooke Report*, p18), and the first transistor set having an Eddystone pedigree was reportedly the 'Stratton Portable' produced in 1961. Graeme Wormald in the QRG notes this set to be an:

> *"…All-band transistor radio… strictly speaking this was not an "Eddystone", but* [it] *was developed in Stratton's Eddystone laboratory…*
>
> *The Laughton family, owners of Stratton and its Eddystone Radio division before the sale to Marconi in 1965, had family connections with the John Myers mail order company.*
>
> *Transistor Radios were new and it was thought that an opening might exist. The radio covered Long, Medium and Short waves up to 30MHz as well as VHF/FM* [quite impressive for its day]. *It was built into a diecast box with ferrite rod aerial in a plastic handle and rabbits' ears for HF/VHF.*
>
> *Needless to say, the build quality was far too good for the cut-throat competition of the mail order market. Three sets were constructed. They were raffled off amongst those involve with the development. You never know; one day… But it gave Eddystone's their first experience of solid state design."*

Building on this knowledge, and staying within their more traditional and familiar territory of communications receivers, Eddystone launched their first all-solid-state general coverage communications receiver in 1962. This set looked identical externally to an S.940, though with transistor circuitry replacing the traditional valves. The S.960 sported 12 germanium transistors and seven diodes, had six ranges covering 500kHz to 30MHz and was powered by an internal 12 volt battery pack. The circuit had one RF stage, three 465kHz IF stages, including a bandpass crystal filter. Its performance was apparently (and very believably) not on a par with the S.940 however, and the S.960 was dropped from the Eddystone range after the Bath Tub manufactured only 150 of the sets over 2 years. It is worth noting that the transistors used in the first experimental Eddystone solid-state sets cost the equivalent of around £50 ($100) *each*.



Interior view of the "960" transistorised receiver. RF and oscillator section is in the centre, with the coils in a diecast housing; intermediate frequency stages on the left; and audio section on the right. The unit in the foreground is the battery container, normally fixed above the centre section.

The next solid-state set out the Bath Tub was the famous EC10 – one of the companies biggest successes in terms of total sales (over 16,000 MkI and MkII series sets combined). This set was an instant success, receiving favourable radio press reviews and satisfying the need for a more 'modern' and compact communications receiver at a (fairly) reasonable price point. The EC10 was housed in a much smaller case (12" wide) than the S.960, while still retaining the famous Eddystone slide rule dial that made tuning the set a pleasure, as well as the hallmark Eddystone mechanical construction that made it *feel* like a quality piece of kit. The EC10 used an all-germanium PNP transistor line-up that shared many circuit design elements with the S.960 (its main features are described below), but was constructed on two 'Paxolin' printed circuit boards, with a zener-stabilized nominal 6.5 volt supply to the RF amplifier, Mixer, local oscillator (LO) stages and the beat frequency oscillator (BFO). The set could be powered from a removable battery pack using 6 'D' sized dry-cells to provide a 9.1 volts, positive earth supply (positive earth was the norm when using all-PNP transistor circuitry). A mains power supply (Type 924) could be substituted for the battery pack.

The MkI model was introduced in 1963 and was phased out in 1969, with the MkII model taking over from 1967 until production of the model finally ceased in 1977 (14 years is a pretty good production run for a radio!). The MkII circuitry was very similar to the MkI, retaining the simple all-germanium transistor design, which was a real anachronism by 1977 - compare this with the very sophisticated EC958 circuitry introduced by Eddystone in the late-1960's (ok, I admit, these sets were aimed at very different markets, however the early 1960's design and component complement of the EC10 was dated by any standards by 1977). The MkII added some minor refinements such as a fine tuning control effected by a varicap diode, standby switching and an S-meter, but was essentially a 'sheep in wolfs clothing' in terms of performance. Cosmetically, the MkII differed mainly by having a more trendy silver-coloured case and finger plate, black trim and more modern knobs. Interestingly, the MkII-style knobs were also used on some of the later MkI models. The EC10 MkI set described in this article (Serial Number 3086) has the older-style knobs, but was manufactured after the Marconi sale in 1965 (no mention of Stratton & Co. Ltd. on the identification plate on this one), so I date it around 1966-7.

The EC10 MkI that I bought in my teens (S/N KP0064) was manufactured in 1964 by Stratton & Co. Ltd. Both look very similar externally and internally.


EDDYSTONE

"EC10" TRANSISTORISED COMMUNICATIONS RECEIVER

A most efficient transistorised communications receiver of light weight, compact dimensions and capable of a really good performance. Five ranges give continuous coverage from 550 kc/s to 30 Mc/s (545 to 10 metres), and included are the medium wave broadcast band, the marine (coastal) band from 1500 to 3000 kc/s, and all the short-wave broadcast bands. Also available are the six major amateur bands and many services in between.

The "EC10" receiver accepts normal AM telephony and CW telegraphy, a special filter being provided to increase selectivity (and also reduce noise) in the CW mode, as is often desirable. Single sideband signals can be successfully resolved by appropriate setting of the BFO for carrier re-insertion. A total of 13 transistors and diodes is used, leading to high sensitivity and consistent results on all ranges.

The main scales occupy a length of nine inches and are clearly calibrated direct in frequency. The standard Eddystone precision slow-motion drive controls the tuning, and is exceptionally smooth and light to handle. An auxiliary logging scale permits dial settings of chosen stations to be recorded.

An internal speaker gives good aural quality and a comparatively high audio output is available — one can easily believe the set is mains operated. For personal listening, a telephone headset can be plugged in to the socket on the front panel, the speaker then being out of action.

Alternative aerial sockets are provided, for dipole, long wire or short rod or wire. Power is derived from six cells housed in a separate detachable compartment. Current consumption is related to audio output and, for long life, HP2 type heavy duty cells are recommended. The standard receiver can readily be converted to AC mains operation by the addition of a small mains power unit, of dimensions identical to those of the battery box.

The receiver is housed in a metal cabinet, and, with robust construction throughout, it will stand up to hard usage over a long period with a high degree of reliability. The finish is an attractive two-tone grey. The dimensions are width 12½"; height 6¾", depth 8"; Weight with batteries is 14 lbs.

LIST PRICE (in U.K.) : £48 0s. 0d.
Cat. No. 924 AC Mains Unit £5 0s. 0d.

Several EC10 variants also exist: the EC10A (1965) that had an IF of 720kHz, compared with the standard 465kHz of the other EC10 models - this was to allow this version to cover the 300-550kHz tuning range for the reception of non-directional beacons, and was produced for the Swedish Mercantile Marine; the EC10A2 (1966-77), having different frequency coverage on its lower ranges compared to the standard EC10, and which incorporated a crystal-controlled 'distress' channel on 2.182MHz (three different mounting versions were available, designated /1, /2 and /3); and the EC10M, badged and marketed by Marconi as the 'Seaguide'. Apart from the general public, EC10 customers included the Post Office, NATO, the Coastguard/coastal shipping services and even the Diplomatic Wireless Service (apparently only 10 'Diplomat' models were made that had 10 crystal-controlled channels in addition to the standard general coverage tuning – see Lighthouse Issue 75, p29). I even heard somewhere that Prince Charles had an EC10 fitted into his Scimitar sports car back in the 1960's - anyone have a photo of this for 'Eddystones in Famous Places'? – come on Charles you must have a snap in your family album we could have for the EUG website…

In Lighthouse Issue 90 (April 2005), Ted Moore reports he has no less than seven EC10 MkI's in his collection – why?... Ted explains:

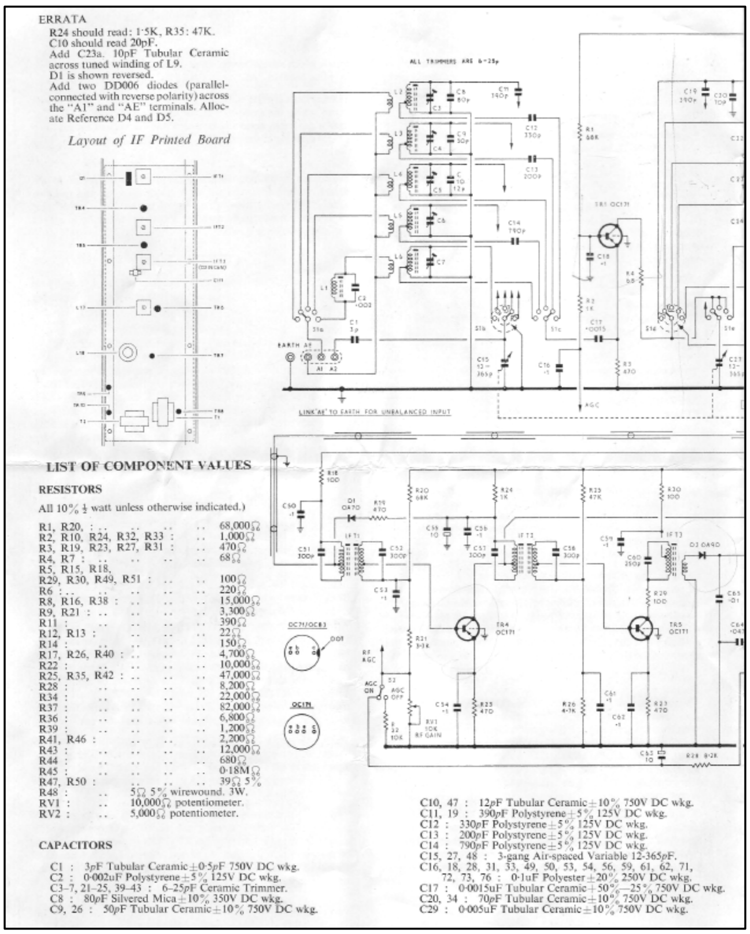
> *"…Well simply because they are all different in some way from each other. Honestly there are FOUR different styles of knobs – as original. There are THREE different styles of scale, thin or thick lettering, and even scale figures at slightly different positions on the scale plate.*

There are also THREE different versions of PCB with some component placing differences. I even have one with ferrite beads fitted on the Base leg of all RF and IF trannies, as original! Colours? I have three different schemes…

Similarly with the MkII, TWO different PCB layouts. THREE colour schemes, and TWO different versions of scale plate… ".

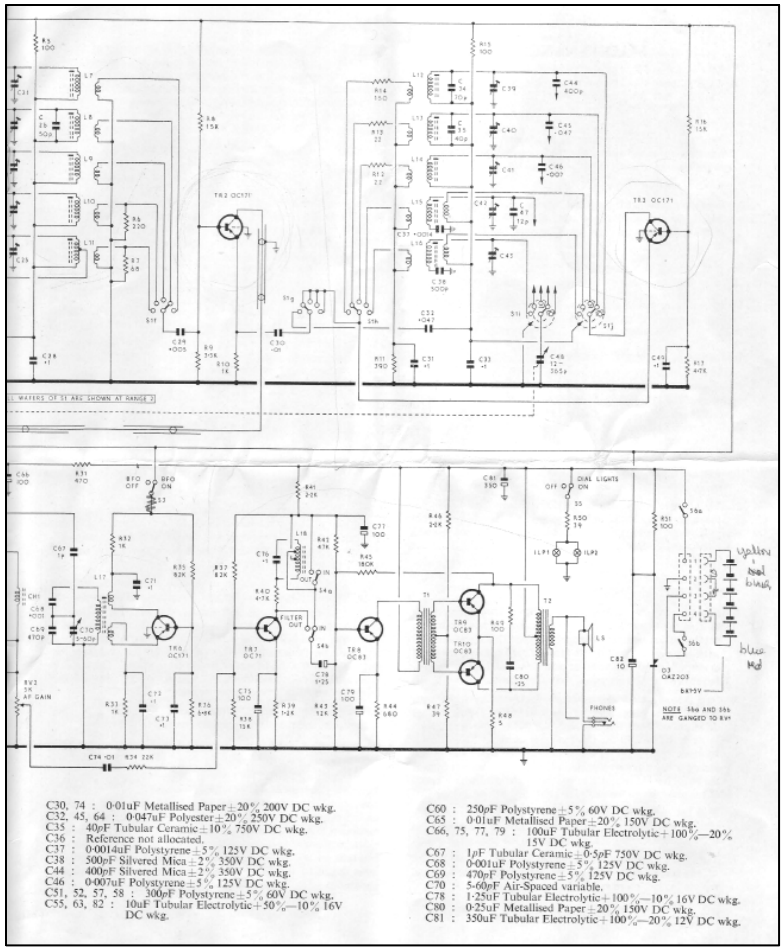
In other words, the EC10 has that typical Eddystone character built into its design, build quality and production history… it just happens not to be fitted with valves.

A Quick Look at the EC10 MkI Circuit and Features



As with the majority of Eddystone valve sets, the early Eddystone solid-state receivers were of generally conservative, almost textbook, design. In the case of the EC10, the manual (appended) includes a fairly detailed description of the circuit so only a brief summary is provided here.

The front-end comprises a grounded-base OC171 RF amplifier, this being transformer-coupled to the base of an OC171 configured as the Mixer. The LO, tracking above the signal on all ranges, comprises another OC171 (why change when you are on a roll?) in a tuned-collector configuration, with the LO signal fed to the emitter of the Mixer transistor. Five tuning ranges are provided, selected by a multi-wafer Yaxley switch. Three stages of IF amplification are present at an IF frequency of 465kHz, comprising three more OC171's (what a roll!), each coupled by double-tuned transformers. Audio amplification is via an OC71 feeding an OC83D driver transistor to a pair of OC83's in transformer-coupled push-pull, as was the norm in the early 1960's. Yet a further OC171 acted as the BFO (feeding its signal to the primary of the second IF transformer), an OA90 diode as the detector, an OA70 as a diode switch (that introduced a damping resistor across the primary of the first IF transformer to assist the AGC circuit in preventing overloading in the presence of strong

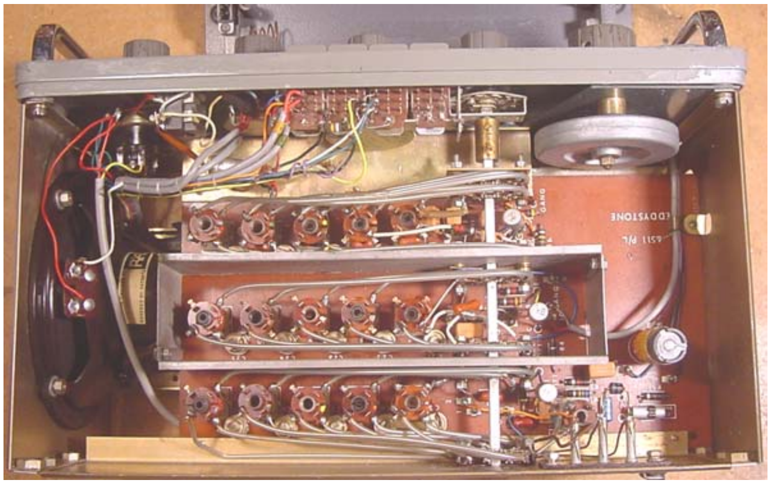


signals), and an OAZ203 6.5 volt zener diode providing a stabilized voltage supply to the RF amplifier, Mixer, LO and BFO stages to promote stability with varying battery supply voltage. The BFO was meant only for CW reception, so the injection level is quite low. A nominal 1kHz audio filter can be switched into the AF amplifier circuit to assist in receiving CW signals.

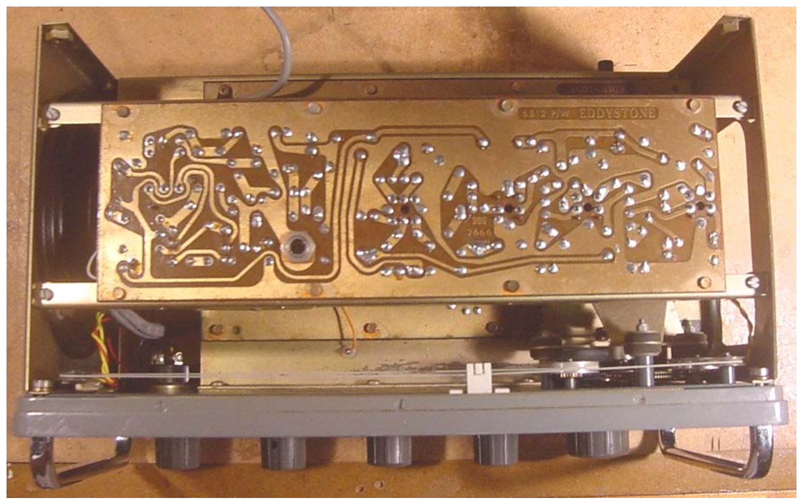
Given the fairly conventional circuitry in most Eddystone sets of the period, the main edge gained over their 'competition' was largely in the superlative mechanical build-quality, the excellent slide rule dial (with the famous silky-smooth feel when the tuning knob was spun), the high-quality inductors used in their tuned circuits, good factory set-up, solid and reliable performance and the prestigious Eddystone reputation. The EC10 range was no exception to this – hence the models' enduring popularity some 45 years after it was first introduced into the marketplace. The models' only real Achilles heel is the longevity and performance, or rather not, of the primitive germanium transistors used in the design, most notably the OC171 small-signal HF transistors used in the RF, Mixer, LO, IF stages and BFO (see sidebar on page 13 and the Preliminary Inspection and Electronic Checks section below) – but hey, that's about all that was available at the time the set was designed. Of course the passive components can also suffer deterioration with age – the most likely culprits being the electrolytic capacitors, though the resistors are not immune to drifting off or becoming noisy with the passing of time (a bit like me). The OC71 and OC83D/OC83 transistors used in the audio stages seem to be more reliable but can also become noisy. The zener also has a bit of a reputation for failing or going out of specification.

Mechanical Construction

Eddystone retained their 'trademark' diecast aluminium front panel and slide rule dial in the EC10 design. The RF circuit board is bolted to the side chassis member opposite the speaker end, to a bracket fitted to the rear of the dial assembly (see below) and to the rear chassis plate. The IF/AF circuit board is bolted to two angled side rails that in turn are



bolted to the upper side chassis members (photo, below). The latter arrangement allows the IF/AF strip to be unbolted, turned through 90 degrees and re-bolted in an upright position, thus allowing extremely good access for servicing and alignment. The RF board has a central metal box-channel fitted to its component side that acts as a screen between the RF, Mixer and LO stages (photo, above) – a functionally similar (but cheaper) format to the diecast structure found in contemporary Eddystone valve sets.



The one-piece steel outer case is held in place with four chrome-plated large-head 2BA bolts that secure into a return on each of the side chassis panels. Cut-outs are present in the rear of the case for the battery box (or the mains battery psu as a substitute), the usual Eddystone- style aerial/ground connections and the maker/serial number tag per the photo of the chassis rear, above. Perforated sections set into the sides of the case allow for ventilation and one serves as a speaker grill. Chrome carrying handles are fitted to the case front and the bolts for these also hold the front panel casting and dial mechanism mounting plate onto the steel side chassis members.

