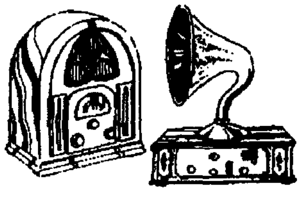
Vintage Radio

by PETER LANKSHEAR



The Eddystone 940 communications receiver

To many enthusiasts, a major attraction of vintage radios is their handsome wooden cabinets. But there is an important and increasingly popular class of receiver which even their most enthusiastic admirers would not call beautiful: the communications receivers, which as their name implies were intended for communicating rather than entertainment.

The classic communications receivers had superior standards of construction and performance, and prices to match — with some costing as much as small cars. Interest in this class of receiver is growing, and there are even 'one brand' societies with international memberships for such legendary makes as Collins, National HRO, Racal and Eddystone.

There is no precise definition, but it is generally accepted that communications receivers should be constructed to high standards with superior performance, stability and flexibility. Controls for many of the internal circuits are available to the operator, who is expected to have some technical knowledge. Other standard features are accurate and resettable dial readouts, beat frequency oscillators and, in more recent models, detectors suitable for single sideband (SSB) reception.

Many readers, especially those with amateur and DXing interests, will be familiar with the name of Eddystone, the brand name of equipment from the British company of Stratton & Co. — which was founded in the early 1920's and is now part of the Marconi group. A maker of fine shortwave components and receivers, Eddystone produced a wide range of communications receivers for marine, military and professional work as well as high performance general-purpose and amateur models which became popular with enthusiasts throughout Australia and New Zealand.

Favourite model

In 1949, Eddystone commenced production of the landmark professional general coverage model 680, covering from 480kHz to 30MHz. Like many very successful communications receivers, the 680 used the circuit concept pioneered 15 years previously by American firm National with their HRO, described in this column for November 1990.

Superbly made and finished, with two RF stages, mixer and oscillator, crystal filter, two IF stages, BFO, detector and audio amplifier, the 680 soon became a favourite and was followed during the next decade by the 680/2 and 680X.

In 1962, a new receiver replaced the 680. Considered by many to be the best-ever general coverage Eddystone receiver, the 940 retained the HRO circuit format, but with a product detector for SSB operation and a special low noise input stage. As well as the general purpose model described here, there were military and coastguard versions. Although produced concurrently with early solid state communications receivers, at 30 years of age, Eddystone's 940 is already old enough to be eligible for vintage status.

Solid construction

In common with most true communications receivers, even those built today, the 940 is massively constructed. Mechanical stability is extremely important for this class of equipment, and an Eddystone specialty is its high quality diecastings. For example, sheet metal front panels were not good enough. In-

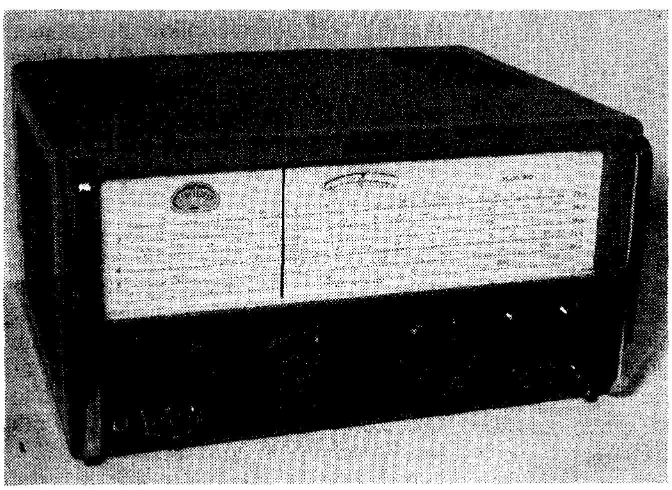


Fig.1: The 940 Communications Receiver. Post-1950 Eddystones featured large, easily read dials and smooth drive assemblies, with no perceptible backlash.

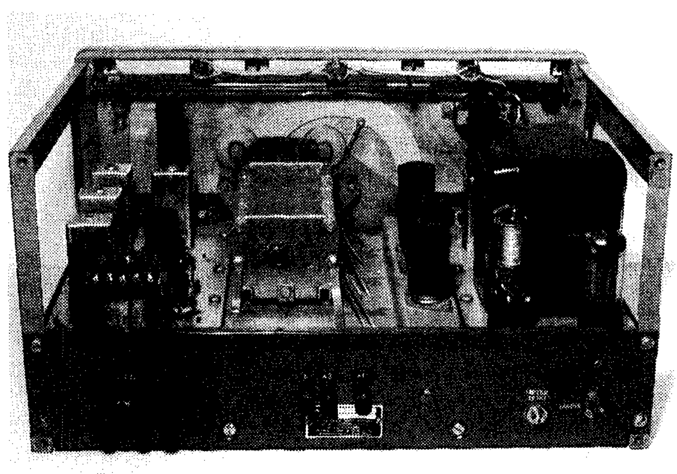


Fig.2: A rear view. The central diecasting provides considerable rigidity and tuning stability. The voltage regulator tube is visible on the right, with the rectifier.

