THE EDDYSTONE 770U MkI/II

by IAN BATTY

Description

The Eddystone 770U is a VHF/UHF receiver manufactured by the famous Eddystone company. It uses a total of 17 miniature 9- and 7-pin valves in the signal circuits, and two octal types in the power supply.

It tunes from 150 MHz to 500 MHz in six bands:

Range 1: 400-500 MHz	Range 4: 220-270 MHz
Range 2: 330-400 MHz	Range 5: 180-270 MHz
Range 3: 270-330 MHz	Range 6: 150-180 MHz

Sensitivity is quoted at better than 10 μV for 15 dB S/N over all bands. On test, the set outperformed its specifications.

The amount of coverage in each band is small: Band 1's coverage only 25% of the signal frequency. This bandspreading is necessary to allow accurate tuning, and the combination of bandspreading and dial gearing does give a very useable instrument. Tuning in to a signal is easy and highly repeatable. Although the set receives A.M., it has no B.F.O. The use of S.S.B. at VHF/UHF was being pioneered by Amateur Radio operators in the late 1960s, but was not in general use.

The principal difference between the MkI and MkII is the push-pull audio output, a noise blanker ("squelch") circuit and the crystal calibrator of the MkII. This article describes a MkI.

Construction

The set is solidly constructed, with the traditional "flywheel" on the tuning knob. This allows the highly-geared tuning system to spin rapidly from end to end across the selected band.

The chassis and front panel withdraw easily from the case, and internal construction is sound. The unit comprises several sub-assemblies: R.F. turret/ 1st I.F. Cascode, 1st/2nd I.F./A.M. Detector/F.M. detector/Noise Limiter, Audio/Metering and Chassis/Power Supply.

The R.F. turret is the most obvious component, and it occupies the screened box in the centre of the main chassis. Its casting occupies some 180 degrees, with the top opening allowing access to internal components and alignment points. The rotating section, with its six-spoke "spiders" is actuated by a six-position Geneva drive. This gives positive switching and accurate registration of the coil banks. The coil banks, similar to T.V. Tuner "biscuits", are supported front and back by large, countersunk screws, which register the coil banks and their sliding contacts against the fixed contacts on the R.F. sub-assembly. The R.F. subassembly houses the R.F. amplifier, 1st mixer and 1st Local Oscillator.

The first stage of the 1st I.F. is the other subassembly within the main screened box.

The 1st/2nd I.F./A.M. Detector/F.M. detector/ Noise Blanker subchassis sits to the left of the screened box. It contains a smaller screened box that houses the 2nd Local Oscillator and 2nd Converter.

The Audio/Metering/Noise Blanker subchassis sits to the rear of the main screened box.

The Power Supply is mounted on the main chassis, and sits to the right of the main screened box.

770U – Top View

770U – Front Panel

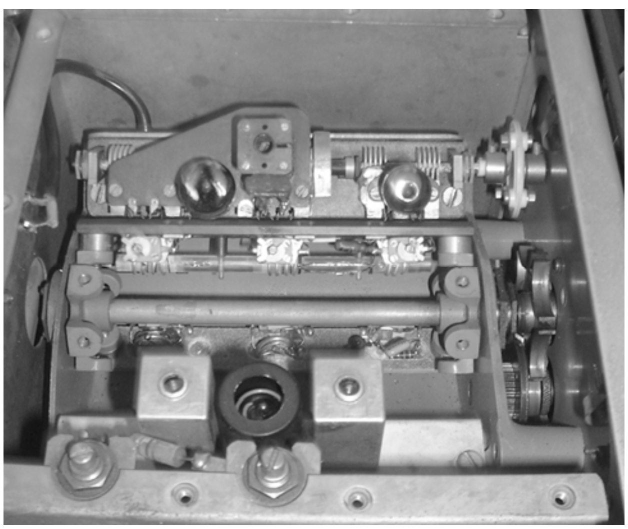
Circuit description

The 770U is a double-conversion superhet. The 1st I.F. is 50 MHz, the 2nd I.F. is 5.2 MHz.