The slide rule dial is a modified Type 898 dial mechanism as found in the small valved Eddystone sets (eg, S.820, S.870 etc). However, here the tuning shaft, vernier scale and gearbox are all offset well over to one side rather than being located centrally. The tuning scale is printed in white lettering on the inside of the dial glass.

All-in-all, a very solid, well-built little set that is extremely easy to access and work on – a refreshing change from many solid-state receiver designs I have encountered.

My Latest Acquisition Arrives…

The vagaries of the Canadian postal service meant my 'new' set took almost two weeks to arrive (probably not helped by a massive dump of snow in northern Ontario that brought the place to a virtual standstill just as I sent my payment off). Anyway, it eventually did arrive and I must say it was very well packed in a box with a resilient foam moulding that could have been made for the set – compliments to the seller.

Cosmetics

The first thing I noticed on unpacking the set was that the case had a strange discolouration and dullness that could best be described as a 'bloom', along with several darker 'blotches' and many coffee mug stains that would not wipe off with soapy water or alcohol. It also had several deep scratches and scuffs – though mainly on the top surface. The paint finish was also not as I recall from my other EC10 or as present on MkII Eddystone valve sets – it was much less shiny and had a slight 'orange peel' finish. For now I decided to buff-up the paint finish with Brasso in an attempt to remove the coffee cup rings and blotches and to just touch up the scratches, though eventually I think I may have the case powder coated. The Brasso did indeed remove the coffee mug stains, darker blotches, some of the scuffs and imparted a shinier finish more in keeping of what I think it should be. I used a concoction of three different Humbrol enamel paint colours to touch-up the scratches and deeper scuff marks. When the paint had cured for several days, I buffed the case with more Brasso to better blend-in the touched-up areas – not a perfect finish, but good enough for now.

The front panel casting was going to be a tougher job though – looks like it will definitely need either a powder coat or spray job to get it looking as it should. It has several areas where the enamel paint has badly cracked and/or detached from the aluminium casting completely (circled red in the photo above) – as though the finish had not adhered to it correctly from new, or surface cracking had introduced moisture that had encouraged the enamel to part company with the aluminium, however, no corrosion was noted on the casting surface. Again, as a temporary fix, larger loose flakes were glued down and a concoction of Humbrol enamels was applied in several coats to build up the thickness of the original enamel finish on the bare areas before buffing-out with Brasso after curing.

The finger plate was bent in one corner (circled red in the photo, right) where I suspect that the set had been dropped onto one of its handles (aargh! – what is it with Eddystone sets I acquire? – this is the third set I have that has suffered from one of its previous owners testing its ruggedness by dropping from a great height) – at least the front panel casting seemed intact. The white lettering on the finger plate was worn off in parts – particularly around the bands change knob, but was otherwise it was ok.

When cleaning the knobs, I noticed that they were in extremely poor condition – they were all suffering from the dreaded cracking syndrome that I had first observed on my S.830/4 and as reported by others in 'Lighthouse'. It seems that the plastic surrounding the central brass insert in this knob design either shrinks with age and/or the different thermal characteristics of the brass and the plastic sets up stresses in the plastic that results in the cracks forming. The larger (tuning) knob only had one crack, but the

smaller ones had multiple cracks – to the point that they looked like 3-D jigsaw puzzles (see photo, left).

The dial glass/scale was in good condition – only a bit grubby – as was the tuning mechanism and dial pointer. Some preliminary cleaning was undertaken, with the intent that the front panel would be removed later to clean the inside of the dial glass (scale) and to allow a more thorough mechanical servicing job undertaken at that time (see below).

The battery compartment was in generally good condition, apart from the paint flaking off in a couple of places (easily touched-up). There was no corrosion present and the original paper battery polarity locator stickers were still in place. The battery pack lead and the (awful) 4 way connector were also ok – but what were Eddystone thinking when they decided to use this silly little connector? Its bad enough when using the 9 volt battery pack (as it can be forced in the wrong way around as noted in p20/21 of Lighthouse Issue 85), but when the mains power pack is used it also connect 240v AC through to the front panel on-off switch via very flimsy wires, with connectors right next to the 9v DC supply – not good at all from a safety point of view…

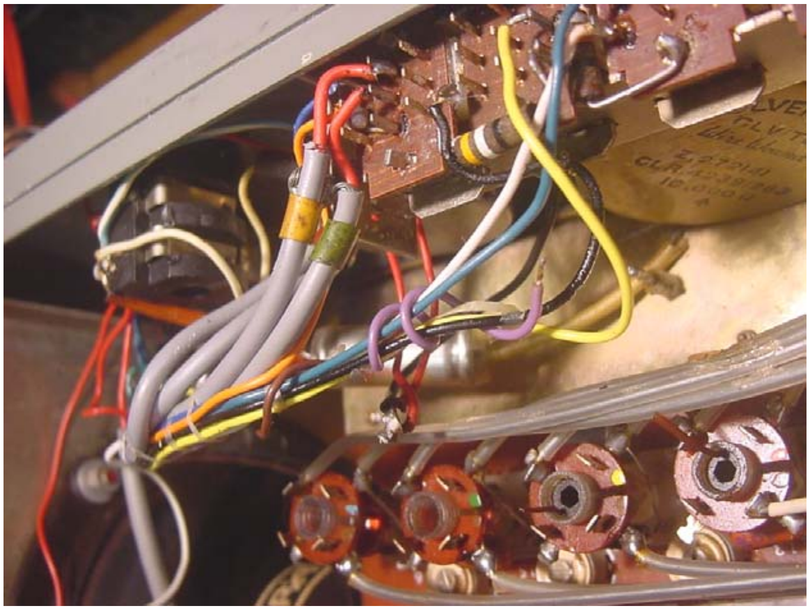
After some thought on the overall cosmetics, I contacted Ian Nutt and ordered a complete set of knobs and a new fingerplate. At the time of writing I am awaiting their delivery.

Preliminary Inspection and Electronic Checks

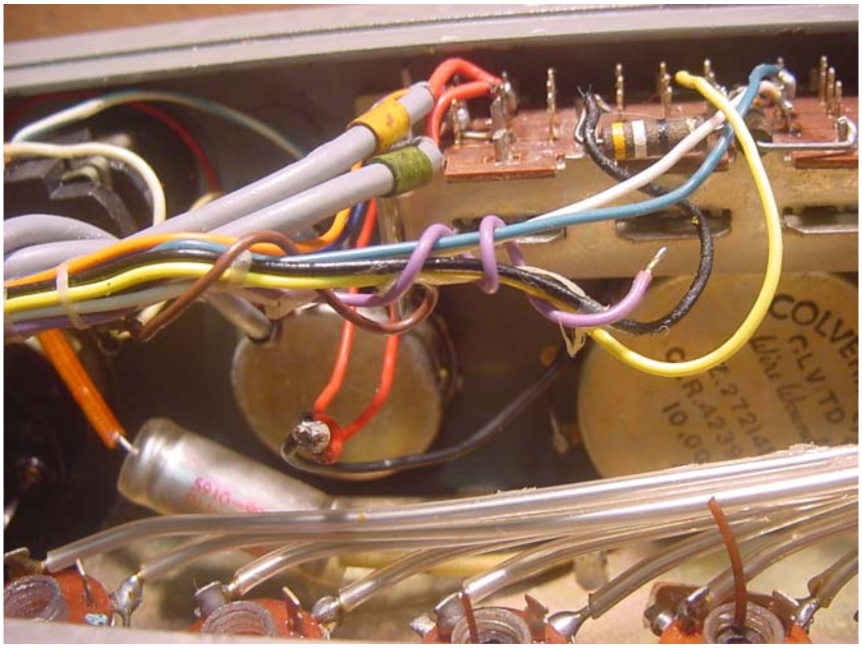
With the case removed, a quick inspection of both the IF/AF strip and RF circuit boards revealed some good news – both appeared completely 'Bath Tub fresh': no re-soldered joints or tell-tale flux residues and after close inspection I am pretty sure that all the components are the original fitment…. Phew.

The seller had reported the set to be working, albeit not very well, so after a quick check of the resistance across the B- to ground I decided to power it up from my bench psu. Well, it did hiss quite a bit but no stations were heard. Also, the RF and AF gain controls had no control over the hiss level whatsoever. I tried injecting a modulated 465kHz IF signal into the 3rd IF transformer – nothing. I then tried injecting an AF signal at the AF gain pot – again, nothing. So I decided to take a closer look…

Looking carefully underneath of the receiver revealed a batch of not-so-good news:



- the variable capacitor for the BFO had been replaced by a (huge) Colvern 10k ohm wire-wound pot coupled to a 0.1uf capacitor, both of which looked like they were WWII surplus – photos, right and below right (at first I suspected that someone had modded the BFO circuit to use a varicap or had wired-in a varicap fine-tuning circuit as per the EC10 MkII – this proved not to be the case though). This pot was so large that it did not fit squarely in the space vacated by the BFO variable capacitor, with the consequence that the shaft passed through the front panel at a rather 'jaunty' angle – a superlative bodge job indeed, yes, full marks to whoever did that one (!);
- the wiring to the above mongrel components led to closer inspection of the wiring around the push switch bank and phones jack… oh dear more bad news;
- Some wires were observed to be hanging loose and not connected to anything;
- The dial lamp switch (the one that does not latch in order to conserve power when on battery power) was not wired to anything; and
- The wiring to the phones jack and speaker had been tampered with. Hmmmm…



Tracing the wires as they stood revealed that:

- the BFO on/off switch wiring was disconnected completely and was hanging loose;
- the wires to the BFO variable capacitor had been removed when the Colvern pot/capacitor

abomination had been installed;
- the Colvern pot/capacitor arrangement was wired as a crude tone control (treble-cut) across the AF gain pot;
- the AF gain pot now fed the phones socket and had been completely disconnected from the AF amplifier stages (the shielded cable to the AF stages had been disconnected and was hanging loose) – at least that explained why no audio apart from a hiss was present at the speaker when I fed an AF signal to the AF gain pot). Perhaps a previous owner had used the set as a tuner feeding an amplifier?;
- the dial lamp wiring, including the 39 ohm dropper resistor, had been removed from its correct switch and was now wired onto the (latching) BFO switch. I guess the guy that decided to do that mod had a sore finger from holding the spring-loaded off-biased (correct) dial-lamp switch in all the time and had an endless supply of batteries available.

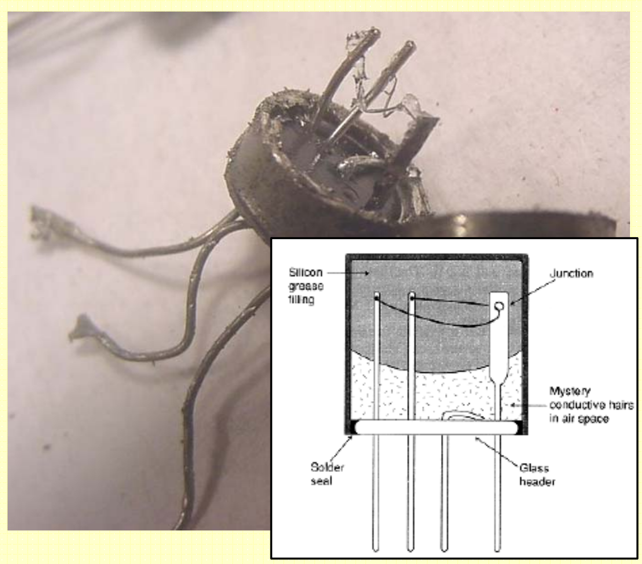
After figuring this lot out I removed the Colvern pot and capacitor and re-wired the switch bank, dial lamps, BFO, AF gain pot, speaker and phones socket all back to their original configurations – luckily the bodger had not shortened any of the wires. I switched the set on again - it was hissing just as before and there was still no control over the hiss volume with either gain control. I figured that there was likely a fault in the RF/IF stages and that the hiss was probably a

Transistors with Whiskers…

The first transistors suitable for use in RF applications used the alloy-junction fabrication process. However, Mullard followed the US-led technology direction by adopting the alloy-drift fabrication technique. The first RF transistors manufactured by Mullard that were available commercially in quantity were the OC169, OC170 and OC171, introduced in 1959. This range was supplemented in 1961 with the AF117 to AF118 series. All these transistors were housed in a TO-7 case style that included, in addition to the base, collector and emitter connections, a fourth lead, connected internally to the transistors' aluminium case to act as a screen.

The internal construction of this transistor family is illustrated below. The collector lead acted as the support post for the semiconductor substrate, with fine wire connections from the emitter and base leads to the substrate. The upper part of the can was filled with a gob of silicon grease (presumably to protect the internal assembly from moisture ingress and possibly to add some resilience against shock). Beneath the silicon grease is a small air space – ok, a bit crude but functional, but here is the weird part…

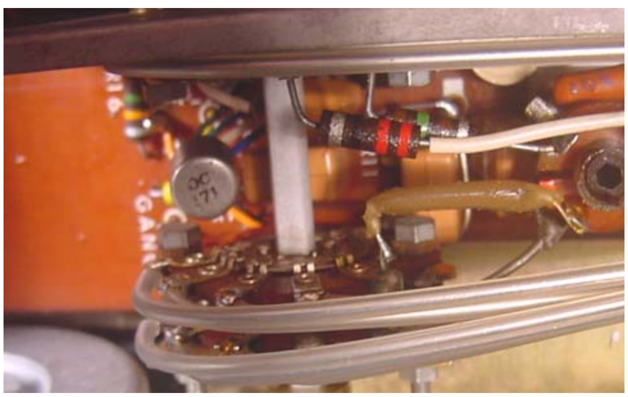
Over many years, microscopic metallic filaments develop inside this air space (these are reportedly only 0.008mm across). These filaments are noted as being 'tough, springy and electrically conductive'. Eventually one or more of these filaments contacts one or more of the leads inside the can, shorting it to the can – effectively 'killing' the transistor. This phenomenon (no explanation found) affects both used and new-old-stock (NOS) devices at random. A sharp tap on the transistor case can effect a temporary cure by dislodging the offending filament. Alternatively you can try cutting the screen lead.



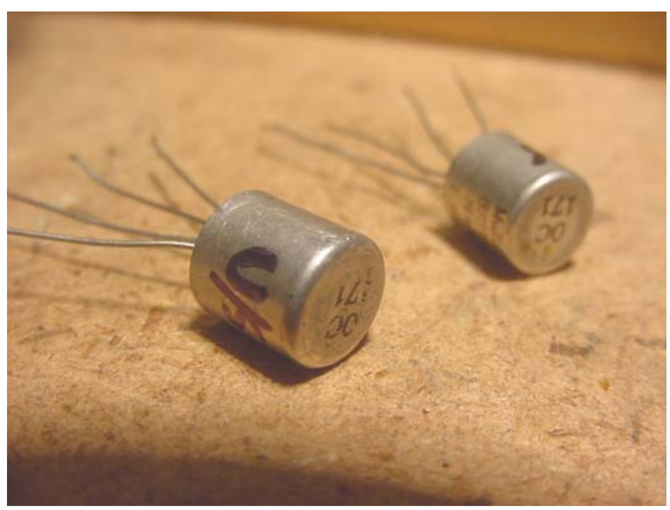
noisy resistor or transistor in the AF gain amplifier that I could fix later.

I re-tried injecting a modulated 465 kHz signal into the 3rd IF transformer – I could hear it this time, indicating the 3rd IF stage, AF stages and detector were functional. I then injected the 465kHz signal into the second IF transformer – a louder signal was heard. Good news so far, however, when injecting the signal into the collector or base of the Mixer stage transistor the signal was almost inaudible. Voltage checks around the OC171 Mixer transistor revealed that it was likely shorted between its base and emitter.

I had about ten OC171's in my junk box (see sidebar on the previous page) recovered many years ago from junk transistor sets (and, I think from my EC10 MkI in the UK when I 'upgraded' its solid-state complement to 'hotter' silicon devices in its RF and Mixer stages as I recall). I had tested all ten OC171's in advance and found that only five appeared to be still working ok (the rest either had a short to the screen, had very high leakage or had an open-circuit to one of the connections). I replaced the mixer OC171 with a tested good device, fitting the coloured insulation sleeves to retain original appearance (albeit the leads were slightly shorter). While the transistor was out of circuit I lifted the bias resistors and checked their values – these were found to be well within tolerance. I switched the set on again and voltage checks around the Mixer transistor looked much better. Now injecting the IF signal into the base of the Mixer transistor produced a very strong AF response.

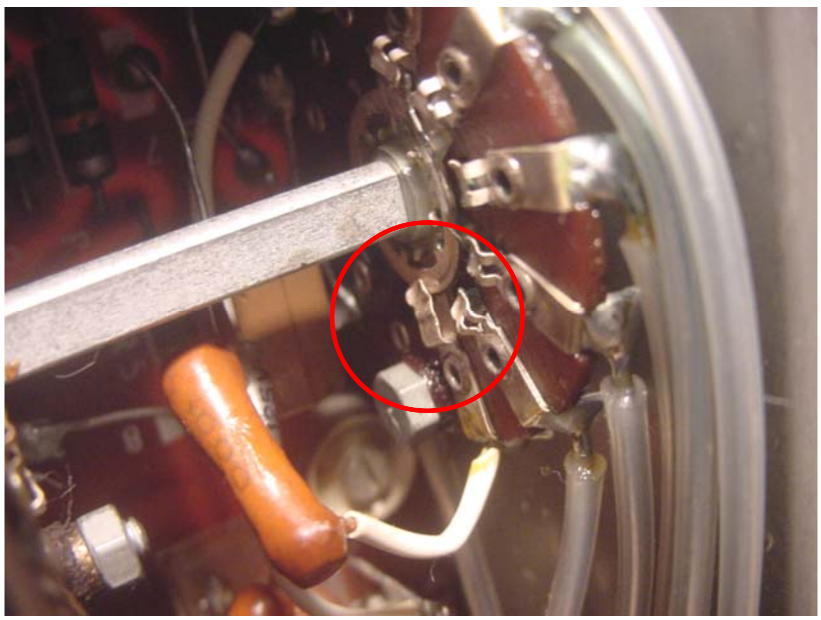


Still no on-air signals could be heard though, even with a long wire attached to the aerial socket. I decided to check if the LO was working (photo, left). Sniffing around the LO coil set with my trusty Millen GDO indicated that nothing was happening in the LO department on any of the ranges. I then did some voltage checks around the LO OC171 – this revealed that the emitter and base were both at ground potential. Ahah! – a case of the dreaded age-related 'whiskers' shorting the device out internally I suspected (see sidebar on previous page). I removed the LO OC171 and sure enough, the emitter and base were shorted to the screen connection (transistor case). I could have tried just cutting the screen lead as per Ted Moore's suggestion in Lighthouse, but I decided to replace it with a tested good device instead. Again with the transistor out of circuit I checked the bias resistors and they



were found to be within tolerance. Replacing the LO OC171 and switching on I immediately noticed an increase in noise accompanied by some fluorescent light 'buzz', and this was controllable by the RF gain control. Injecting an RF signal into the Mixer transistor base produced a strong signal when the EC10 was tuned to the same frequency. All bands seemed to be working ok when checked with the signal generator fed into the Mixer stage, however, there were still no signals to be heard with an aerial connected…

I suspected the RF stage transistor was probably faulty as well, however as I was preparing to check the voltages around the RF OC171, I noticed that there was some corrosion on the aerial wafers of the band switch and that the rotor contact on one of the switch wafers on the transformers between the RF amplifier and the Mixer stage looked 'loose' (had lost its 'spring') – circled red in photo, below. I cleaned up all the switch wafers using De-Oxit and Q-Tips and then when holding the loose spring connection firmly against the switch rotor the set burst into life – many stations coming in loud and clear on the broadcast band (medium wave) and several on the short wave bands too. I carefully adjusted the spring contact so it was making a firmer connection with the switch rotor and then did a quick check on all bands with my signal generator. The calibration was found to be not too far out - so I decided to leave alignment until I had undertaken some further electrical checks and mechanical servicing and clean-up of the dial mechanism (see below). At least it looked as though the RF stage OC171 was still functioning (for now at least – I guess its only a matter of time before it goes the same way as the others). I will probably have to do a more permanent fix on the switch wafer though – not a trivial job if I have to replace it, even if I can get an exact replacement wafer (three different types of Yaxley switch were reportedly used in the production run of the EC10).