CAPACITORS

C1–5, 18–22, 33–37, 49–53 : 3–30 pf Air Trimmer.
C6, 23, 38, 58, 68, 69 : 28 pf Silvered Mica ±10% 358V DC.
C7, 24, 39, 56 : 10 pf Silvered Mica ±10% 350V DC.
C8, 25, 40 : 12 pf Tubular Ceramic ±10% 350V DC.
C9, 26, 41, 63 : 4-gang Air Spaced Variable.
C10, 27, 42, 48 : 100 pf Polyctyrene ±5% 350V DC.
C11, 12, 14, 29, 44, 71, 78, 80, 81 : 0·1 uF Plate Ceramic - 80 —20% 200V DC.
C13 : 0·003 uF Metallised Paper ±20% 350V DC.
C15, 28, 30, 43, 46, 64, 73–75, 79, 82, 83, 89, 92 : 0·847 uF * Polyecter ±10% 400V DC.
C16, 17, 31, 32, 91 : 6 pf Tubular Ceramic ±10% 350V DC.
C45, 88, 93 : 58 pf Tubular Ceramic ±10% 350V DC.
C47, 86, 87 : 100 pf Tubular Ceramic ±10% 350V DC.
C54 : 0·004 uF Silvered Mica ±1% 350V DC.
C55 : 3625 pf Silvered Mica ±1% 350V DC.
C57 : 1625 pf Silvered Mica ±1% 358V DC.
C59 : 1200 pf Silvered Mica ±1% 350V DC.
C61 : 400 pf Silvered Mica ±1% 350V DC.

*0·05 uF may be fitted as alternative.

C62 : 15 pf Tubular Ceramic ±10% 350V DC.
C65, 76, 77, 84, 85 : 0·001 uF Polystyrene ±5% 125V DC.
C66, 67 : 8·002 uF Polystyrene ±5% 125V DC.
C68, 98 : 3–11 pf Air Spaced Variable.
C70 : 390 pf Polystyrene ±5% 125V DC.
C72 : 0·25 uF Metallised Paper ±20% 150V DC.
C90, 101, 103–105, 107 : 8·01 uF Tubular Ceramic ±20% 358V DC.
C94 : 0·81 uF Metallized Paper ±20% 150V DC.
C95, 96 : 500 pf Metallised Paper ±20% 358V DC.
C97 : 0·005 uF Tubular Ceramic ±20% 350V DC.
C99 : 200 pf Silvered Mica ±5% 350V DC.
C100 : 10 uF Tubular Electrolyaic 16V DC.
C102, 106 : 25 uF Tubular Electrolytic 25V DC.
C108 : 32 · 32 uF Tubular Electrolytic 350V DC.
C109 : 50 uF Tubular Electrolytic 450V DC.