The 1st R.F. amplifier (6AM4) operates in grounded-grid, for best gain and stability.

The mixer, a GEX66, is a germanium diode. This introduces a considerable conversion loss (notionally, 12 dB), so the R.F. amplifier's performance is even more critical in delivering sensitivity than is usually the case.

The picture below shows the VHF/UHF section at the top: the R.F. amplifier is to the left, the Local Oscillator to the right. The diode mixer is hidden by the first 50 MHz I.F. transformer just to the right of the R.F. Amp. One coil set is engaged with the fixed contacts, and you can see three trimmers (L-R: Antenna, R.F. and L.O.). The coils are just distinguishable. The smaller flexible coupling at top right is the tuning drive, and the more complex mechanical system at right centre is the 6-position Geneva Drive for the coil turret. Near the bottom are the first 1st I.F. amplifier with its associated transformers. The two screwdriver adjustments at the extreme bottom are for the signal strength meter (A.M. zero, F.M. centre scale).



770U R.F. Chassis

The 1st Local Oscillator (6AF4) is an Ultraudion. For bands 6 to 3, it operates at 50 MHz (1st I.F.) above the signal, for bands 2 and 1, it operates below the signal to give better frequency stability.

The first stage of the 1st I.F. uses a 12AT7 in cascode to give the best possible combination of gain and noise figure. A short coaxial connection from the 1st mixer ensures the least possible signal loss. The 1st I.F.'s second stage is a 6AK5 in conventional grounded-cathode connection.

The 2nd Local Oscillator and 2nd converter are both handled by a 12AT7 inside a screened box. The 2nd I.F. at 5.2 MHz is implemented by two 6BA6s.

The A.M. detector is a GEX13 germanium diode, with two halves of a 6AL5 used as noise limiter and AGC. The F.M. channel (also at 5.2 MHz) uses a 6AU6 limiter and a 6AL5 discriminator.

The audio section in the MkI uses both sections of a 12AU7 as the low-level amplifier with a single 6AM5 as the output valve.

The MKII uses a 12AU7 as the preamplifier/phase splitter, and two 6AM5s as the push-pull output.

The MKII uses a 6AU6 as a noise amplifier, two GEX13 diodes for the noise rectifier, and half of a 12AU7 (muting amplifier) to interrupt the cathode return of the audio preamplifier.

The MKII's calibrator uses a 6AM6 as a 50 MHz crystal-controlled oscillator/harmonic generator, and a BFY19 transistor as a 600 Hz audio tone modulator. This allows easy identification of the calibration markers at 50 MHz intervals. The MKII's calibrator sits on the top cover of the main R.F. unit.

History and repairs.

I bought the 770U some years ago. The set was basically dead, mainly due to the poor design of the coil bank contacts and subsequent destruction of the contacts. This is a common and known manufacturing fault in the 770U, which I'll detail later.

Initially, the set turned on, and there was some noise. On examination, many of the coil slugs were out of adjustment, or jammed. The two 12AT7s had been replaced by 12AU7s: the 12AU7, though equivalent to a pair of 6C4s in one envelope, do not give the same gain/noise figure as the 12AT7. To top it off, the 1st L.O. was not lighting up. The heater showed continuity, so the problem was most likely in the valve socket.

Loosening/replacing the various I.F. coil slugs and aligning the set brought the "low frequency" section back to life. The sensitivity at the 1st I.F. is quoted as 2.5 μV (!), implying that the entire R.F. preselector has a gain loss of some 4x (-12 dB).

It was time to check the preselector. The construction of the coil turret is such that any misalignment of the coil contact fingers will either give no contact, or will shear the contact fingers right off.

I had another 770U, and was considering "Christmas Tree-ing" one of them to make a single good set. I managed to locate a "remainder" set of coil banks and contact fingers online, and set about repairing my set. I was relieved – I *hate* the idea of Christmas Tree-ing, but sometimes…

The contact fingers must be aligned to better than +/-0.25 mm, not a job for an unsteady hand. I repaired on coil bank, then looked in the "remainder" box for some new ones to replace the other damaged banks.