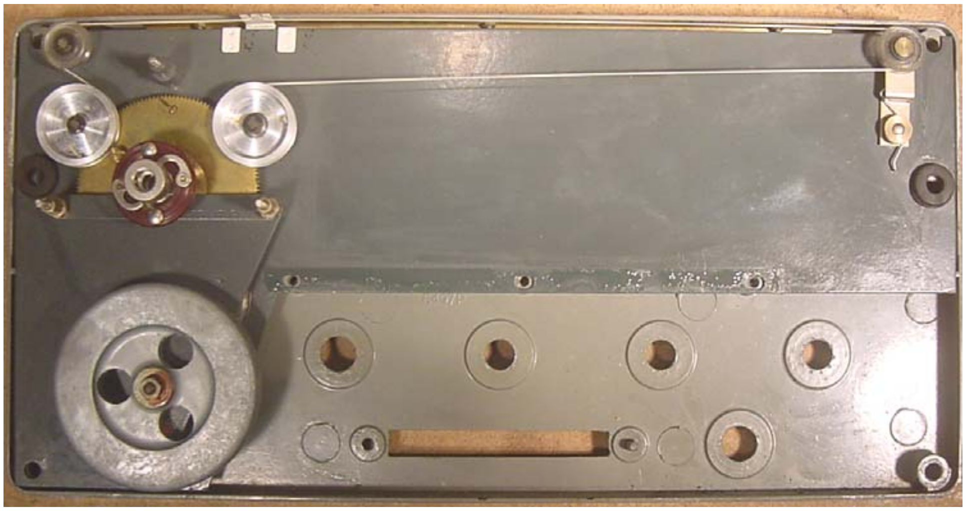
I then decided to see if the BFO was working. I connected a junk box NOS 5-70pf variable capacitor into the circuit where the original had been removed, switched it on and hey-presto, up came the BFO – almost bang on frequency as well.

The AGC circuitry was then tested and found to be working ok (and with it switched out strong signals were found to overload the set). The AF filter was also working, though I left checking the resonant frequency until I re-aligned the set at a later date. The restored dial lamp circuit was now working ok, though one of the bulbs was kaput. I made a mental note to investigate using less current-thirsty high-output LED's in place of the L.E.S. incandescents.

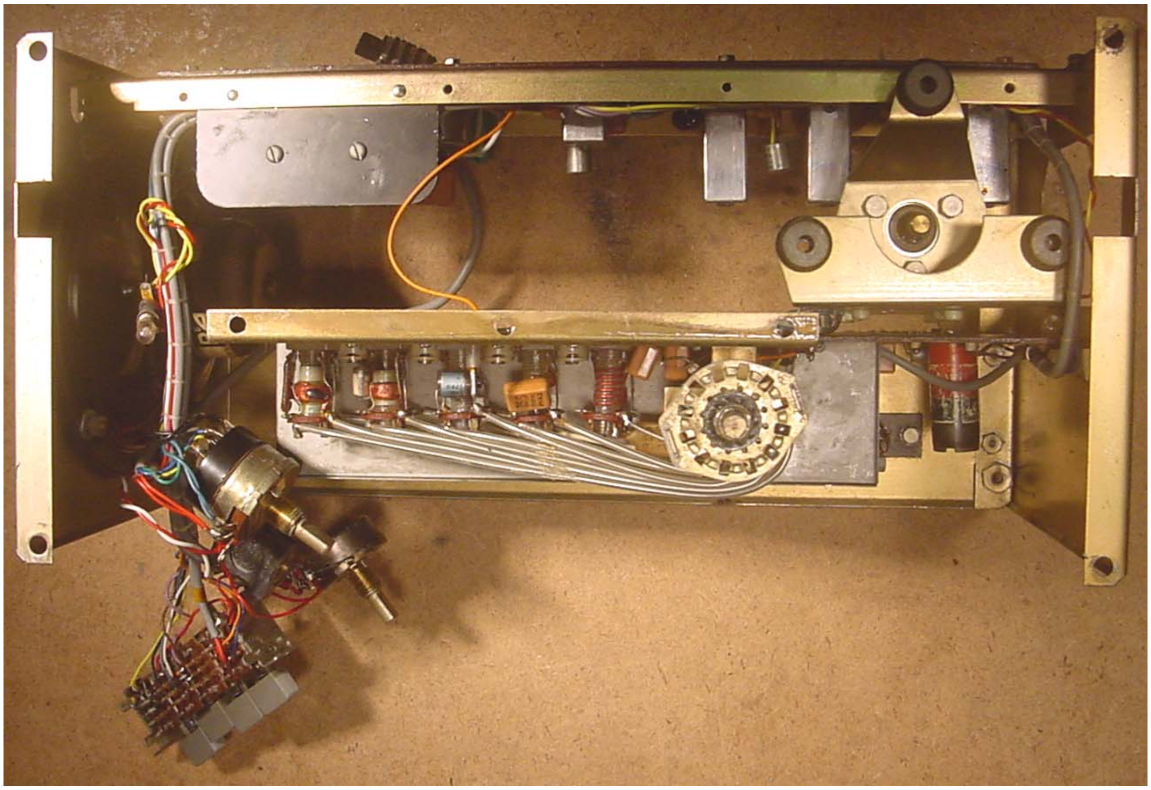
Front Panel Removal/Replacement, Tuning Mechanism Servicing, Dial (Scale) Cleaning

As noted above, the EC10 utilizes a modified Type 898 dial mechanism as found in the small valved Eddystone sets (eg, S.820, S.870 etc). For a fuller description of this mechanism please refer to my article on its use in an HBR13C homebrew receiver downloadable from the EUG website. In this adaptation, the tuning shaft, vernier scale and gearbox are all offset well over to one side rather than being located centrally. Also, the spool pulleys in the EC10 (this set at least) are turned from aluminium rather than brass as in the Type 898) and are slightly larger. Speaking of the Type 898 dial, I was recently given an unused one (thanks Ralph! much appreciated) – photos of the EC10 dial mechanism and the Type 898 are included at the end of this article for comparison.

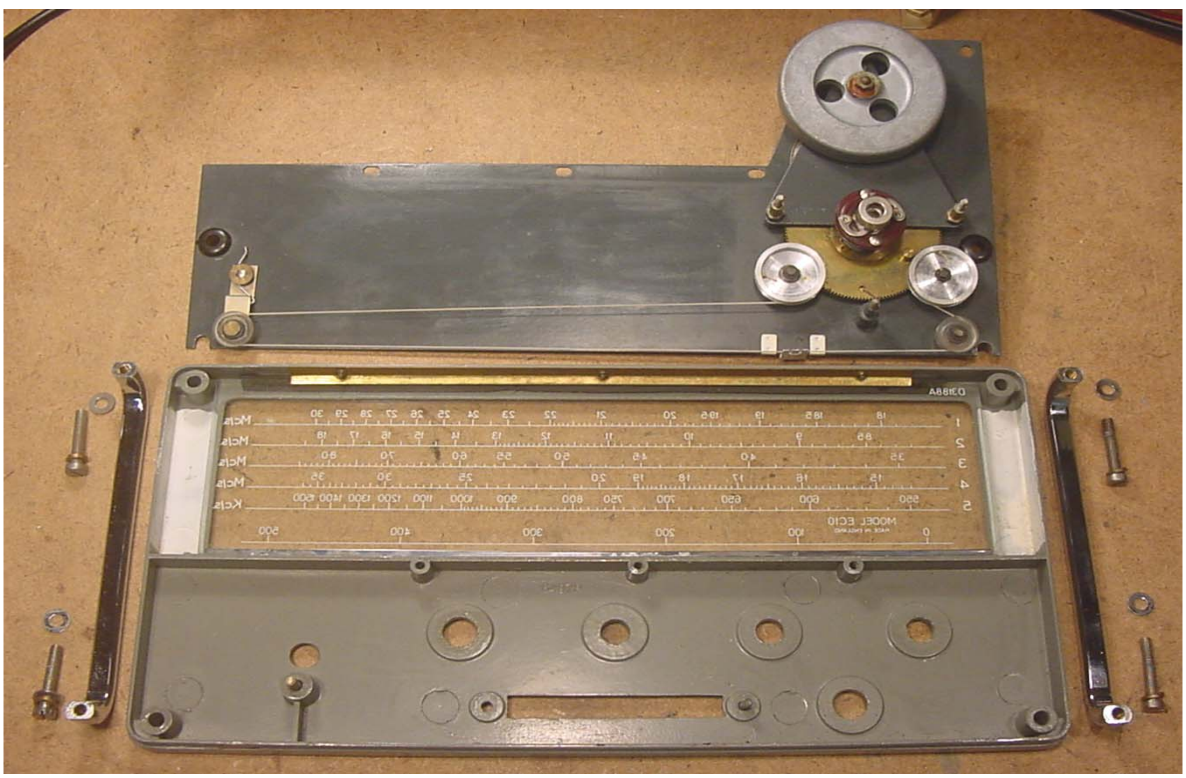
The metal pointer slider runs along the top edge of the sturdy grey-painted metal mounting plate that forms the support for the idler pulley wheels, gearbox (with cut-out for the circular vernier scale), grommets for the dial lights and an angle bracket that



supports the RF circuit board along its front edge. The front of this plate is visible behind the dial glass. This assembly is mounted onto the cast aluminium front panel, which is in



turn bolted to the two chassis side-plates. Removal of the front panel in this simplified form of 'traditional' Eddystone construction is fairly straightforward (though please study the photos very carefully before you start). Here is my recipe:



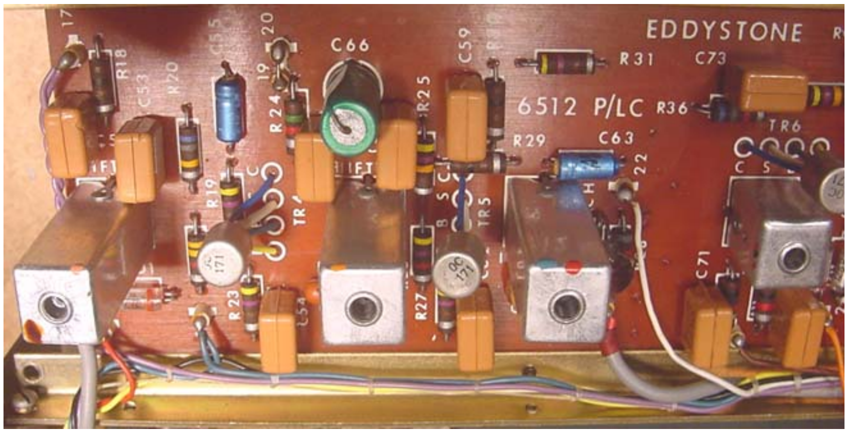
- Remove the four 2BA bolts securing the chassis side plates to the front panel (these are screwed into the carrying handles – watch out for the washers);
- Remove the retaining nuts from the front panel controls and phones jack. Take care doing this - use the correct nut-spinner if available and an over-size thick paper or Teflon washer to act as a guard to prevent scratching the fingerplate;
- Carefully remove the finger-plate (it will likely be stuck down with some double-sided adhesive tape), clean with soapy water and store safely;
- Remove two grub screws in the flexible coupler on the tuning gang shaft (preferably the ones on the tuning capacitor side);
- Remove the three 'Posidrive' self-tap screws holding the RF circuit board front mounting bracket to the drive assembly mounting plate;
- Pull out the two dial lamp holders from their grommets;
- Remove the three 6BA nuts securing the tuning capacitor rubber mounts to the gearbox and drive assembly mounting plate;
- Remove the two 4BA 'Posidrive' retaining screws holding the push switch bank onto the front panel; and
- Gently pull the front panel casting away from the chassis, with the tuning drive assembly attached;
- To separate the casting from the tuning drive mechanism, remove the single 4BA bolt that passes through the mounting plate just beneath the tuning shaft. This will have some locking compound applied to its nut, so may be difficult to loosen.

Take this opportunity to carefully clean the dial glass with luke-warm slightly soapy water and a cotton wool ball. The dial glass can be removed from the front panel casting to facilitate this by removing the three small screws holding its angled retaining strip

along its upper edge. This is also a good time to clean any hardened oil/grease from the gearbox bearings and gears, the friction drive spring (photo above) and to re-lubricate the gears and tuning shaft bearing with suitable grease (I used a very sparing amount of Moly-grease). Clean the friction clutch mechanism and ensure the outer edge of the drive plate and mating surface on the tuning shaft are grease-free.

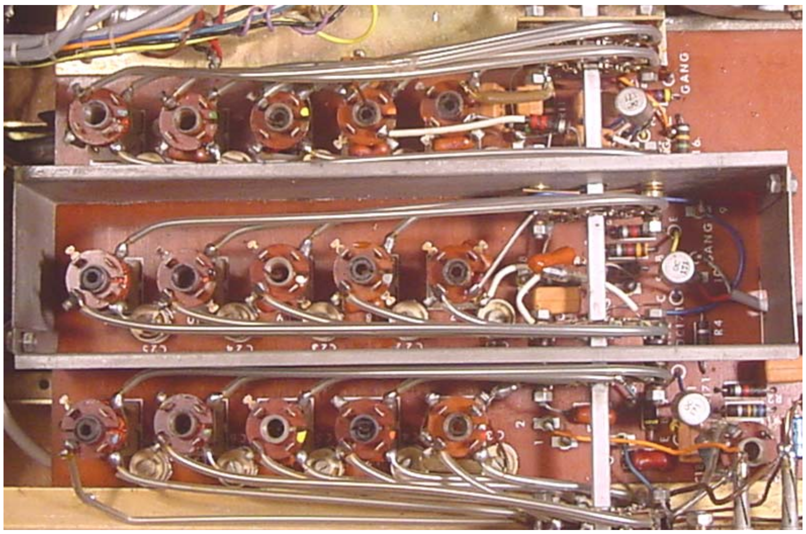
Re-assembly is simply a reversal of the above, but care is needed to ensure that when the dial pointer is at the '0' mark on the logging scale the circular vernier scale is also reading '0' and the tuning capacitor gang is almost fully meshed (maximum capacitance). You may need to adjust the position of the flywheel on the tuning shaft to get the correct amount of float such that the knob spins smoothly.

Re-Alignment



The alignment procedure for the EC10 is very straightforward and is detailed in the appended manual – so is not repeated here. However, you may find that a 'mad twiddler(s)' got there before you, so there may be some nasty surprises lurking in those coil formers – watch out for bits of snapped-off iron dust slug, cross threaded slugs and even damaged/loose wires to the coils.

Before aligning, I opted to carefully remove each slug, one at a time, clean the coil former threads with a pipe cleaner (yes, you can still buy them), discard the *de-rigueur* piece of knicker elastic, wipe the slug clean, dab some Rocol Kilopoise goop onto the slug and screw each one back into its former to approximately the same position as it was before being removed. Broken or jammed-in slugs must be coaxed out slowly with plenty of patience – those small coil formers can break all too easily. Any slugs that appear in any way cracked or damaged should preferable be replaced.



Power Supply

Not having a Type 924 mains power supply handy, I decided to improvise. I had several mains power 'blocks' from consumer electronic products that I had picked up over the years at thrift stores and fleamarkets (these power supplies are also known as 'wall warts'

– photo, right). This type of unit usually supplies an unregulated DC supply of whatever nominal voltage and current is indicated on the back of the 'wart'. However, when unloaded, the voltage output from the supply can be significantly in excess of that indicated, so some caution is advised (varies from 'wart' to 'wart'). I decided to use one of these gadgets to feed unregulated DC into the EC10, with a simple transistor/zener regulator fitted into the sets' battery compartment. I had a suitable 600mA unit in my junk box – plenty of 'oomph' for those 'thirsty' dial lights here (so maybe I won't replace their friendly glow with LED's after all…). A simple, cheap and very effective power supply solution with the benefit of no mods needed to the EC10.

Conclusion

The Eddystone EC10 MkI is a very popular little radio, and quite rightly so – although not in the same league in terms of performance as its contemporary Eddystone thermionic technology communications receiver siblings, it nevertheless filled an interesting spot in the marketplace at a reasonably affordable price point. Indeed, there was nothing quite like it around when it was introduced. It had the added advantage of being fairly compact (if not very lightweight) and battery-powered, hence suitable for use when travelling away from home, in a car, or on a boat. Interestingly, the Range 3 scale has an excellent tuning length from 4.00 MHz to 6.00MHz (actually about 25 turns of the tuning knob), ideal for pairing the set up with a 2-meter converter having this output frequency span – this was the popular way of receiving on 144 – 146MHz back then… I recall lugging my original EC10 with its trusty 'Burns Electronics' kit-built 2-meter converter bolted to the back of its case up many a hill in my youth. I guess that's the real reason for this second time around with an EC10 for me – pure nostalgia (and fun of course!).