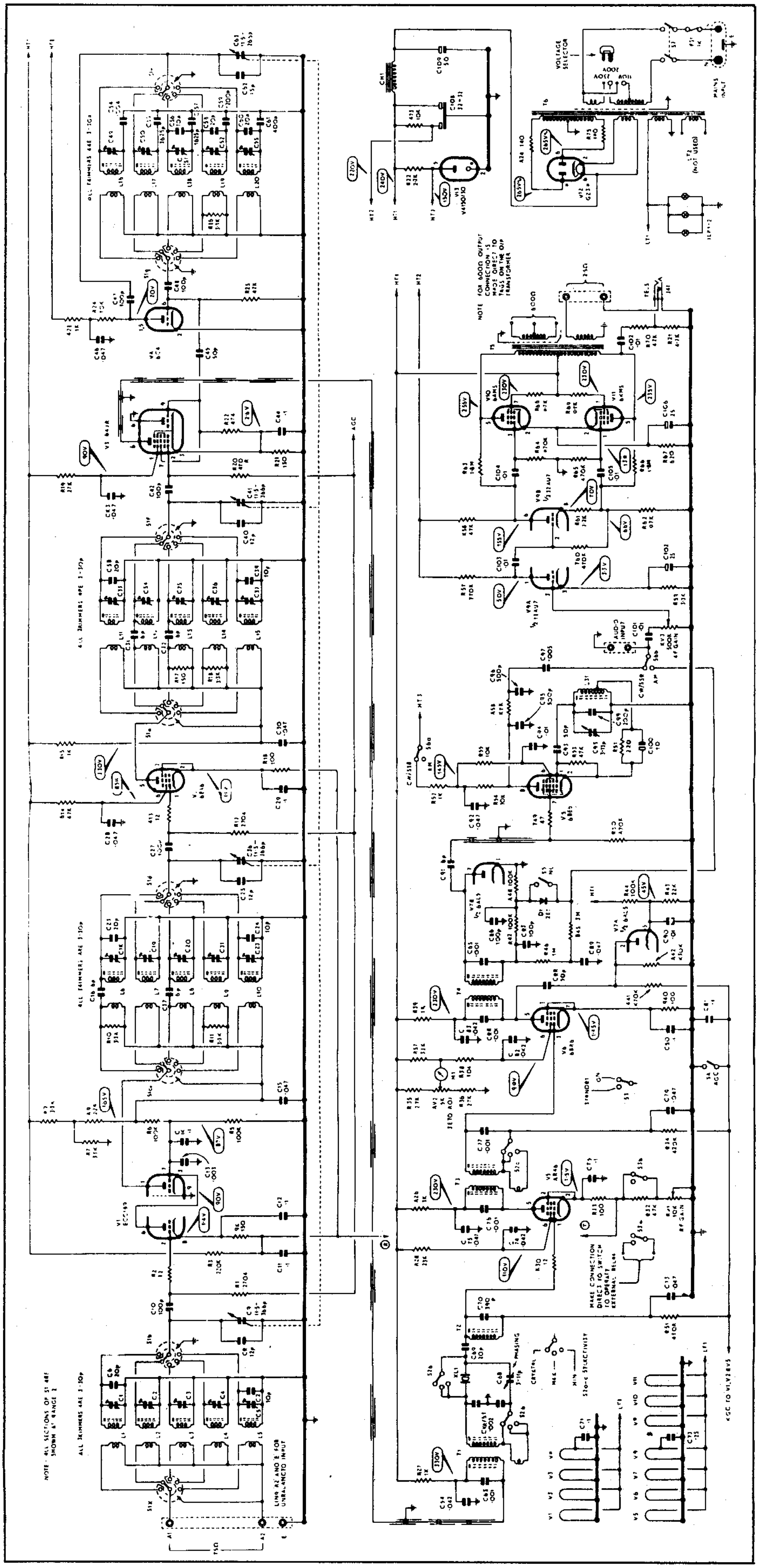
RESISTORS

R1, 12, 57 : 0·27 MΩ ±10% ½ watt.
R2, 13, 30 : 12Ω ±10% ½ watt.
R3 : 0·22MΩ ±18% ½ watt.
R4, 17, 21 : 150Ω ±10% ½ watt.
R5, 6, 44, 47, 48 : 0·1MΩ ±10% ½ watt.
R7, 28, 37 : 33,000Ω ±10% 1 watt.
R8 : 2,200Ω ±10% ½ watt.
R9 : 3,300Ω ±10% 1 watt.
R10, 11, 18, 26, 59, 61 : 3,300Ω ±10% ½ watt.
R14 : 47,000Ω ±10% 1 watt.
R15, 23, 27, 29, 39, 53 : 1,000Ω ±10% ½ watt.
R16, 33, 40 : 100Ω ±10% ½ watt.
R19, 35, 36 : 27,000Ω ±10% 1 watt.
R20, 31, 34, 41, 42, 50, 60, 64, 65 : 0·47MΩ ±10% ½ watt.
R22, 25, 32, 52, 56, 58, 62, 78 : 47,000Ω ±10% ½ watt.
R24, 54, 55 : 18,000Ω ±10% ½ watt.
R30, 73 : 10,000Ω ±10% 1 watt.
R43 : 22,000Ω ±10% ½ watt.
R45 : 2MΩ ±10% ½ watt.
R46 : 1MΩ ±10% ½ watt.
R49 : 47Ω ±10% ½ watt.
R51 : 228Ω ±10% ½ watt.
R63, 66 : 1·8MΩ ±10% ½ watt.
R67 : 620Ω ±10% ½ watt.
R68, 69 : 4,700Ω ±10% 1 watt.
R71 : 4,700Ω ±10% ½ watt.
R72 : 2,700Ω ±5% 6 watt wire-wound.
R74, 75 : 140Ω ±5% 6 watt wire-wound.