Eddystone were not helpful – I had five "New In Box" coil banks, just one of which had any identifying marks. I could not find any part numbers on them, and the coil/capacitor combinations are hard to distinguish, given that they operate at such high frequencies.

Taking a punt, I replaced a few coil banks. Now for the 1st L.O. The valve "socket" consists of a cover plate and bare sleeve contacts, with the barest skeleton of insulation – a sensible design at VHF/UHF, where every pF of extra capacitance makes a difference. One of the two heater pin sleeve contacts had failed. By butchering another 7-pin socket, I was able to get heater power to the L.O.

The R.F. section came alive, and on Band 6 (the lowest) I was able to get alignment and good sensitivity.

Band 2 (330 MHz-400 MHz) was next. My trusty Marconi TF 2015 (bought at auction and repaired specially for this job) was having trouble "finding" the 770U: or maybe it was the other way around.

I made a wire loop, and connected it to my 2.4 GHz frequency counter. Putting the loop near the L.O., I was able to measure its frequency. Band 2's L.O. is below signal, so I should have been measuring from 280 MHz to 350 MHz.

Sure enough, I was able to determine the L.O. frequency, but there was a problem: the L.O. was consistently at least 5 MHz out. This meant that the L.O. coil needed adjustment – it's the "hairpin" on the right of the photo below. The picture shows why I needed a strong cup of coffee!

L.O. Coil – "Hairpin" on Right

As well, the Antenna circuit just would *not* come into alignment. This is an especially hard set to adjust – even a well-insulated metal-tip screwdriver "skews" the alignment on every coil by a good amount. So it's measure-tweak-measure-tweak… until you finally hit on just the right setting.

Making tiny adjustments to the various coils eventually brought the set to life. In some cases, I had to remove the coil bank completely, squeeze the turns closer or wider apart, replace the coil bank then measure/align again. The antenna coils were the most problematic – most of the coil banks' antenna coils would not tune correctly at either end. Be aware that this is a laborious process, and Eddystone recommend that you make *no* adjustments to coils unless the set is more than one percent off calibration. Had it not been for the annoying need to mentally offset the dial indication by 5 MHz each time I tuned a signal in, I would certainly not have bothered to align the set exactly.

Two curious things…

First, as I mention in an article on the Eddystone EC10, both it and the 770U quote quite high sensitivity figures for the 1st I.F. input: 4 μV for the EC10, 2.5 μV for the 770U. It appears that Eddystone do regard the RF section as a "preselector", and rely on the IF/AF sections to provide the major part of a set's gain.

Second, Eddystone seem to have an unusual idea of diode mixers. Their manual quotes "… the (1st I.F.) employs the shunt cascode configuration and preserves the low noise figure achieved by employing a diode in the 1st mixer stage." Well, I know that diode mixers are noisy, and I reckon that any device which *also* gives a 12 dB conversion loss is *not* a low-noise device. They may be justified in comparing the germanium diode to a valve mixer at 500 MHz, but their description is strange in isolation.

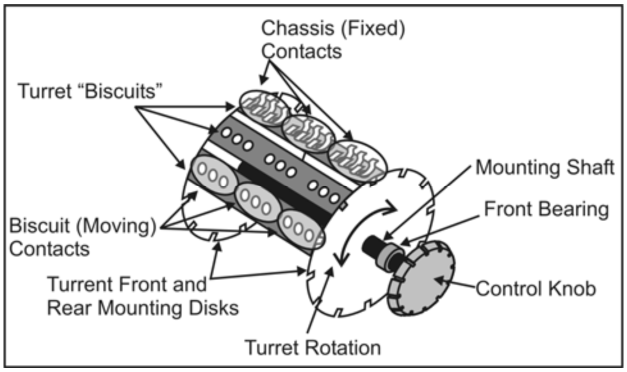
Those Coil Banks

There are probably many 770Us lying at the bottom of harbours, faithfully mooring small vessels of all kinds.