Well, that's it for Part 1 of this article. I will live with the case and front panel in its cleaned and touched-up condition for a while but will most likely have them re-finished (probably powder-coated) at a later date. The replacement knobs and finger plate are on order from Ian Nutt – when they arrive and/or I have the powder coating done I will supplement this article with Part 2, providing updated photos and some additional details of the restoration work undertaken on this set. In the meantime I will keep the little guy on the desk in my office and compare its performance with my trusty S.750 (about sixteen years its senior and therefore of course predating any 'trannie' set in the world) – should be an interesting (if perhaps a little unfair) exercise. Stay tuned…

73's

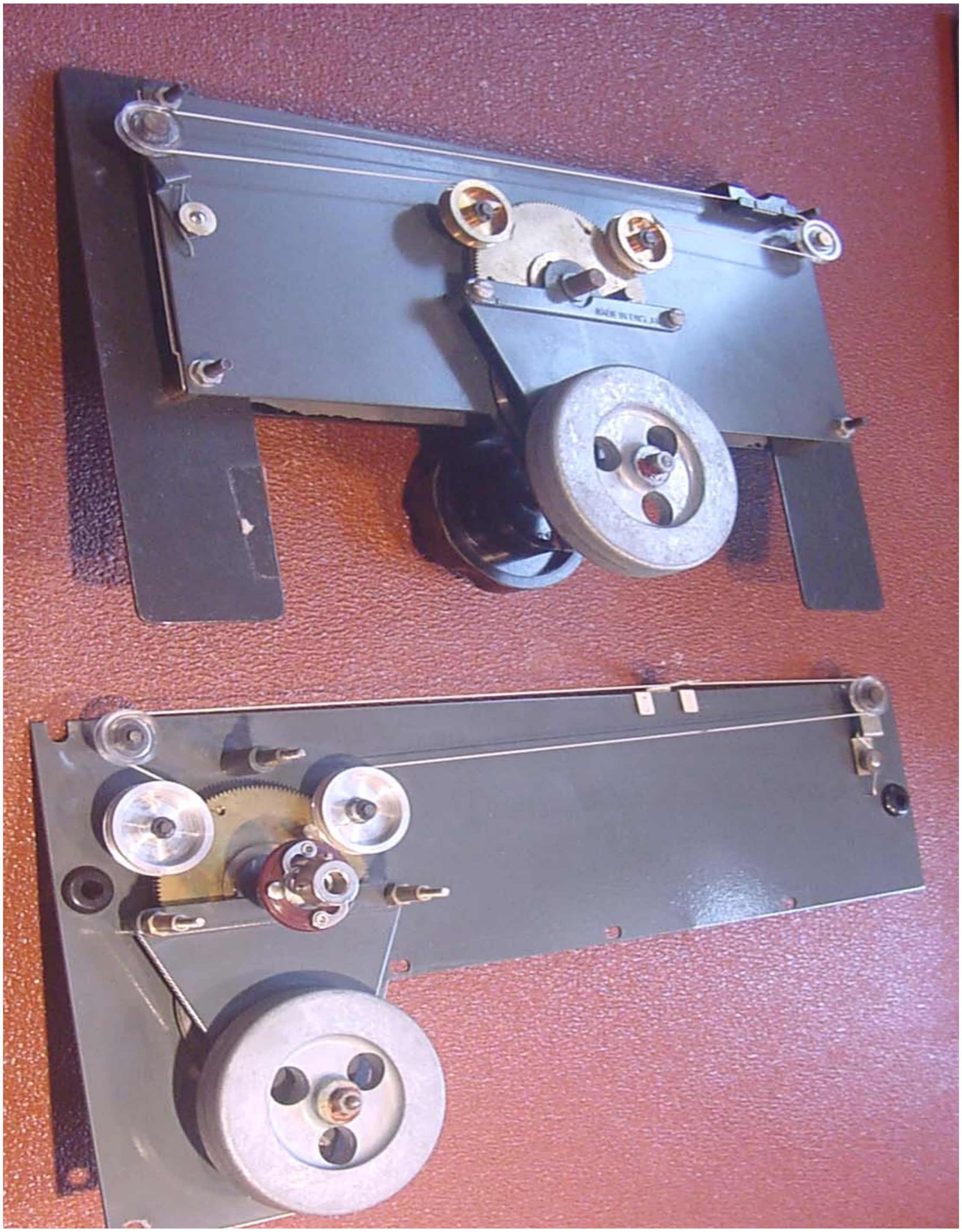
Some Useful References

- Lemons, Wayne, Transistor Radio Servicing Course, 2nd Ed. 1977
- Patchett, GN, Radio Servicing VBol4 Fault Finding, 5th Ed. 1963
- King, Gordon, Radio and Audio Servicing Handbook, 2nd Ed. 1970
- Davidson, Homer, The Illustrated Home Electronics Fix-It Book, 2nd Ed.1988
- Hibberd, RG, Transistors: Principles and Applications, 1965
- Mullard Ltd. Transistor Audio and Radio Circuits, 1969
- Armstrong, DT, Miniature Hearing Aid, Radio-Electronics, Vol.24, No. 12, December, 1953
- Various documents downloaded from the EUG website, including:
  - The Ultimate Quick Reference Guide (QRG), 2nd Ed., 2005, Graham Wormald, G3GGL
  - The Cooke Report by Bill Cooke
  - EC10 MkI and MkII Manuals and promotional literature
  - S.960 Manual and promotional literature
  - O'Hara, Gerry, A Potted History of my 'Radio Life' and the Restoration of an Eddystone S.740, June, 2006
  - O'Hara, Gerry, Use of the Eddystone '898' Drive Unit in an HBR 13C Homebrew Receiver (under 'Technical Information'), January, 2008
  - EUG Newsletter/Lighthouse articles featuring the EC10 MkI and MkII, listed below for convenience (see also articles on other small Eddystone solid-state sets of this era, ie. EB35, EB36, EB37 and EY11):

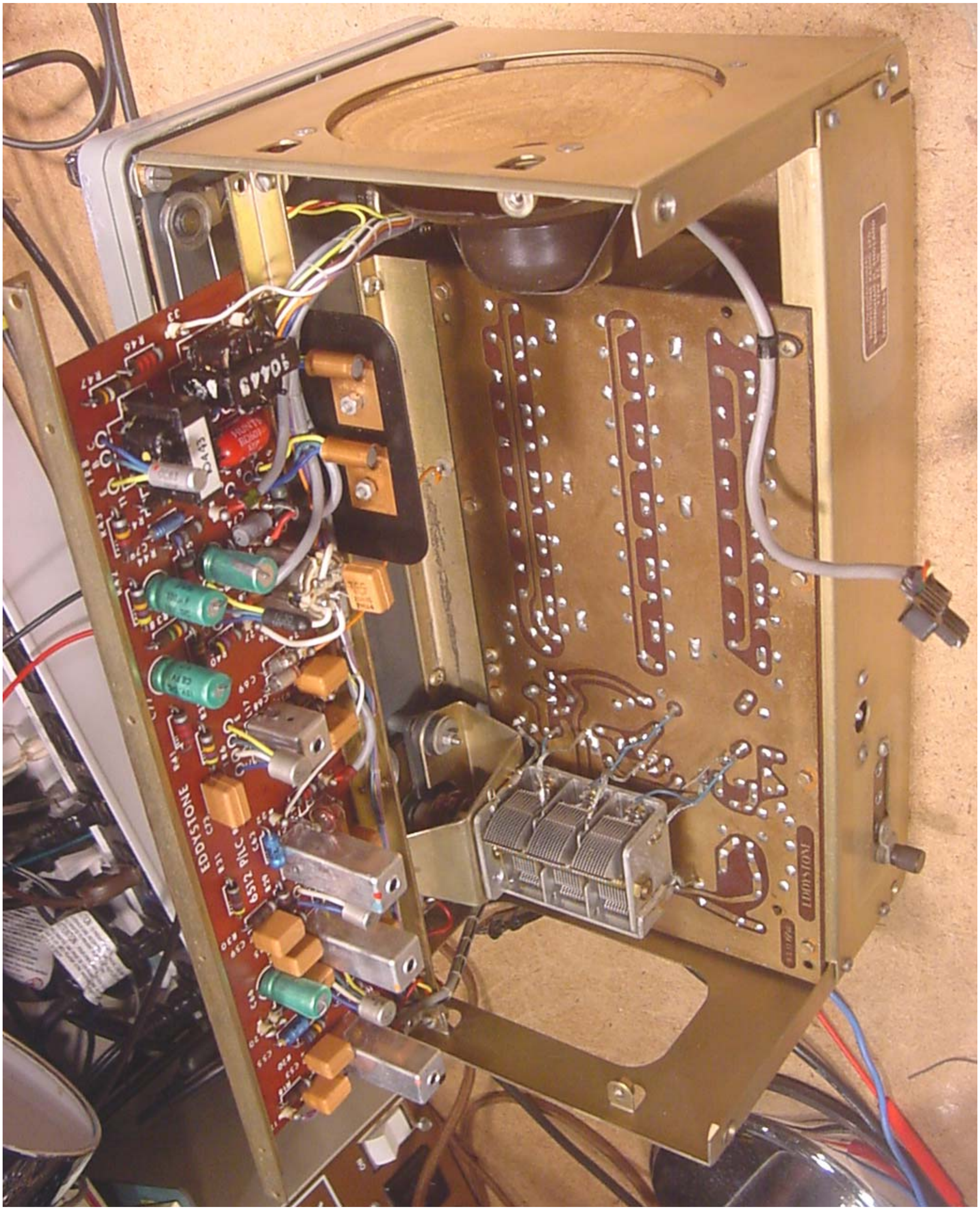
Some Interesting 'Trannie' and Article-Related Websites:

- http://www.eddystoneusergroup.org.uk/):
- http://people.msoe.edu/~reyer/regency/
- http://www.pbs.org/transistor/background1/events/tradio.html
- http://history.sandiego.edu/GEN/recording/transistor.html
- http://www.geocities.com/aldoandr/transistor.html
- http://www.antiqueairwaves.com/regencytr-1.htm
- http://www.vintage-technology.info/pages/history/histpamtr.htm
- http://s206301103.websitehome.co.uk/tr.radio.history.htm
- http://www.qsl.net/vk3jeg/edd_ec10.html
- http://homepage.ntlworld.com/lapthorn/ec10.htm
- http://www.shopingathome.com/Eddystone%20EC10%20EC10%20Mk2.htm
- http://ourworld.compuserve.com/homepages/Andrew_Wylie/
- http://www.vintage-radio.com/repair-restore-information/transistor_transistor-faults.html
- http://www.vintage-radio.com/repair-restore-information/index.html
- http://users.arczip.com/rmcgarra2/index.html
- http://www.radio-workshop.co.uk/manuals.shtml
- http://www.transistor-repairs.com/print.html
- http://hometown.aol.co.uk/oldradioparts/semiconductors.htm

- http://www.ronmansfield.com/radiobooks.htm
- http://semiconductormuseum.com/Museum_Index.htm
- http://homepage.ntlworld.com/lapthorn/ec10.htm



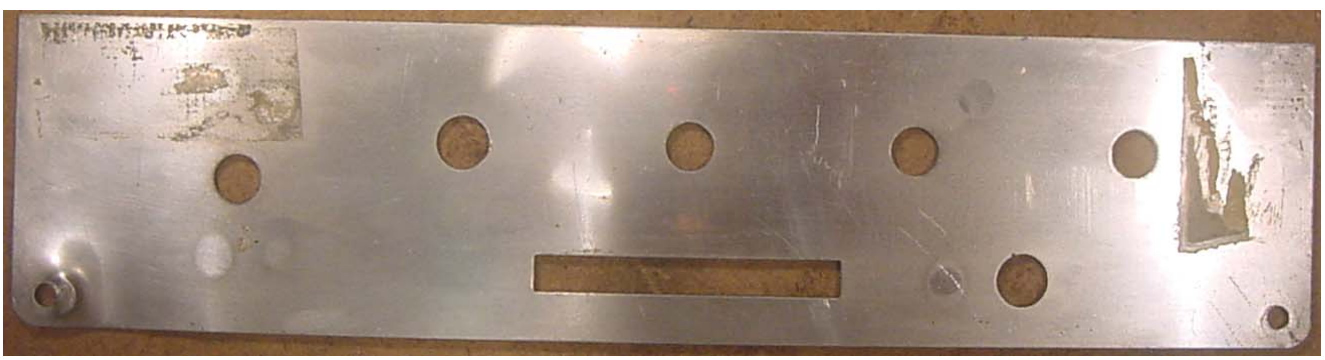
Above: Compare the Type 898 dial mechanism (top) with the EC10 dial mechanism (below) – a traditional Eddystone adaptation of a proven, robust design

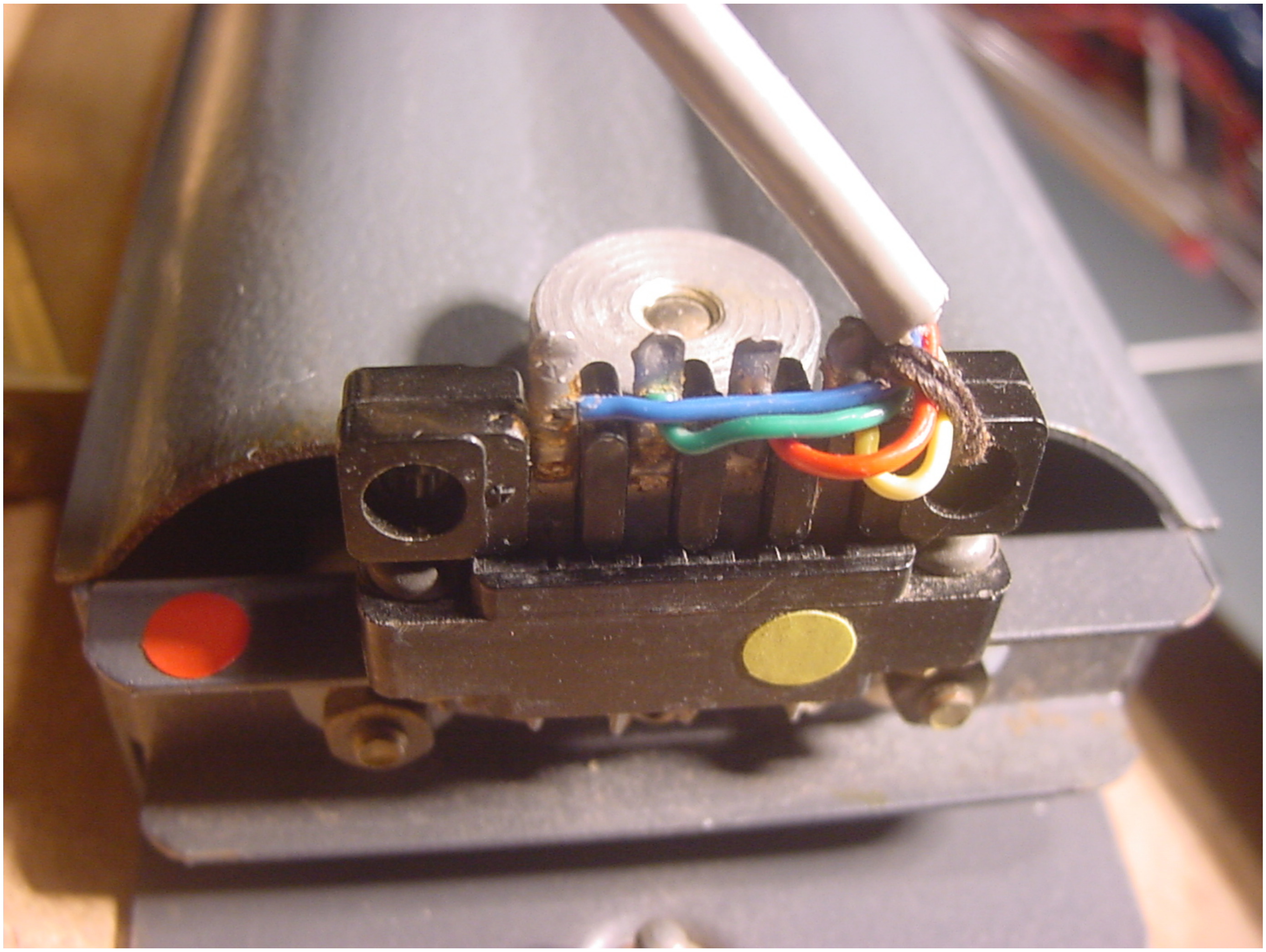


Above: Superb accessibility to all components as well as easy IF transformer/BFO coil adjustment is afforded by the EC10's clever design feature for rotating the IF/AF strip through 90 degrees while maintaining all connections. This also provides excellent access to the RF board printed circuit tracks – useful for replacing those pesky OC171s - Bill must have had a premonition…

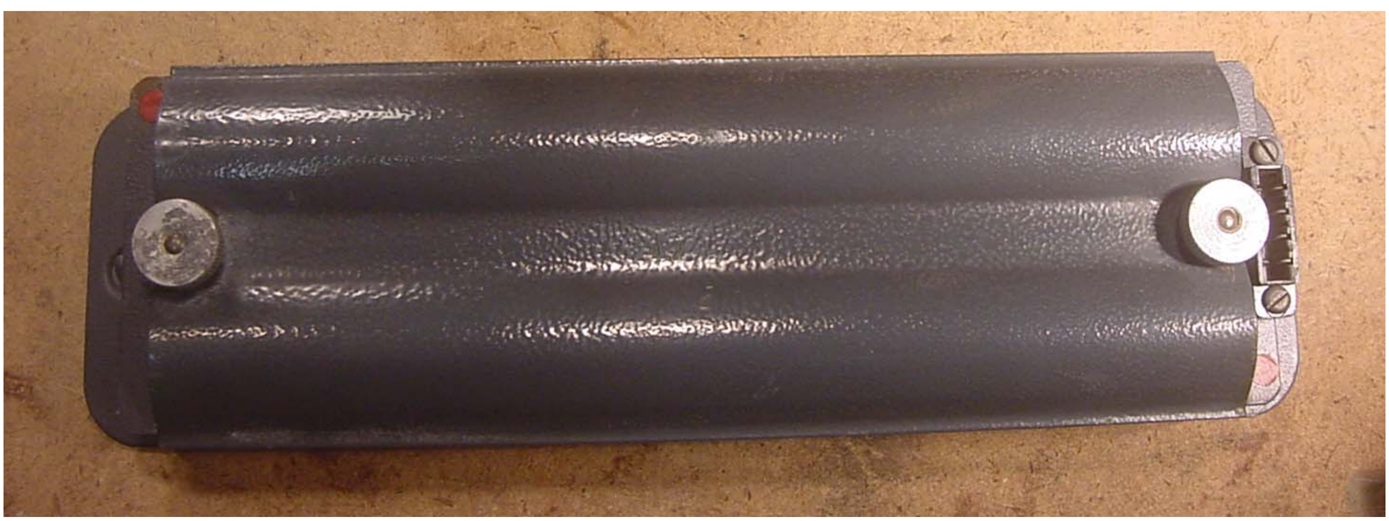
Left: The front panel of the gearbox is formed by the mounting plate for the dial drive. The circular vernier scale is visible through a cut-out in the mounting plate above the tuning shaft

Below: The worn and damaged finger plate - looks like a bullet has passed through one of the holes that secure the handles in place (lower left of the photo of the rear of the finger plate shows this best) – ouch!