VOLTAGES

All voltages indicated on the circuit above were taken using a meter of 20,000Ω/V sensitivity and an applied mains voltage of 240V. A variation of ±5% should be allowed and readings should be taken between the point indicated and chassis. Range switch should be at '5.' Gain controls at maximum. Mode switch to CW/SSB, Standby switch to ON and AGC OFF.

Fig.3 (right): The complete schematic for the Eddystone 940, which used a total of 11 valves plus rectifier. The component values are shown above.



stead, an intricate moulding provides a panel with superb rigidity and stability as well as good looks.

Half the front panel area is taken up by the tuning dial. Below it are the controls, dominated by the two large knobs for tuning and band change. Other control knobs and switches are placed symmetrically on either side.

Eddystone were leaders in dial drive construction, and for many years sold uncalibrated dial units for incorporation in high class projects. For the uninitiated, to turn the tuning knob of an Eddystone receiver is a revelation in smoothness and precision, with absolutely no backlash evident at all.

A few flicks of the 940 tuning knob are sufficient to spin the combination of a flywheel and loaded gears the 70 turns necessary to traverse the entire dial. The tuning scales are about 320mm long, providing a 10kHz resolution on all but the highest frequencies. However, it is the logging scales that make resetting of tuning precise. Behind the dial is a 150mm diameter disk with calibrations on its edge visible through a window.

The combination of a logging scale on the dial face and the disc gives a readout length of about 10 metres for each band!

Mounted centrally behind the panel is the tuner chassis, another massive diecasting. On it are the RF amplifier, mixer and oscillator valves, together with the four-gang tuning capacitor. Underneath are the coils, each with its own air dielectric Philips 'beehive' trimmer and adjustable iron core. Each stage is separated by partitions in the casting and directly below the valves is the wavechange switch.

Viewed from the rear, to the right on a steel chassis is the power supply and product detector. A third chassis contains the crystal filter, IF stages, detector and audio amplifier.

Circuit details

The circuit is worth looking at in detail, for although much of the technology is familiar, there are some features never found in domestic receivers.

Aerials can be just about anything from balanced arrays down to short lengths of wire, and the input stage tuning is quite conventional. The first valve, however is a double triode cascode (*cascaded triode*) RF amplifier, normally associated with TV tuners and what is more, the 6ES7/ECC189 valve used is, like RF pentodes, of the variable-mu type! Why did Eddystone use such an unconventional front end?

The reason is *noise*, the limiting factor in the sensitivity of high gain receivers. When a signal is submerged in noise, further amplification is pointless, and in an ideal system, the only noise would come from the aerial. As well as the all too familiar man-made variety, aerial noise occurs naturally as a result of atmospheric, cosmic and thermal effects.

Unfortunately, receivers also generate their own noise, but in good design the problem is normally confined to hiss from the first stage valve. All types of valves generate noise, but converter valves are by far the worst offenders. Pentode RF amplifiers, especially higher mutual conductance types such as the 6BA6 are a considerable improvement, but the least noise is generated by high mutual conductance triodes.

Aerial noise level is not constant throughout the spectrum, but for a given bandwidth, the amount progressively decreases as frequency is raised. Provided that there is a well designed RF amplifier ahead of the converter, and given a reasonable aerial, receiver generated noise at frequencies below 15 - 20MHz is negligible. However, above about 15MHz, aerial noise becomes so low that noise generated in the first valve does become significant and the reason that triode RF amplifiers were used extensively in valve TV tuners.

The problem is that simple triodes are unstable as RF amplifiers. A very effective way of taming them is by the cascode connection, in which the input triode is a conventional amplifier driving the cathode of a grounded-grid second amplifier. By preventing any coupling between the first and second tuned circuits, the cascode connection provides a high gain, stable and very low noise RF amplifier. The variable-mu characteristic of the ECC189 permits the application of full AGC to the cascode stage.

Second RF stage

Next in the Eddystone 940 is a second RF stage, this time a more conventional type using a 6BA6/EF93 pentode. Its purpose is to provide additional amplification and most importantly, extra selectivity for improved image rejection on the higher frequency bands. With the intermediate frequency of 450kHz, the image is only 900kHz from the fundamental. Thanks to the use of this second stage with its additional preselection, at 20MHz the image rejection of the 940 is 40dB. Many domestic receivers would have difficulty in achieving 10dB at this frequency.