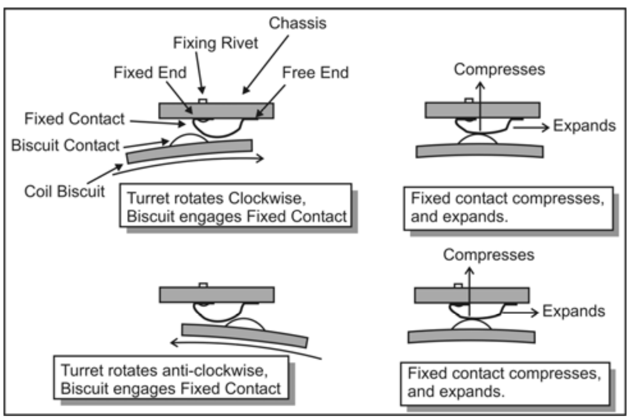
This is a pity – the 770U, when working, works well. For its day and its technology, it is a good performer and pleasant to use. Its Achilles Heel is the woefully designed R.F. turret and its delicate contacts.

If you've ever pulled a T.V. set's turret tuner to pieces, you'd be familiar with the compact design of the turret itself, and with the robust nature of the biscuits and their contact sets. Most turret tuners use small contact buttons on the biscuits, and allow these to mate radially to spring contacts mounted on the main chassis of the tuner.

Proper alignment allows a small interference between the moving and fixed contacts, and the interference is resolved by the fixed, springed, contacts displacing “outwards”, away from the incoming moving contact. Severe interference simply crushes the fixed contact, with the result that it may lose its resilience and not mate correctly with a moving contact that is properly in alignment. The drawings below show how this contact design works.



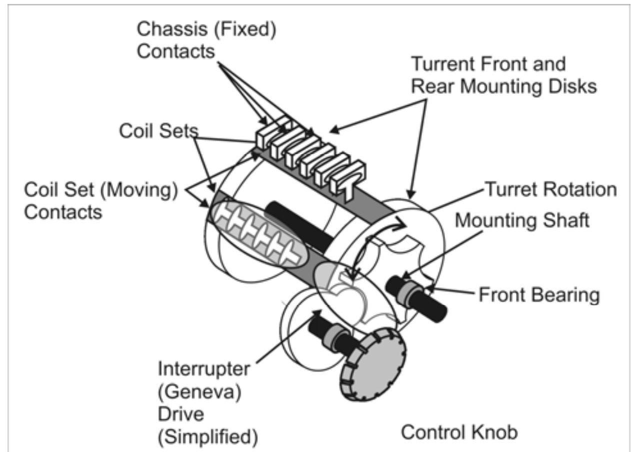
Radial (“T.V. Tuner”) Simplified Construction



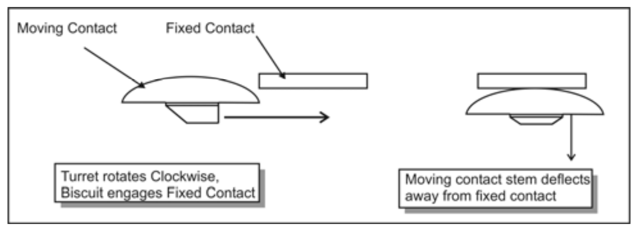
Radial (“T.V. Tuner”) Contact

This radial contacting gives two major benefits. Firstly, within manufacturing tolerances, electrical contact is positive and reliable; and damage to the coil biscuits and their contacts is virtually impossible. Secondly, there is only one set of sprung contacts: the fixed ones. Only the fixed contacts need ever be adjusted, and faulty biscuits are simply thrown away and replaced. Turret tuners are small and lightweight compared to the 770U R.F. unit, but this small and lightweight construction is an advantage – the compact size allows robust and reliable construction without the need for large and bulky castings and high-precision manufacture.