Above: Saving the worst till last, here is the dreadful power-supply connector. The yellow paper spot is the only indication of what end of the plug on the flying-lead goes to what end of the socket on the battery box (photo, below), or worse, on the Type 924 mains psu. The red paper spot in the photo above indicated the positive end of the batteries. Note the ease with which a short could occur in the wiring…



Eddystone

TRANSISTORISED COMMUNICATION RECEIVER
MODEL EC10

INSTRUCTION MANUAL

The EDDYSTONE Model EC10 is a fully transistorised single conversion communication receiver covering the frequency band 550 kc/s to 30 Mc/s in five ranges. Provision is made for AM and CW reception and the unit is powered by a self-contained battery pack.

A total of ten transistors is employed together with five diodes one of which is a zener type which serves to stabilise the supply for the RF section of the receiver. This arrangement helps to maintain a sensibly constant performance with falling battery voltage. Current drain has been kept to a minimum to prolong battery life.

A wide variety of aerials can be accommodated including a small telescopic rod aerial for portable operation. An internal five inch loudspeaker is fitted and arrangements are made for using low impedance telephones where this is more convenient. A push-pull audio output stage is employed and a selective audio filter can be introduced for CW reception under conditions of severe adjacent channel interference.

Independent RF and AF Gain controls are fitted and the other controls include separate BFO and AGC switches and a variable BFO pitch control. The tuning drive is a geared type and is flywheel-loaded for ease of operation. Tuning scales are some nine inches in length and are calibrated directly in terms of frequency. Dial illumination is provided for use when necessary and is controlled by a switch on the panel.

The receiver is light in weight, has contemporary styling with compact dimensions and is housed in a strong metal cabinet. High quality components are used in all parts of the circuit and reliable operation is assured throughout the world.

TECHNICAL DATA

Frequency Coverage

550 kc/s to 30 Mc/s in 5 ranges :—

Range 1	..	18·0 — 30·0 Mc/s
Range 2	..	8·5 — 18·0 Mc/s
Range 3	..	3·5 — 8·5 Mc/s
Range 4	..	1·5 — 3·5 Mc/s
Range 5	..	550 — 1500 kc/s

Intermediate Frequency

465 kc/s.

Semiconductor Complement

TR1	OC171	RF Amplifier.
TR2	OC171	Mixer.
TR3	OC171	Local Oscillator.
TR4	OC171	1st IF Amplifier.
TR5	OC171	2nd IF Amplifier.
TR6	OC171	Beat Oscillator.
TR7	OC71	Audio Amplifier.
TR8	OC83	Audio Driver.
TR9 / TR10	2 × OC83	Audio Output.
D1	OA70	AGC Attenuator.
D2	OA90	Detector/AGC.
D3	OAZ203	Voltage Stabiliser.
D4/5	2×DD006	Aerial Protection Diodes.

Power Supply

9V from 6 × 1·5V leak-proof dry cells, external supplies of 12V or 24V DC (positive earth) using Voltage Converter Type 945 or standard AC mains supplies using AC Power Unit Type 924.

Consumption

36mA quiescent, 77mA at 50mW and 180mA at 500mW output. Dial lamps when in use add 90mA to the normal current drain.

Aerial Input Impedance

Ranges 1 — 4	..	75Ω (nom) balanced or unbalanced.
Range 5	.. ..	400Ω (nom) balanced or unbalanced.

A high impedance input connection is provided for use on all ranges and is suitable for use with short rod aerials.

Sensitivity

Better than 5uV for 15dB s/n ratio on Ranges 1—4.
Better than 15uV on Range 5.

IF Selectivity

Typical overall bandwidths at 6dB and 40dB down are 5 kc/s and 25 kc/s respectively.

IF Breakthrough

Ranges 1 — 4	..	greater than 85dB down.
Range 5	.. ..	greater than 65dB down.

Image Rejection

20dB at 18·0 Mc/s and 50dB at 2·0 Mc/s.

Calibration Accuracy

1% on all ranges.

Frequency Stability

Drift does not exceed 1 part in 10^4 per °C change in ambient temperature.

AGC Characteristic

An 80dB increase in signal produces less than 12dB change in output. Taken from 6uV at 2·0 Mc/s on Range 4.

Audio Output and Response

The maximum audio output exceeds 1 watt and 800mW is available at 10% distortion.

Frequency response is level within 6dB over the range 300 c/s to 8 kc/s except when using the audio filter. The filter is resonant at approximately 1,000 c/s and can be brought into circuit for selective CW reception. 6dB bandwidth is of the order 180 c/s.

Dimensions and Weight

Height	.. ..	6⅜″ (16·2 cm.).
Width	.. ..	12½″ (31·7 cm.).
Depth	.. ..	8″ (20·3 cm.).
Weight (less batteries)	.. ..	12¾ lb. (5·8 kg.).
Weight (with batteries)	.. .. ..	14 lb. (6·3 kg.).

CIRCUIT DESCRIPTION

The RF Section of the receiver comprises TR1, TR2, and TR3 (3 × OC171). TR1 is a grounded-base amplifier with signal input applied to the emitter from a tap on the appropriate tuned circuit which is selected by S1a, b and c. L1/C2 is introduced on Range 5 and serves as an IF rejector circuit to limit IF breakthrough when using this band. AGC can be applied to the RF Stage and manual gain control is effected by RV1 which also controls the 1st IF Amplifier TR4. The RF Stage is coupled to the Mixer by L7-L11 which have low impedance secondaries to match the base impedance. Oscillator injection is to the emitter and IF output is taken from the collector to the 1st IF transformer IFT1.

A tuned collector circuit is employed in the Local Oscillator Stage (TR3) which tracks above the signal frequency on all ranges. Injection for the Mixer is taken from a low impedance link winding on the appropriate oscillator coil.

All three stages in the RF Section are operated from the stabilised supply provided by the zener diode D3 (OAZ203). This gives a nominal 6·5V and maintains sensibly constant performance with falling battery voltage. All tuned circuits associated with TR1-TR3 employ precision wound coils and have individual trimming adjustments. The circuits are arranged in such a manner that the coils which are not in use are shorted out to prevent absorption and dead spots in the tuning.

IF amplification is provided by TR4 and TR5 (2 × OC171) which operate at 465 kc/s with a total of five tuned circuits to ensure a high degree of adjacent channel selectivity. AGC and manual gain control are applied to the first stage while the second operates at constant gain. Improved operation under strong signal conditions is given by the diode switch (D1 : OA70) which introduces a damping resistor (R19) across the primary of IFT1 when the signal exceeds a certain level. This action assists the AGC circuit and prevents overloading of the Detector and TR5.

The diode (D2 : OA90) which serves as the Detector is housed in the IFT3 screening can and also provides the AGC voltage which is applied to TR1 and TR4 via the filter circuit C63/R28. Audio output from the Detector is coupled through C74 to the base of the Audio Amplifier which is an OC71 (TR7).

TR6 is introduced for CW reception and provides a locally generated carrier which is amplified by TR5 and applied to the Detector along with the normal signal. The beat frequency obtained can be adjusted by means of the pitch control C70. TR6 derives its supply from the zener diode D3.

An audio filter (L18/C76) is included in the coupling between TR7 and the Audio Driver Stage TR8 (OC83). The filter is resonated at approximately 1,000 c/s and will be found most useful for CW reception when interference is severe. The filter can be switched out by S4 when receiving AM signals.

The push-pull Output Stage operates in Class "B" and provides a 3Ω output to feed the internal loudspeaker. Low impedance telephones can be plugged into a socket on the panel and the circuit is arranged so that the speaker output is interrupted when telephones are in use.

INSTALLATION

Batteries

The EC10 receiver is supplied without batteries. **Six** standard 1·5V dry cells are required and these are of a type which is available in all parts of the world. It is recommended that leak-proof types are used wherever possible, the Ever Ready HP2 being suggested as the most suitable battery for this receiver. Other batteries which can be used are as follows:—

EVER READY	U2	OLDHAM	K532
VIDOR	V0002	PERTRIX	601
DRYDEX	T20/T21	SIEMENS	T1
G.E.C.	BA6103	RAYOVAC	3LP

N.A.T.O. Stock No. 6135–99–910–1101.

To fit the batteries, first unscrew the two knurled screws which retain the battery box at the rear of the receiver. Lift the box clear and free from the receiver by disengaging the four-way connector at the right-hand end. Now remove the inner cover from the box, sort the batteries into two groups of three and slide them into the battery troughs.

Use the diagram printed on the battery container as a guide when fitting the batteries and make absolutely sure that they are in the correct positions before switching on the receiver. **Switching on with the batteries connected the wrong way round will damage the transistors.** Replace the inner cover, re-connect the four-way plug and then re-fit the battery container in the rear of the set. It should be noted that the plug is a non-reversible type so that there is no chance of the battery polarity being reversed at this point.

Aerial Connections

Sockets are provided for connecting short rod aerials, normal single wire aerials and either balanced or unbalanced transmission line feeders. Single wire aerials are connected to the "A1" socket with the special shorting plug in position between the "AE" socket and the "EARTH" terminal. This same shorting plug is also used when the receiver is fed with coaxial line or when using a short rod aerial. In the case of a coaxial feeder the outer braid is attached to the "EARTH" terminal and the inner conductor to the "A1" socket.

If a balanced feeder (twin transmission line) is employed, the shorting plug is removed and the feeder wires are connected to "AE" and "A1". The shorting plug can be pushed temporarily into the "A2" socket to avoid loss. This latter socket is used only for connecting short rod aerials when a full size aerial is not available. The socket is not suitable for connection of resonant loaded whip aerials which should be connected at the "A1" socket with the link in place between "AE" and "EARTH."

In some cases a good earth will give improved results and it is well worth taking the trouble to install one. Reduction in the level of locally generated noise will be one of the advantages gained from proper earthing of the receiver.

Telephones

Telephones or an external loudspeaker can be connected to the socket on the panel. The output is matched to 3Ω and will give satisfactory results with telephones of up to 600Ω impedance. Higher impedance can be used but with some reduction in output and slightly inferior quality.

OPERATION

Operation of the receiver is quite straightforward and a few minutes spent in manipulating the various controls will quickly familiarise the user with their functions.

The SUPPLY switch is ganged to the RF GAIN control and is moved to the "on" position by rotating the RF GAIN in a clockwise direction. Tuning is with the large knob at the right-hand side of the panel, the drive mechanism being a precision unit employing spring-loaded split-gears giving a reduction ratio of the order 110–1. This facilitates accurate tuning on the HF ranges while flywheel-loading allows the control to be "spun" to permit rapid movement from one part of the dial to another. The dial calibration is in Mc/s on all ranges except Range 5 where the scale is marked in kc/s. Range numbering appears at the left-hand end of the dial and is repeated on the WAVECHANGE switch which is located immediately to the left of the TUNING control.

The calibrated vernier which appears in the window above the TUNING control is used in conjuction with the bottom logging scale on the main dial. Combining the two readings will give an arbitrary figure which corresponds to the actual frequency to which the receiver is tuned. The readings can be recorded to allow rapid re-setting to specific frequencies.

Independent RF and AF GAIN controls are provided, the former being a combined RF and IF control. Four push-button switches control the following functions :—

AF FILTER IN/OUT, BFO ON/OFF, AGC ON/OFF and DIAL LIGHTS ON/OFF. The DIAL LIGHT switch is mechanically biased to the "off" position and must be held in the "on" position to obtain scale lighting. Illumination of the dial will not normally be required and since the scale light consumption doubles the average current drawn from the supply, this facility should be used only when absolutely essential. The other switches are of the press-to-operate press-to-release type and lock in the "on" position.

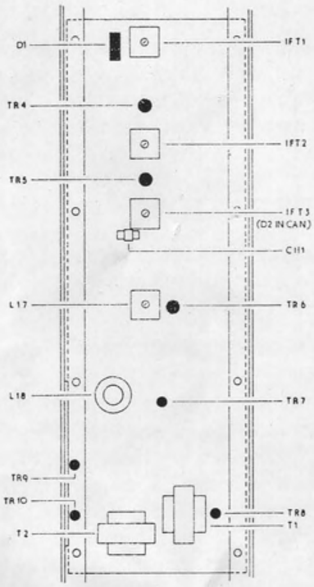
The remaining control is the BFO PITCH control which is functional only when receiving CW signals. It allows the BFO to be set to either side of the incoming signal and when using the audio filter it provides a means of setting the beat note to coincide with the resonant frequency of the filter (1,000 c/s).

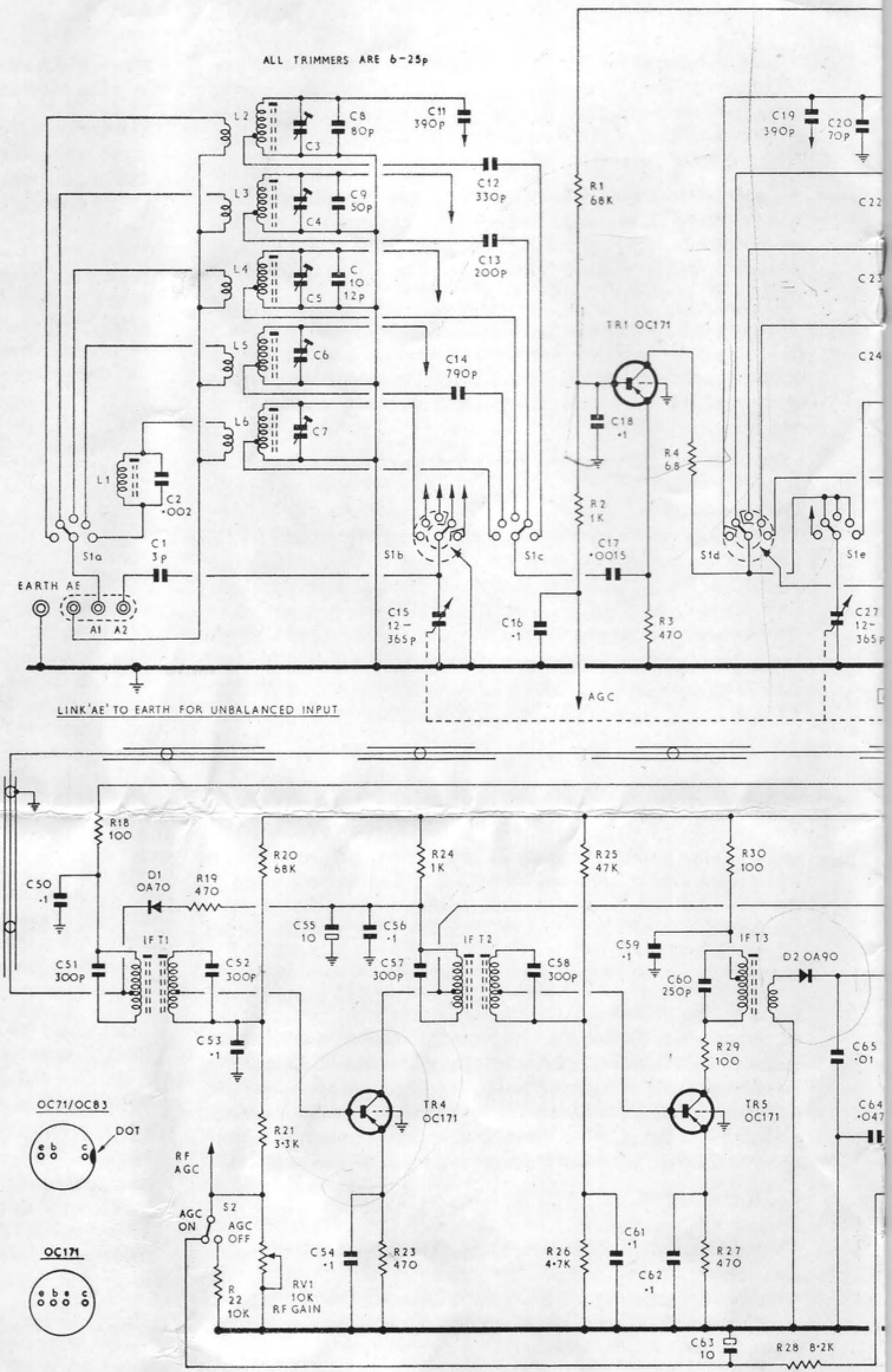
The AGC will normally be switched "off" when receiving CW signals (BFO "on") and under this condition of operation it is usual to reduce the setting of the RF GAIN to prevent overloading of the pre-detector stages. When receiving AM signals the AGC should be in use and the RF GAIN is then advanced to maximum to secure optimum AGC action.

ERRATA

R24 should read: 1·5K, R35: 47K.
C10 should read 20pF.
Add C23a. 10pF Tubular Ceramic across tuned winding of L9.
D1 is shown reversed.
Add two DD006 diodes (parallel-connected with reverse polarity) across the "A1" and "AE" terminals. Allocate Reference D4 and D5.