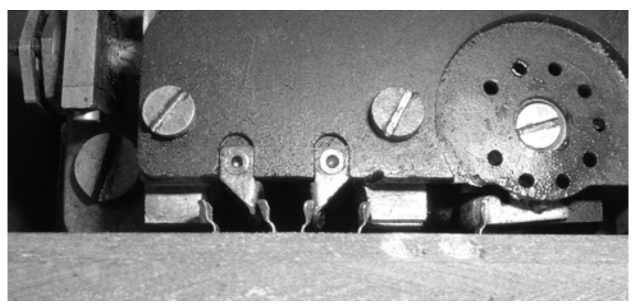
The 770U uses peripheral contacting. This means that *every* moving contact on *every* coil bank must be very carefully adjusted. The interference must be held to better than +/-0.25 mm to ensure that contacts is firmly made, but that the contact finger’s leading edge *does not* engage the fixed contact: to do so will shear the contact finger right off, as the photo on the next page shows.



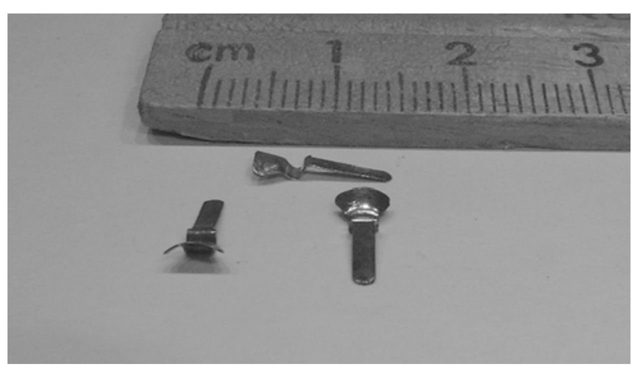
Peripheral (Eddystone) Turret



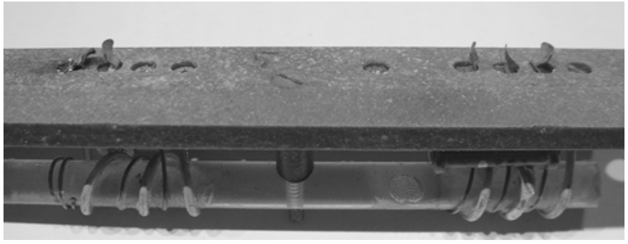
Peripheral (Eddystone 770U) Contact



Close-up Of Mated 770U Contacts



… and What They Really Look Like



… and If You Get The Spacings Wrong

I cannot comment on whether the contact alignment, once completed, is good for life. The entire unit is very ruggedly constructed, and I suspect that this ruggedness was necessitated by the problems of contact destruction. I do know that Bill Babb commented that contact destruction was the most common reason for obsoleting of the 770-class of receiver.

What should have been done in the MKII

1. Dump the mechanical design of the R.F. unit. Using radial-wipe contacts would considerably improve the set's reliability – there would be no more sheared-off coil contacts. Going to radial-wipe contacts would also greatly relax the demand for mechanical rigidity, allowing the R.F. unit to be more compact and of a lighter weight of construction.

2. Rethink the valves used and the method of construction in the R.F. unit. The Band 1 coil set's inductors are so small they are no more than shorting links. Worse, on Band 1 (400~500 MHz) the antenna circuit is untuned, presumably because it was impossible to get a small enough value of inductance with a tapping to match into the grounded-grid stage's low input impedance. A coaxial line *would* have done as a tuned circuit, but I suspect it was either not economical or practical to include.

   Indeed, I remember building transceivers for 576 MHz that used tuned lines of some 50 millimetres in length, by virtue of "Acorn" and other base-less valves. Given that "more inductance gives better Q", the front end's performance would benefit from coils with more inductance than the existing "shorting links".

3. Replace the Belling-Lee antenna connector with a BNC connector. The Belling-Lee (IEC 169-2) connector was designed in 1922 (!) for medium-frequency R.F. applications. It is *not* suitable for VHF/UHF (despite its wide use on television receivers and antenna systems) and is a recognised source of signal distortion, especially with UHF HDTV.

4. Add a scale shift mechanism, or a fine tune control, so that minor tuning inaccuracies can be compensated for. It is *most* annoying to have to mentally add or subtract the amount by which the set is off calibration at any one time.

5. It's surprising that Eddystone did not use a cascode R.F. amplifier. The cascode is the circuit-of-choice for VHF/UHF amplifiers, and was widely used in VHF T.V. tuners until the high-performance frame-grid triodes became available – though these would have come too late for the 770U. My own experiments gave noise figures below 6 dB for a frame-grid front end at 144 MHz, somewhat better than 1 μV sensitivity.

In use

The set's stability depends critically on the stability of the 1st L.O., and this is impressive when you consider the frequencies involved. After a few minutes' warmup, the stability of initial tuning (and its repeatability) are exceptional. Checking with my frequency counter, I was easily able to set the 1st L.O. (and therefore, the set's receiving frequency) to within some +/-20 kHz of the dial indication.

The "heavy" bandspreading gives a small tuning range, only about 25% on Range 1 (400~500 MHz). This puts the 10 MHz markers about 25 mm apart on the 305 mm (12 inch) "sliderule" dial, and allows easy and accurate tuning – this implies about 1 MHz per 2.5 mm, which does allow easy "homing in" at these Ultra High Frequencies. The customary "flywheel" is vital for quick tuning, as it needs some 67 revolutions of the tuning knob to span the entire length of the dial.

My set, the MKI, uses a single 6AM5 as the output valve. This gives a maximum of some 1.4 watts, adequate for small room listening. Considering the application, with the provision of 600 Ω line output for relaying to other equipment and headphone output for close listening, this is adequate.

The set provides a 2nd I.F. output to allow attachment of a Panoramic Adaptor, or a second receiver. The second receiver (tuned within the 2nd I.F. bandpass) would be used to pick up a subsidiary or "guard" band signal just adjacent to the primary signal being received by the set.

Alternately, a second channel (at the 1st I.F. of 50 MHz) can be fed *in* to the set.

It also provides audio terminals, allowing extraction of the received signal, or *injection* of an external audio signal.

And if you can't get to the gym regularly, moving a 770U (at around 23.6 kg) from bench to bench is a nice little workout.

Yes, but what *can* you pick up on it?

Not the 2 metre (144-148 MHz) ham band – I'll have to go back to my Hallicrafters S27 for that.

But I do get television sound from Channel 9 (local version of Channel Ten) – coverage is from Channel 6 sound to Channel 12 sound. A bit of band-surfing also brought some VHF/UHF aircraft radio (225~400 MHz). I don't currently have an antenna for the 432 MHZ Ham band, but it's on the "to do" list.

I guess the main reasons for resurrecting this set are twofold. It was made by an iconic manufacturer in the radio reception field, working close to the limits of easily-available technology of the day: though it's a design that I believe to be poorly-resolved. And it is one of a fast-vanishing breed of specialist electronic equipments that speak of a time when general-coverage equipment was sought after and widely used, even up to around half a gigahertz.

A reminder about slugs

Once you have *finally* winkled that jammed slug out, and either freed it up or popped a new one back in to the former, *don't* use varnish/nail polish, correction fluid or wax to hold it in place. Use thin PTFE "Plumber's tape" to stop the slugs from moving – it will hold them in place, but will not gum up or jam. It's more easily available than the thin rubber I used to use in the "Neosid"-style coil cans, and you can fold it on itself for a thicker hold on looser slugs.

References

Some manual downloads are in Deja View (DJVU) format – you will need the Deja View plug-in for your browser to read the files.

About the 770U

Ian Batty – for a reproduction of the manual.

http://bama.sbc.edu/eddyston.htm – for a scanned version of the manual.

http://www.shopingathome.com/Eddystones.htm – for a brief descrption.

http://www.eddystoneusergroup.org.uk/ – for all Eddystone info, including manuals.