Layout of IF Printed Board





LIST OF COMPONENT VALUES

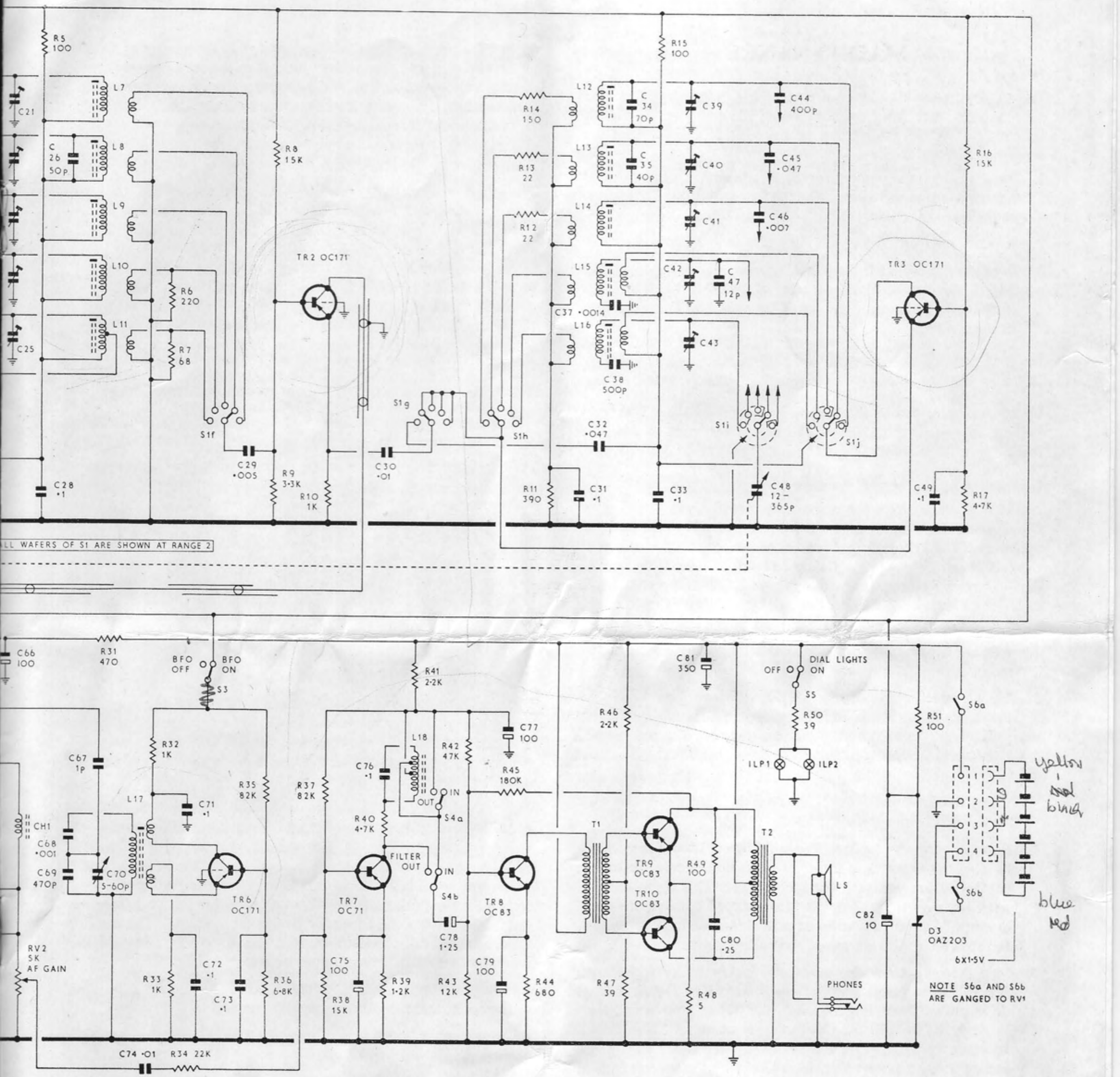
RESISTORS

All 10% ½ watt unless otherwise indicated.)

R1, R20,	68,000Ω
R2, R10, R24, R32, R33 :	1,000Ω
R3, R19, R23, R27, R31 :	470Ω
R4, R7 :	68Ω
R5, R15, R18, R29, R30, R49, R51 :	100Ω
R6 :	220Ω
R8, R16, R38 :	15,000Ω
R9, R21 :	3,300Ω
R11 :	390Ω
R12, R13 :	22Ω
R14 :	150Ω
R17, R26, R40 :	4,700Ω
R22 :	10,000Ω
R25, R35, R42 :	47,000Ω
R28 :	8,200Ω
R34 :	22,000Ω
R37 :	82,000Ω
R36 :	6,800Ω
R39 :	1,200Ω
R41, R46 :	2,200Ω
R43 :	12,000Ω
R44 :	680Ω
R45 :	0·18MΩ
R47, R50 :	39Ω 5%
R48 :	5Ω 5% wirewound. 3W.
RV1 :	10,000Ω potentiometer.
RV2 :	5,000Ω potentiometer.

CAPACITORS

C1 : 3pF Tubular Ceramic ±0·5pF 750V DC wkg.
C2 : 0·002uF Polystyrene ±5% 125V DC wkg.
C3–7, 21–25, 39–43 : 6–25pF Ceramic Trimmer.
C8 : 80pF Silvered Mica ±10% 350V DC wkg.
C9, 26 : 50pF Tubular Ceramic ±10% 750V DC wkg.
C10, 47 : 12pF Tubular Ceramic ±10% 750V DC wkg.
C11, 19 : 390pF Polystyrene ±5% 125V DC wkg.
C12 : 330pF Polystyrene ±5% 125V DC wkg.
C13 : 200pF Polystyrene ±5% 125V DC wkg.
C14 : 790pF Polystyrene ±5% 125V DC wkg.
C15, 27, 48 : 3-gang Air-spaced Variable 12-365pF.
C16, 18, 28, 31, 33, 49, 50, 53, 54, 56, 59, 61, 62, 71, 72, 73, 76 : 0·1uF Polyester ±20% 250V DC wkg.
C17 : 0·0015uF Tubular Ceramic +50%—25% 750V DC wkg.
C20, 34 : 70pF Tubular Ceramic ±10% 750V DC wkg.
C29 : 0·005uF Tubular Ceramic ±10% 750V DC wkg.



C30, 74 : 0·01uF Metallised Paper ±20% 200V DC wkg.
C32, 45, 64 : 0·047uF Polyester ±20% 250V DC wkg.
C35 : 40pF Tubular Ceramic ±10% 750V DC wkg.
C36 : Reference not allocated.
C37 : 0·0014uF Polystyrene ±5% 125V DC wkg.
C38 : 500pF Silvered Mica ±2% 350V DC wkg.
C44 : 400pF Silvered Mica ±2% 350V DC wkg.
C46 : 0·007uF Polystyrene ±5% 125V DC wkg.
C51, 52, 57, 58 : 300pF Polystyrene ±5% 60V DC wkg.
C55, 63, 82 : 10uF Tubular Electrolytic +50%—10% 16V DC wkg.
C60 : 250pF Polystyrene ±5% 60V DC wkg.
C65 : 0·01uF Metallised Paper ±20% 150V DC wkg.
C66, 75, 77, 79 : 100uF Tubular Electrolytic +100%—20% 15V DC wkg.
C67 : 1pF Tubular Ceramic ±0·5pF 750V DC wkg.
C68 : 0·001uF Polystyrene ±5% 125V DC wkg.
C69 : 470pF Polystyrene ±5% 125V DC wkg.
C70 : 5-60pF Air-Spaced variable.
C78 : 1·25uF Tubular Electrolytic +100%—10% 16V DC wkg.
C80 : 0·25uF Metallised Paper ±20% 150V DC wkg.
C81 : 350uF Tubular Electrolytic +100%—20% 12V DC wkg.

MAINTENANCE

General

The EC10 receiver should require very little in the way of routine maintenance apart from replacement of the batteries. If a fault should develop, the cabinet can be removed by carrying out the procedure detailed below :—

1. Remove the battery container by unscrewing the two knurled retaining screws and disengaging the four-way battery connector at the right-hand end.
2. Remove the four cabinet retaining screws.
3. Free the cabinet from the panel by applying pressure with the fingers between the rear inner edge of the cabinet and the ends of the strip which supports the IF printed board near the top of the cabinet.
4. Slide the cabinet away from the panel.

Dial Bulbs

Faulty dial bulbs can be changed by levering the holders free from the rubber mounting grommets at the extreme ends of the dial. Replacement bulbs should be of the L.E.S. type rated at 6V, 50mA.

Instructions for re-stringing the drive cord

In the unlikely event of the pointer drive cord either breaking or slipping out of the pulley grooves, replacement will present no real problems if the instructions given below are followed carefully. If the cord is broken, a new length should be obtained and this can be made longer than the length actually required (32″ : 82 cm.) to make it easier to handle. Right-hand and left-hand in the instructions given below are as viewed from the rear of the receiver.

1. Remove the existing cord and then set the tuning gang to full mesh.
2. Tie a double knot in one end of the replacement cord and feed the cord through the hole provided in the left-hand drive pulley with the knot on the inside of the rim. The hole should lie at approximately "4 o'clock."
3. Wind approximately one and a half turns anti-clockwise round the drive pulley and then pass the cord under and over the left-hand guide pulley.
4. Pass the cord across the dial from left to right and then, while holding the free end of the cord in tension, rotate the tuning control to fully unmesh the tuning gang. This operation will wind just over three complete turns of cord onto the left-hand drive pulley and tension must now be maintained to prevent the cord from slipping out of the pulley groove.
5. Pass the cord clockwise round the jockey pulley (right-hand side of the receiver) and then back across to the right-hand drive pulley. Feed the cord into the pulley groove and then through the hole in the rim (hole lies at about "10 o'clock). Increase the tension on the cord until the outer rim of the jockey pulley takes up a position level with the nearest edge of the panel handle retaining screw. Mark the cord with a pencil at the point where the retaining knot must be tied.
6. Free the cord from the jockey pulley and while maintaining tension, draw the cord through the hole in the right-hand drive pulley until the cord tightens on the left-hand guide pulley.
7. Tie a double knot in the position marked in (5) above and cut off any surplus cord. Feed the cord back through the hole and replace in position round the jockey pulley.
8. Set the tuning gang to full mesh and slide the pointer to 'O' on the logging scale. Attach the pointer to the cord (when viewed from above the cord should pass under the two outer prongs at the rear of the pointer carrier) and then check the drive for free and normal operation.

Re-alignment

The initial factory alignment of the receiver should hold for a long period of time and re-alignment should not be carried out unless there is a clear indication that it is in fact necessary. Alignment should be carried out only by individuals with a sound knowledge of the procedures involved and the test equipment listed below must be available if the task is to be completed satisfactorily. It should be noted that any figures quoted for sensitivity etc., are based on the assumption that a new set of batteries is in use. It is further assumed that the receiver cabinet has been taken off as described earlier.

The following items of test equipment are required for re-alignment–

Signal generator(s) covering 465 kc/s and the range 550 kc/s to 30 Mc/s with provision for modulation at 30% (400 c/s) and with an output impedance of 50/75Ω.

Crystal controlled harmonic generator providing 100 kc/s markers up to 7·5 Mc/s and 1 Mc/s markers up to 30 Mc/s.

Output meter matched to 3Ω with plug to mate with telephone socket.

Trimming tools :— Miniature insulated screwdriver with $\frac{1}{16}$″ blade, small metal-tipped insulated screwdriver and a Neosid Type H.S.1. hexagonal core adjuster.

Re-alignment of the IF Stages and BFO

First locate and remove the four screws which retain the IF printed wiring board. Turn the board through 90° into a vertical position and replace two of the screws to keep the board in this position. All trimming adjustments are now accessible and there is no need to unsolder connections to the board.

Now stand the receiver on one end to allow connection of the generator output lead to the Range 5 Mixer coil L11 (see underside view of receiver). The generator should be arranged to provide a 50Ω source and the earth lead can be clipped to the screen adjacent to the coil. Disable the Local Oscillator by shorting out the forward section of the tuning gang (C48) and then plug the lead from the output meter into the telephone socket on the panel. The speaker is automatically disconnected on insertion of the plug and the meter will therefore indicate true output power.

Switch on the generator, allow it adequate time to stabilise against drift and then set the receiver controls as follows :—

Range Switch ..	Range 5.	AGC/BFO ..	.. Off.
Tuning	560 kc/s.	Audio Filter ..	.. Out.
RF/AF Gains ..	Maximum.		

Tune the generator to 465 kc/s (with modulation 30% at 400 c/s) and then set the attenuator to give a reading of approximately 50mW on the output meter. Peak the cores in IFT1, IFT2 and IFT3 for maximum output, all cores being set on the "outer" peak. Re-check each adjustment several times to ensure accurate alignment and then set the attenuator for an output reading of 50mW. The input should be of the order 4uV at 465 kc/s. If the IF sensitivity appears to be on the low side investigation can commence with a check on the AF sensitivity. At 1,000 c/s an input of 12mV across RV2 should result in an output of 50mW.

Leave the generator tuned to the intermediate frequency, switch off the modulation and unplug the output meter. Set the BFO pitch control to mid-travel (index on knob at 12 o'clock) and check that the mid position corresponds to the half-capacity setting of the capacitor and that clockwise rotation of the control results in an increase in capacity. If necessary, slacken the grub screw and re-set the knob before proceeding. With the control at mid-travel, switch on the BFO and adjust the core in L17 for zero-beat. Check for normal operation of the BFO control and then disconnect the generator and the shorting link across C48.

Re-alignment of the RF Section

The first step in this part of the procedure is a check on the overall calibration accuracy. Proceed as follows :—

Connect the output of the harmonic generator to the "A1" and "AE" sockets with the shorting link in place between "AE" and "EARTH." Set the generator to provide 1 Mc/s markers and then with the BFO switched on, tune across Range 1, checking the scale accuracy at each megacycle point. The scale accuracy should be within 1% (i.e. 300 kc/s at 30 Mc/s, 180 kc/s at 18 Mc/s etc.) and re-alignment of the Local Oscillator should not be attempted unless the error observed is greater than this.

Repeat the check on Ranges 2 and 3, again using the 1 Mc/s markers and then check Range 4. The 100 kc/s markers can be introduced

Range	Frequency	Trimmer	Frequency	Core
1	29·0 Mc/s	C39	18·0 Mc/s	L12
2	18·0 Mc/s	C40	8·5 Mc/s	L13
3	7·5 Mc/s	C41	3·5 Mc/s	L14
4	3·5 Mc/s	C42	1·5 Mc/s	L15
5	1400 kc/s	C43	560 kc/s	L16

on this range so that checks can be made at the half-megacycle points. Finally use the 100 kc/s markers to check Range 5.

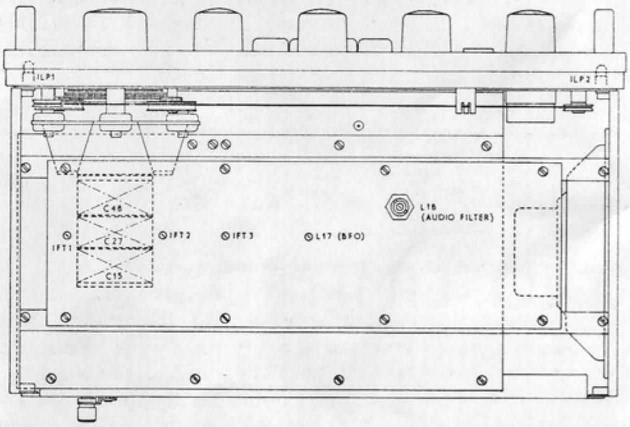
If errors in excess of 1% are noted, carry out normal tracking procedure using the alignment frequencies and adjustments listed in the preceding Table. Adjustment should be restricted to the ranges on which excessive error is noted and care should be taken to repeat the adjustment of trimmer and core until interaction between the two adjustments is nullified.

Alignment of the RF (Aerial) and Mixer circuits can now be commenced. Disconnect the harmonic generator and connect the standard signal generator (modulation 30% at 400 c/s) and arrange the output impedance to match 75Ω for Ranges 1—4 and 400Ω for Range 5. Re-connect the output meter and switch off the BFO.

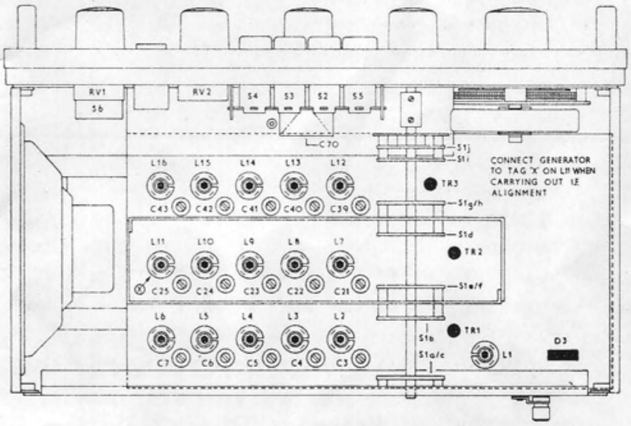
Adjustments are made at the same frequencies employed for oscillator alignment but using the trimmers and cores listed in the second Table. As with oscillator alignment each adjustment should be repeated several times to cancel the interaction between core and trimmer.

Range	Trimmer			Core		
	Frequency	Aerial	Mixer	Frequency	Aerial	Mixer
1	29·0 Mc/s	C3	C21	18·0 Mc/s	L2	L7
2	18·0 Mc/s	C4	C22	8·5 Mc/s	L3	L8
3	7·5 Mc/s	C5	C23	3·5 Mc/s	L4	L9
4	3·5 Mc/s	C6	C24	1·5 Mc/s	L5	L10
5	1400 kc/s	C7	C25	560 kc/s	L6	L11

On completion of the adjustments on Range 5, tune the receiver to the low frequency alignment point (560 kc/s) and the generator to 465 kc/s. Increase the generator output until an indication is obtained on the output meter and then adjust the IF rejector coil L1 for **minimum** output. Re-tune the generator to 560 kc/s, reduce its output and check the alignment of L6 for maximum signal. Repeat the checks once more at both 465 kc/s and 560 kc/s and then carry out a sensitivity check on all ranges.



Plan View of Model EC 10 Receiver



Underside View of Model EC 10 Receiver

VOLTAGE ANALYSIS

The voltage readings given in the Table will prove useful in the event of the receiver developing a fault which makes it necessary to carry out voltage checks. All readings are typical and were taken with a meter having a sensitivity of 20,000Ω/V. The batteries were in new condition and a tolerance of 10% will apply to all readings taken with a meter of the sensitivity quoted. The tolerance should be increased if a meter of lower sensitivity is employed and allowance must be made for the state of the batteries.

Readings should be taken under "no-signal" conditions with the controls set as follows: All readings are NEGATIVE with respect to chassis and the stabilised supply should lie in the range 6·4—6·6V.

Wavechange ..	Range 1.	AF Gain ..	Maximum.
Tuning	20 Mc/s.	AGC	Off.
RF Gain ..	Maximum.	BFO	On.

Reference	Collector	Base	Emitter
TR1*	6·35V	1·0V	0·68V
TR2	6·5V	1·2V	1·1V
TR3	6·3V	1·35V	1·2V
TR4**	5·6V	1·15V	0·87V
TR5	7·5V	0·7V	0·4V
TR6	6·3V	0·75V	0·6V
TR7	4·0V	0·97V	0·9V
TR8	8·9V	1·5V	1·5V
TR9	9·1V	0·15V	0·07V
TR10	9·1V	0·15V	0·07V

* Readings become 6·5V, 0·1V and 0V with RF Gain at min.

** Readings become 7·35V, 0·35V and 0·16V with RF Gain at min.

SPARES

The following list details all major spares for the EC10 receiver. The Serial No. of the receiver must be quoted in all correspondence and enquiries should be directed to the "Sales and Service Dept."

Inductors, Transformers etc.

L1	465 kc/s IF Rejector coil	D3204
L2	Range 1 RF (Aerial) coil	D3189
L3	Range 2 RF (Aerial) coil	D3190
L4	Range 3 RF (Aerial) coil	D3191
L5	Range 4 RF (Aerial) coil	D3192
L6	Range 5 RF (Aerial) coil	D3193
L7	Range 1 Mixer coil	D3194
L8	Range 2 Mixer coil	D3195
L9	Range 3 Mixer coil	D3196
L10	Range 4 Mixer coil	D3197
L11	Range 5 Mixer coil	D3198
L12	Range 1 Oscillator coil	D3199
L13	Range 2 Oscillator coil	D3200
L14	Range 3 Oscillator coil	D3201
L15	Range 4 Oscillator coil	D3202
L16	Range 5 Oscillator coil	D3203
L17	Beat Oscillator coil	6656P
L18	Audio Filter coil	D3216
IFT1	1st IF transformer (465 kc/s)	6653P
IFT2	2nd IF transformer (465 kc/s)	6654P
IFT3	3rd IF transformer (465 kc/s)	6655P
T1	Audio Driver transformer	6657P
T2	Audio Output transformer	6658P

Miscellaneous

Range Switch	Clicker mechanism	5625P
	Wafers : Sla/c, Sle/f, Slg/h	5393P
	Wafers : Slb, Sld, Sli, Slj	5404P
Push Switch Assembly (S2—5)		6510P
RF Gain control (with switch)		6861P
AF Gain control		6860P
Dial bulbs (L.E.S. 50mA 6·7mm.)		6659P
Dial bulb holders		6600P
Phone jack		6660P
Loudspeaker		7347P
Aerial socket strip		D3209
Earth terminal		6371P
3-gang tuning capacitor		6528P
Flexible coupler		D2017
BFO tuning capacitor		D830
Drive Assembly		LP2864
Pointer Assembly		D3215
Dial glass (calibrated)		D3188
Knobs (large)	D3613/1 : Skirt	7089/1P
Knobs (small)		D3617/2
Shorting plug (AE)		D3210

Manufacturers :

EDDYSTONE RADIO LIMITED

ALVECHURCH ROAD, BIRMINGHAM 31

Telephone : 021-475 2231 Cables : EDDYSTONE, BIRMINGHAM

Telex : 33708

Printed in England

Issued December, 1968

EC10

Eddystone

TRANSISTORISED COMMUNICATIONS RECEIVER

Although classed as a general purpose receiver, the "EC10" is finding many applications in the professional field, and is of particular value where portability and operation independent of a mains supply are essential requirements. Continuous coverage is given from 550 kHz to 30 MHz in five ranges and an excellent performance obtains throughout. The receiver accepts CW and AM signals and, whilst not specifically designed for s.s.b., it operates reasonably well in this mode also

Relatively inexpensive, the "EC10" receiver is nevertheless built to the normal high engineering standards associated with Eddystone equipment.

Frequency Coverage
550 kHz to 30 MHz, in five ranges.

Circuit
Single superheterodyne using ten transistors and three diodes. One RF stage, separate oscillator, two IF stages, push-pull class "B" output.

Power Supply
Six HP2 cells housed in a detachable compartment with Zener diode stabilisation to earlier stages. AC mains power supply unit, (Cat. No. 924), interchangeable with battery unit, available as an extra.

Tuning System
Precision slow motion drive, 110 to 1 reduction ratio. Horizontal scales, 9″ long, calibrated to within 1%. Logging and auxiliary vernier scales.

Controls
Independent RF and AF gain; tuning; wave-change; BFO pitch; push-buttons for AF Filter; AGC on/off; BFO on/off; dial lights (biased at off).

Input Impedance
Nominal 75 ohms on ranges 1 to 4, and 400 ohms on medium wave range. High impedance connection for short aerial, effective on all ranges.

Sensitivity
Better than 5 microvolts on Ranges 1 to 4, and 15 microvolts Range 5, for 15 dB signal-to-noise ratio.

Spurious Responses
Image ratio approximately 50 dB at 2 MHz and 20 dB at 18 MHz. Breakthrough at the I.F. (465 kHz) better than 65 dB.

AGC
Not more than 15 dB change of output level when input signal increased 80 dB above 6 microvolts (at 2 MHz on range 4).

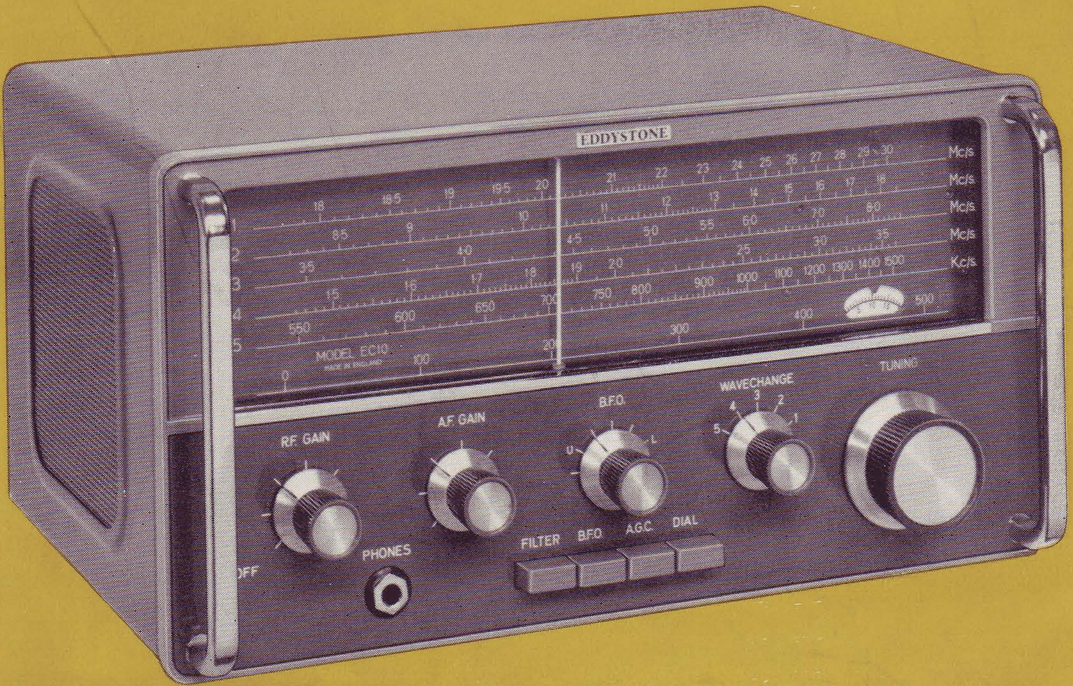
Audio Output
Maximum output approaches 1 watt. Internal speaker and panel jack for telephones or external speaker.

Physical Details

Width	$12\frac{1}{2}$″ (31·7 cm).
Height	$6\frac{3}{8}$″ (16·2 cm).
Depth	8″ (20·3 cm).
Weight with battery ..	14 lb. (6·3 kg).

Finished two-tone grey and suitable for use in all parts of the World.

OF MAJOR INTEREST TO ALL RADIO ENTHUSIASTS



THE EDDYSTONE EC10

Transistorised Communications Receiver

RUGGED · COMPACT · LIGHT

The Eddystone " EC10 " Receiver is a transistorised communications model of compact dimensions and intended for operation from its own internal battery supply. Five ranges give continuous coverage from 550 kc/s to 30 Mc/s, and included are the medium wave broadcast band, the marine band from 1500 kc/s to 3000 kc/s, and all the short wave broadcast bands. Also available are six amateur bands from 160 metres to 10 metres.

The " EC10 " accepts normal AM signals and CW telegraphy, a special filter being provided to increase selectivity in the latter mode. Although not designed for single sideband operation, signals in this mode can be received by appropriate setting of the BFO for carrier insertion. The sensitivity is high and an excellent and consistent performance is realised on all ranges.

Features standard to Eddystone receivers are incorporated in this new model. The flywheel-loaded tuning knob controls a finely engineered gear drive with a reduction ratio of 110 to 1, resulting in smooth precise tuning. The main scales occupy a length of nine inches and are clearly marked directly in frequency to an accuracy of calibration within 1%. Tuning to a given frequency is therefore relatively easy and an auxiliary logging scale permits dial settings of preferred stations to be recorded for future reference.

Alternative aerial sockets are provided, allowing the use of a really good aerial system where circumstances permit, or of a short rod or wire where nothing better can be arranged. An internal speaker is fitted and a telephone headset can be used where preferred.

Power is derived from six U2 type cells housed in a separate detachable compartment. Current drain—and hence battery life — is dependent on the audio output. For long life, it is recommended that the HP2 heavy duty type of cell be fitted. An alternative mains-operated power supply unit is also available.

The receiver is housed in a metal cabinet and, with robust construction throughout, it will stand up to hard usage over a long period with a high degree of reliability. Chromium plated handles are fitted on the panel and the finish is an attractive two tone grey.

FOR PROFESSIONAL AND AMATEUR USE

TECHNICAL SPECIFICATION OF THE "EC 10"

Frequency Coverage (550 kc/s to 30 Mc/s) as follows:—

Range 1	18.0 Mc/s to	30.0 Mc/s.
Range 2	8.5 Mc/s to	18.0 Mc/s.
Range 3	3.5 Mc/s to	8.5 Mc/s.
Range 4	1.5 Mc/s to	3.5 Mc/s.
Range 5	550 kc/s to	1500 kc/s.

Transistor Complement

Ref.	*Type*	*Circuit Function*
TR1	OC171	RF Amplifier
TR2	OC171	Mixer
TR3	OC171	Local Oscillator
TR4	OC171	1st IF Amplifier
TR5	OC171	2nd IF Amplifier
TR6	OC171	Beat Frequency Oscillator
TR7	OC71	Audio Amplifier
TR8	OC83	Audio Driver
TR9/10	2 x OC83	Push-Pull Audio Output
D1	OA70	AGC Attenuator diode
D2	OA90	Detector and AGC
D3	OAZ203	Voltage Stabiliser

Power Supply is derived from six U2 type cells housed in a separate detachable compartment which is readily accessible from the rear. Current drain depends on the audio output, being 36mA quiescent, 77mA at 50 milliwatts output, and 180mA at 500 milliwatts.

The dial lamps add an additional 90mA to the normal current drain. Voltages to parts of the circuit are stabilised with a Zener diode.

Operation from AC mains. The Cat. No. 924 Power Supply Unit is interchangeable with the standard battery unit and operates from 100/125 or 200/250 volt AC mains. The unit delivers 9 volts (stabilised) at up to 200 mA.

Tuning Arrangements. The scales are horizontal, occupying a length of approximately nine inches. Frequencies are clearly marked to a calibration accuracy within 1%. The tuning control is flywheel-loaded and operates a gear drive with a reduction ratio of 110 to 1. A logging scale and auxiliary vernier allow dial settings to be recorded.

Controls. Independent RF and AF gain controls enable the gain to be balanced to suit strong or weak signals. As shown in the illustration, some of the controls are of the push-button type. Points are indicated for setting the BFO pitch control for reception of upper and lower sideband signals.

Aerial Input Impedance

Ranges 1 to 4	75 ohms (nominal) balanced or unbalanced.
Range 5	400 ohms (nominal) balanced or unbalanced.

A high impedance input connection is provided for use on all ranges and is suitable for use with a short rod or whip aerial.

Sensitivity for 15dB s/n ratio is better than 5 microvolts on Ranges 1 to 4 and better than 15 microvolts on Range 5 (550-1500 kc/s).

I.F. Selectivity. The intermediate frequency is 465 kc/s. The selectivity is fixed to give a bandwidth of 5 kc/s at the 6 dB points and 25 kc/s at the 40 dB points.

Spurious Responses. The image rejection is approximately 50 dB at 2 Mc/s and 20 dB at 18 Mc/s. Breakthrough at the intermediate frequency is greater than 85 dB down on ranges 1 to 4, and greater than 65dB down on range 5.

AGC Characteristic. The audio output level does not change by more than 15dB when the input level is increased by 80 dB above 6 microvolts. (Taken at 2 Mc/s on range 4).

Audio Output approaches 1 watt maximum. A 5" diameter speaker is built in, and a jack is provided on the panel for telephones. Recommended headsets are the Eddystone Cat. No. LP. 2924 and LP. 2921.

Frequency response is level over the normal audio frequency range, except when the audio filter is in use. This filter is intended for CW reception, and resonates at 1000 c/s, the bandwidth being approximately 180 c/s at 6 dB points.

Construction. The receiver is housed in a metal cabinet and construction is robust throughout. Chromium plated handles are fitted and the finish is an attractive two-tone grey. High quality components and printed circuit techniques are incorporated, and the receiver is suitable for use in all parts of the world.

Dimensions and Weight

Height	$6\frac{3}{8}$ in. (16.2 cm)	Weight (less batteries) $12\frac{3}{4}$ lb. (5.8 kg)
Width	$12\frac{1}{2}$ in. (31.7 cm)	Weight (with batteries) 14 lb. (6.3 kg)
Depth	8 in. (20.3 cm)	

Instruction Manual and Guarantee. A comprehensive instruction manual is supplied and our usual 12 month guarantee applies.

List Price in U.K. £53. 0. 0.

(Cat. No. 924 AC Power Unit £5. 0. 0. extra).

In the interests of continued improvement, we reserve the right to amend this specification without notice.

Manufacturers :

EDDYSTONE RADIO LTD.

ALVECHURCH ROAD, BIRMINGHAM 31

Telephone: PRIORY 2231 Cables: EDDYSTONE, BIRMINGHAM

Telex: 33708

Printed in England

Issued October, 1967

Eddystone Radio Limited
A GEC-Marconi Electronics Company
Alvechurch Road, Birmingham 31, England
Telephone: 021-475 2231
Cables: Eddystone Birmingham Telex: 33708

Transistorized Marine Communication Receivers

EC10A2
Series

General Description Receivers in the EC10A2 Series are primarily intended for use on small sea-going vessels but are equally suited to many other applications in the maritime field. Full coverage of the HF Band from 1·5MHz to 30MHz is available, together with the 300–550kHz Marine Band. Instant selection of the International Distress and Calling Channel (2182kHz) is provided by a built-in crystal controlled converter unit.

Thirteen transistors and seven diodes are employed in the solid-state single-conversion circuit which includes a BFO, audio filter for CW reception, an efficient AGC system, separate RF and AF gain controls, 600Ω line output to feed a remote listening position and provision for desensitizing when used in conjunction with an associated transmitter.

The receiver can be operated from 12V or 24V DC supplies with positive or negative earthing. Zener regulation is employed throughout.

Three versions of the EC10A2 receiver are currently available, one for bench-mounting and two suitable for installation in standard 19-in racking. Type designations are as follows:

Solid-state design

Compact size

Rack or bench versions

Integral speaker

2182kHz facility

12V or 24V operation

EC10A2/1:	Standard bench-mounting version with integral cabinet loudspeaker.
EC10A2/2:	Standard rack-mounting version with single panel-mounted loudspeaker.
EC10A2/3:	Special rack-mounting version with two panel-mounted loudspeakers, one of which is available for use with ship intercommunications systems, etc. The internal cabinet loudspeaker is retained to facilitate conversion to EC10A2/1 (bench-mounting).

EC10A2/1: Bench-mounting version

Performance Summary

Input impedance
Aerial: 75Ω except Range 5 (400Ω)

Frequency coverage
Range 1: 18·0–30·0MHz

Range 2: 8·5–18·0MHz

Range 3: 3·5–8·5MHz

Range 4: 1·5–3·5MHz

Range 5: 300–550kHz
Sixth position of Range Switch selects crystal controlled converter for 2182kHz

Stability
1 part in 10^{4}/°C. 2 parts in 10^{5}/°C at 2182kHz.

Calibration accuracy
1% on all ranges.

Reception modes
CW–MCW–AM (Audio filter and tunable BFO for CW reception).

Sensitivity
Ranges 1–4 and 2182kHz: 5μV for 15dB S/N.
Range 5: 15μV for 15dB S/N.

Image rejection
25dB at 18MHz, 55dB at 2MHz.

IF rejection
85dB on Ranges 1–4 and 2182kHz.
65dB on Range 5.

Intermediate frequency
720kHz.

Selectivity
7kHz B/W at −6dB, 30kHz at −40dB.

AGC characteristic
Less than 12dB change in output for 80dB increase in input level.

Audio output

Loudspeaker (3Ω):	1W max. 800mW at 10% distortion.
Line:	600Ω (balanced or unbalanced).
Headset:	Low/medium-Z.
Response:	Within 6dB 300Hz–8kHz.
CW Filter:	6dB B/W of 180Hz.

Power supplies
Integral voltage converter unit to suit external DC supply of 12V or 24V (pos. or neg. earthing).

Controls
Tuning, Range Switch, RF Gain/Supply Switch, AF Gain, BFO Pitch, BFO On/Off, AGC, AF Filter, Dial Light Switch.

Overall dimensions

EC10A2/1
Width: 12·5in (31·7cm)

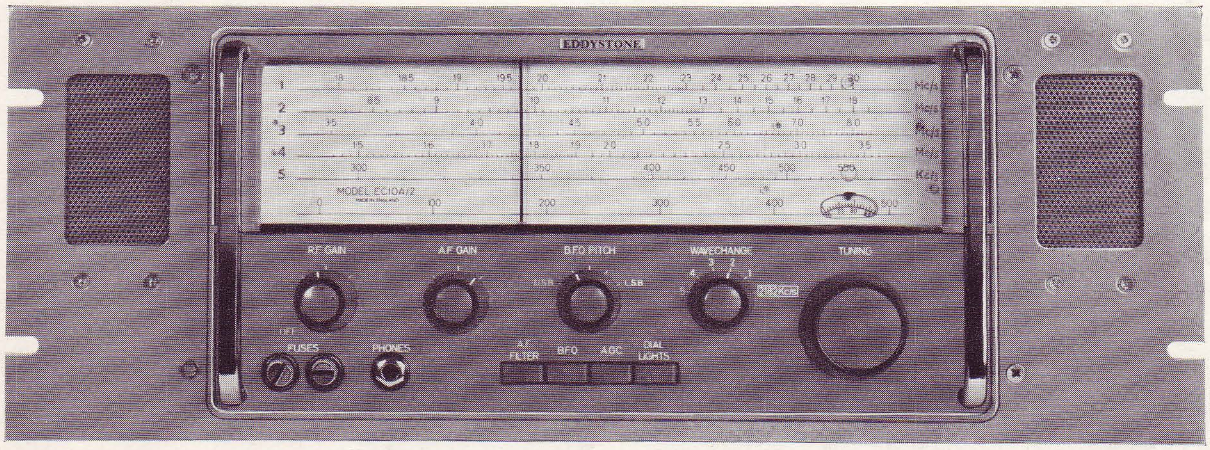
Height: 6·375in (16·2cm)

Depth: 8in (20·3cm)

Weight: 14lb (6·3kg)

EC10A2/2 and EC10A2/3
Panel: 19in × 7in (48·2 × 17·7cm)

Weight: 16·25lb (7·4kg)



EC10A2/2: Rack-mounting version

"960" TRANSISTORISED HF COMMUNICATIONS RECEIVER

A fully transistorised superheterodyne receiver, giving continuous coverage from 500 kc/s to 30 Mc/s and offering all normal communications facilities. The " 960 " is capable of a good all-round performance and is ready for immediate operation, being independent of a mains supply of any type.
Printed circuit techniques are used and operation is from a 12 volt battery, internal or external.

FREQUENCY COVERAGE	Six switched ranges, covering from 500 kc/s to 30 Mc/s.
CIRCUIT AND SEMI-CONDUCTOR COMPLEMENT	RF Amplifier : Mixer : Local oscillator : Three-stage IF Amplifier with band-pass crystal filter : BFO : AGC rectifiers : Audio amplifiers and push-pull output : Zener stabiliser : Noise limiter. In all twelve transistors and seven diodes. A carrier level meter is fitted.
TUNING DRIVE AND SCALES	The 140/1 geared tuning mechanism is smooth, positive and free from backlash. The long horizontal scales are clearly marked in frequency to an accuracy better than 1%. Secondary logging scale.
CONTROLS	Tuning : Wavechange : RF Gain : AF Gain and on/off switch : Crystal : AGC : Noise Limiter : BFO pitch : Standby switch : Battery check switch : Meter zero adjuster.
SENSITIVITY	Sensitivity for a 15 dB signal/noise ratio is better than 6uV over frequencies above 1200 kc/s, and better than 20 uV below 1200 kc/s.
SELECTIVITY	Without crystal, bandwidth is 5 kc/s at 6 dB points. With crystal, 500 c/s at 6 dB points.
OSCILLATOR STABILITY	Better than 1 part in 10^4 per degree C change in ambient temperature.
IMAGE REJECTION	50 dB at 1·6 Mc/s : 20 dB at 18 Mc/s.
AGC	Increase of 90 dB in input level above 5 uV leads to a change not exceeding 16 dB in audio level (at 6 Mc/s).
AUDIO OUTPUT	Maximum output exceeds 1 watt. Internal monitor speaker fitted and terminals for external speaker. Jack for telephones on front panel. 600 ohm line connections.
AERIAL INPUT	Nominally 75 ohms.
BATTERY CONSUMPTION (at 12 volts)	Quiescent .. 35 mA. 50mW output .. 65 mA 1 watt output .. 210 mA
DIMENSIONS	Width $16\frac{7}{8}$ inches (43 cm.) : Depth 11 inches (28 cm.) : Height $8\frac{3}{4}$ inches (22·2 cm.). Weight is approximately 32 lbs. (14·5 kgs.).
FINISH	Modern styling and appearance. Two-tone grey finish.

EDDYSTONE

TRANSISTOR HF COMMUNICATIONS RECEIVER

MODEL 960

The Eddystone " 960 " receiver is a fully transistorised communications receiver, giving continuous coverage over the frequency range 500 kc/s to 30 Mc/s. It is a receiver capable of a good all-round performance, which can be brought into immediate operation and is quite independent of a mains supply of any type.

Provision is made for the reception of A1, A2, A3 and A3a signals. Printed circuit techniques are employed in this receiver, which is robustly constructed and functions reliably over a wide range of ambient temperatures. Operation is from a 12 volt dry battery housed inside the receiver, or from an external 12 volt direct current supply.

Styling and presentation are in keeping with modern practice.

Eddystone 960 Receiver

SPECIFICATION

Frequency Coverage

Six switched ranges as follows :—

Range 1	20 Mc/s to	30 Mc/s.
Range 2	9·0 Mc/s to	20 Mc/s.
Range 3	4·2 Mc/s to	9·0 Mc/s.
Range 4	2·2 Mc/s to	4·2 Mc/s.
Range 5	1·13 Mc/s to	2·2 Mc/s.
Range 6	500 kc/s to	1130 kc/s.

Semi-Conductor Complement

TR1	OC171	RF Amplifier
TR2	OC170	Mixer
TR3	OC171	Local Oscillator
TR4	OC45	1st IF Amplifier
TR5	OC45	2nd IF Amplifier
TR6	OC45	3rd IF Amplifier
TR7	OC45	AGC Amplifier
TR8	OC45	Beat Frequency Oscillator
TR9	OC71	Audio Amplifier
TR10	OC83	Audio Driver
TR11 TR12	OC83	Push-pull Audio Output
D1	OAZ204	Voltage Stabiliser
D2	OA70	Detector
D3	OA70	AGC Rectifier (IF)
D4	OA70	AGC Rectifier (RF)
D5	GEX23	BFO Pitch (capacity diode)
D6	OA70	Noise Limiter.
D7	DD006 or 2E1	Reverse Polarity Protection

Tuning Drive and Scales

The geared tuning mechanism is made to precision limits and has a reduction ratio of 140/1. The movement is smooth, positive and free from backlash. The long horizontal scales are clearly marked in frequency, to an accuracy better than 1%. A secondary logging scale is also provided.

Construction

The receiver is robustly constructed and is housed in a steel cabinet, with diecast front panel and coil unit. Modern printed circuit techniques are employed, using components of high quality. Long reliable service is thus ensured.

Controls

The following controls are conveniently located, and appropriately marked, on the front panel.

> Tuning : Wavechange : RF Gain : AF Gain : Crystal in/out : BFO Pitch : Standby Switch : NL Switch : AGC Switch : BFO Switch : Battery check switch : Meter zero (at rear).

The main battery supply on/off switch is part of the AF gain control.

Other Features

A carrier level meter is fitted on the front panel, with a zero adjustment control at the rear. The same meter has a secondary scale and, by operating a panel switch, the battery voltage can be checked.

A standby switch reduces the sensitivity and mutes the receiver.

The noise limiter is an efficient protection against ignition and other pulse types of noise.

It is intended that normally the internal speaker be used but an external one (2·5 ohms impedance) can easily be connected if desired.

AVERAGE TECHNICAL FIGURES

Sensitivity

For a 15dB signal/noise ratio, 30% modulation at 400 c/s, AM sensitivity is better than 6 uV on all ranges except No. 6 where the figure is better than 20 uV. Absolute sensitivity is better than 3 uV on ranges 1 to 5, and better than 6 uV on range 6.

Selectivity

Crystal out ; bandwidth is 5 kc/s at 6 dB points and 12 kc/s at 30 dB points.

Eddystone 960 Receiver

Crystal in ; bandwidth at 6 dB points 500 c/s ; at 30 dB points 4 kc/s. The intermediate frequency is 465 kc/s.

Image Rejection

50 dB at 1·6 Mc/s ; 20 dB at 18 Mc/s.

AGC Characteristic

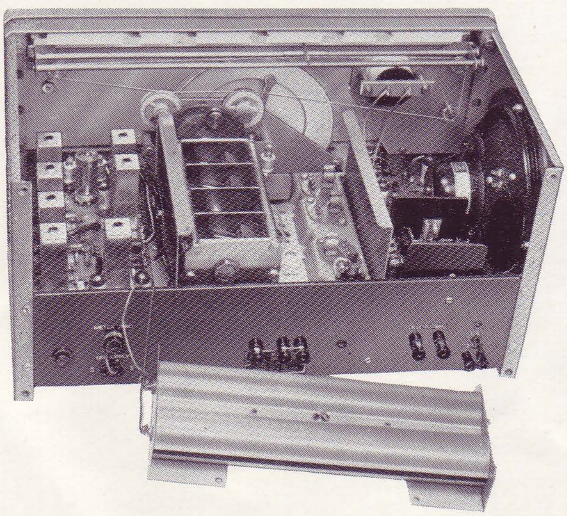
For a change of input level of 90 dB above 5 uV (at 6 Mc/s), audio level does not change by more than 16 dB.

Stability

Oscillator stability is better than 1 part in 10^5 per degree Centigrade change in ambient temperature.

Audio Outputs

Maximum output to internal or external speaker (nominal 2·5 ohms) 1 watt. Jack for telephones, nominal impedance 2000 ohms. Connections for 600 ohm line. The frequency response does not deviate more than 3 dB from 50 c/s to 8000 c/s (taken at AF gain control).



Interior view of the "960" transistorised receiver. RF and oscillator section is in the centre, with the coils in a diecast housing; intermediate frequency stages on the left; and audio section on the right. The unit in the foreground is the battery container, normally fixed above the centre section.

Aerial Input

Nominal 75 ohms, balanced or unbalanced.

Power Supply

The receiver is supplied complete with eight fresh " Ever Ready " " U2 " leak-proof cells, giving a working voltage of 12. These are housed internally in a firmly mounted steel container which is readily accessible for replenishment by removing the cabinet. The receiver can also be energised from an external source by disengaging the plug at the rear and inserting one connected to a 12 volt battery. In either case, the voltage can be immediately checked on the panel meter. Approximate current consumption is as follows:—

quiescent	35 mA.
50 milliwatt output	65 mA.
1 watt output ..	210 mA.

Protection Against Reversed Polarity

It is essential care is taken to ensure correct polarity of the energising battery. A silicon diode is incorporated to minimise the possibility of damage to the transistors should the polarity be inadvertently reversed.

Temperature Range

The receiver performs satisfactorily over a temperature range from —20°C to +55°C.

Physical Details

Width : $16\frac{7}{8}''$ (43 cms). Depth 11″ (27·9 cms). Height $8\frac{3}{4}''$ (22·2 cms). Weight : 32 lbs. (14·5 kgs) approx.

The finish is in two-tone grey.

Manual

A comprehensive Instruction Manual is supplied.

In the interests of continued improvement, we reserve the right to amend this specification without notice.

Manufacturers :

STRATTON & CO. LTD.

BIRMINGHAM 31 :: ENGLAND

Telephone : PRIORY 2231/4 Cables : STRATNOID, BIRMINGHAM

Printed in England

Issued February 1962

Miniature Transistor Hearing Aid

The trend in hearing aids which has been toward compactness has been given a boost with the introduction of the transistor.

By DAVID T. ARMSTRONG

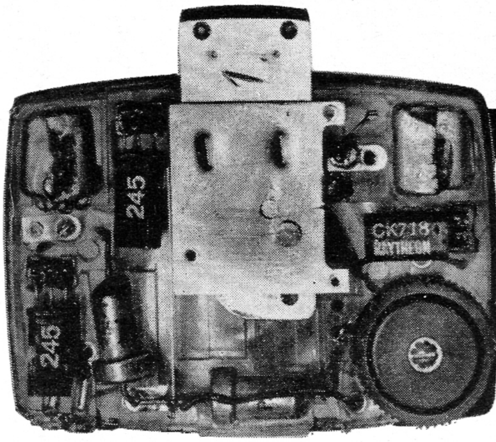


Photo of Transist-Ear chassis. Compartment on top houses small energy capsule.

TRANSISTORIZED hearing aids are appearing on the market in quantity. The high efficiency of the transistor and its low power consumption give it a decided edge over vacuum tubes. Battery power is still required, but the drain is cut to such a tiny figure that the life of a battery is extended many times. The entire absence of an A battery in any all-transistor type hearing aid makes possible a unit small enough to be worn on the wrist or hidden in a woman's hair. These are real applications, not just theoretical possibilities. There has been a great deal of controversy over the merits of transistors in hearing aids. Like anything else that is new, certain obstacles must be overcome before final success is reached. One company actually stopped their production of transistor hearing aids, but with technical improvements, they have resumed.

Miniaturization has been achieved by using subminiature components for resistors, capacitors, and transformers, and by redesigning the microphone and receiver into magnetic types. By using miniature components and lightweight metals, Maico has produced the *Transist-Ear* using three Raytheon CK718 transistors. The instrument weighs a little over 2 ounces and its over-all dimensions are 2⅝ x 1⅞ x 1³⁄₁₆ inches.

The engineers responsible for this all-transistor hearing aid did *not* attempt to convert vacuum tube circuits to transistor applications by what is becoming known in the art as the "duality" technique. Rather, they started from scratch and designed circuits on the basis of which the associated components were specifically selected, for use in an all-transistor hearing aid. In this way they were able to balance the gain for the three stages and secure the greatest gain where it would produce the minimum accompanying noise. Hence this device is not any more noisy than a comparable type vacuum-tube hearing aid.

The circuit diagram of the Transist-Ear is shown in Fig. 1. Transformer coupling is used for the three grounded-emitter transistor amplifier stages. The bias resistor in each stage was selected to provide a predetermined collector current. In the present state of transistor manufacture there is wide variation in the characteristics of the individual CK718 Raytheon transistors used with this instrument; thus it is important to match the bias resistor with the individual transistor used in a particular stage.

The resistors R1 and R2 were selected to give 0.35 to 0.5 ma collector current; R3 was selected to give 1.7 to 2.1 ma collector current. These individual transistors vary considerably in gain and noise as well as in impedance. As part of the quality-control program established for the manufacture of these hearing aids, each transistor is checked in the laboratory and marked as a first-stage, second-stage, or output-stage transistor.

The grounded-emitter circuit has been found to be superior for this type of transistor application, partly because the input resistance is completely independent of transistor parameters. Current design practice uses the grounded emitter almost exclusively for all but the output stage of amplifiers. In the output stage, a grounded-base circuit is found to be better for some applications. It provides a wider swing of collector voltage with linear operation, and hence greater efficiency. In this circuit, however, the output stage is a grounded-emitter type to control the gain and attenuate the noise.

The audio-frequency field is ideal for transistor applications because of the high gain, low noise, and high efficiency obtainable. The limitation on how weak a signal can be handled is noise. Noise is much lower for junction-type transistors than for point-contact types. A transistor with a noise figure of 15 db at 1,000 cycles for a 1-cycle bandwidth has an equivalent noise input power of approximately 10^{-15} watts. A signal

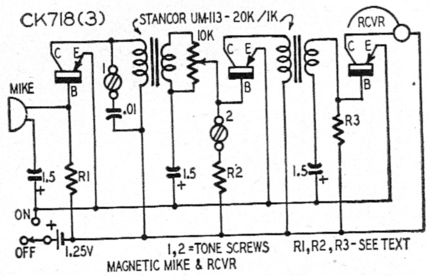


Fig. 1—Schematic of the Transist-Ear.

From Trumpet to Transist-Ear. 15 years of progress in hearing aid development.

input of one micromicrowatt will have a 30 db signal-to-noise ratio.

The frequency response of this instrument is adjustable and can be fitted to the hearing loss of the user by adjusting tone screws 1 and 2 shown in the circuit diagram of Fig. 1. Normal response is obtained with screw 2 in and screw 1 out. Thus insertion or removal of the screws emphasizes tones for which the user's loss is most severe or attenuates those tones for which the user's hearing is nearly normal.

When screw 1 is in, the .01-μf capacitor is connected to the circuit. When screw 2 is in, the resistor R2 is connected to the circuit.

Subminiature tantalytic capacitors, hermetically sealed in silver cans, were used because it is believed they have an extremely long life. The low operating voltages permit use of small-size, low-voltage capacitors. The energy capsule is a mercury cell (illustrated in photo). This is ⅝ inch in diameter and ¼ inch thick. This energy capsule is housed in a drawer. This tiny energy capsule will supply power for operating this hearing aid for 70 to 90 hours.

All-transistor type hearing aids are not low priced. They cost more than comparable vacuum tube models. However, the operating costs are low and transistors do not require replacement as tubes do.

The low cost and high operating efficiency of the *Transist-Ear* are among its most remarkable features. The total battery drain of the three transistors is 30 ma at 1.3 volts, or 3.9 milliwatts. Dividing the electrical output delivered to the receiver, 1 milliwatt, by the total battery drain, indicates an efficiency of approximately 25%. This all-transistor circuit is eight times as efficient as a conventional vacuum-tube hearing aid.

The three transistors are immune to damage from shock or vibration, and they are designed to retain their original operating characteristics over a long period of time. When these transistors are properly hermetically sealed (this is extremely important) by the encapsulating plastic they are impervious to moisture. This is emphasized in view of some recent experiences with hearing-aid devices not properly hermetically sealed. These were found to be affected by the moisture and body temperature of the user.

The estimated life of transistors is about 100,000 hours, which would be equivalent to 20 years of use; compare this with the 5,000-hour life of a vacuum tube. (The switching of a transistor on and off may have some effect on its useful life.)

The magnetic microphone is much sturdier than the crystal microphone formerly used, and is far less likely to be affected by high humidity. The microphone is mounted on a soft floating rubber cushion to reduce to a minimum the noise created by friction of the case and the clothing. Compartmentalization design techniques were utilized to place the components in special snug-fitting niches in a nylon chassis. This design feature was adopted because it is expected to contribute to long life by reducing the possibility of damage through shock or vibration.

The interstage audio transformers are triumphs of miniaturization. They measure a ⅜-inch cube, and were specifically designed for such applications by Chicago Standard Transformer Corp., as their ultraminiature transistor transformers. They are the tiniest iron-core audio transformers currently available. They weigh less than ⅒ ounce and are no larger than the transistors they power. They are constructed of extremely fine wire, wound on molded nylon bobbins, with special nickel alloy steel transformer core laminations. They have a useful range below the 1-milliwatt level.

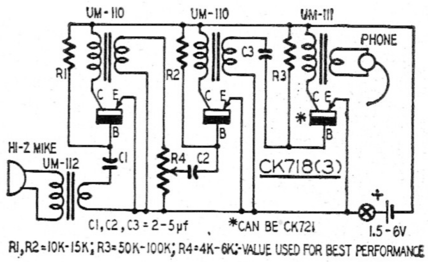


Fig. 2—Transistor audio amplifier.

For comparison purposes the Stancor suggested circuit is given in Fig. 2, with the recommended values of the associated components. The available transistor ultraminiature transformers and their design characteristics are given in Table I.

Table I. Characteristics of the Stancor Ultraminiature Transistor Transformers

Part Number	Application	Primary impedance (ohms)	Secondary impedance (ohms)	Primary d.c. resistance (ohms)	Secondary d.c. resistance (ohms)
UM-110	Interstage	20,000	1,000	1,675	285
UM-111	Output or matching	1,000	50/60	120	9.0
UM-112	High impedance microphone input	200,000	1,000	4,000	195
UM-113	Interstage	20,000	1,000	1,350	205
UM-114	Output or matching	500	50/60	70	9.0

There is no a.v.c. in this circuit. Further, the distortion in the output is related to the output power level. Special circuits involving response-shaping networks and volume compression circuits are desirable in a hearing aid, but these are usually available only for custom built units.

A desirable accessory for a hearing aid is a telephone pickup coil which will enable the user to hear telephone conversations without the distortion introduced by transducing the signals from the telephone ear-piece to the hearing-aid magnetic microphone.

Practically no heat is generated by a transistor hearing aid; hence there is no problem of heat dissipation. END