Only the heptode section is used in V3, a 6AJ8/ECH81 frequency converter. V4, a separate 6C4/EC90 triode tuned anode oscillator is coupled into the injection grid of the heptode. Use of a separate oscillator valve for improved stability was frequent in top-line communications

SPECIFICATIONS: Eddystone Model 940

FREQUENCY COVERAGE MHZ		INTERMEDIATE FREQUENCY
Range 1	12.7 - 30.00	450 kHz
Range 2	5.40 - 12.70	Variable selectivity
Range 3	2.40 - 5.40	Crystal filter
Range 4	1.03 - 2.40	
Range 5	0.48 - 1.03	VALVES
		11 Miniature 2 Octal

IMAGE REJECTION		AUDIO FREQUENCY
1 MHz ..	9D db	2.5 watts
8 MHz ..	75 db	2.5 or 600 ohms
20 MHz ..	40 db	

SENSITIVITY
3 microvolts for 15 db signsl-to-noise ratio.

Vital statistics for the 940. After 30 years, there is no problem in meeting the original performance specs.

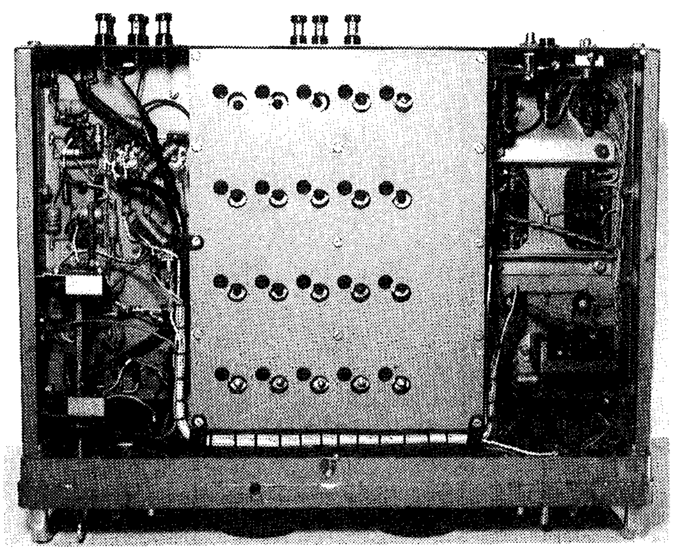


Fig.4: The underside of the 940, showing the meticulous wiring and the large coil box with its cover in place.

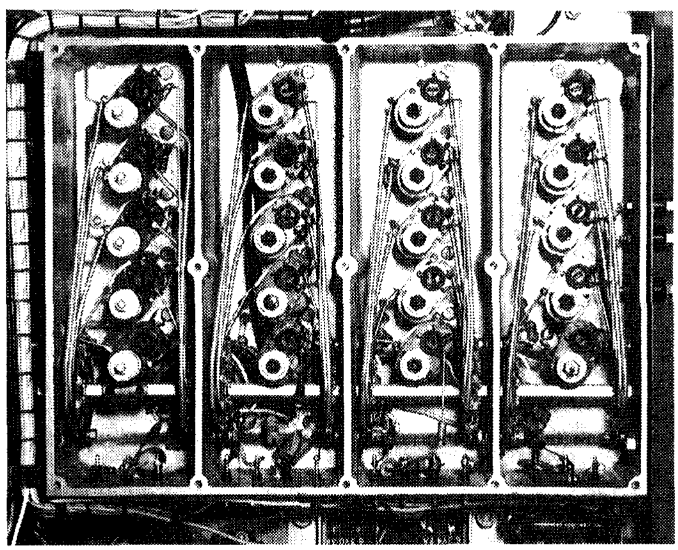


Fig.5: No receiver can be better than its coils. The heart of the 940 is its diecast coil box and RF chassis, shown here.

receivers. The oscillator HT supply is regulated at 150 volts by the VR150/30 gaseous voltage regulator valve V13.

Variable selectivity

Apart from using more modern components, the two stage IF amplifier with V5 and V6, 6BA6/EF93 type valves is little different from the ancestral HRO. Variable IF selectivity is controlled by a three position switch. In the sharpest position, with a bandwidth of only 400Hz at 6dB down, there is a crystal filter — remarkably similar to the pioneer Robinson design used in the 1930 Stenode receiver. In fact like the Stenode, the quartz crystal is sealed in a valve envelope, in this instance the small B7G size.

The second position of the selectivity switch short-circuits the crystal and provides a 4kHz bandwidth at the 6dB point. In the broadest position, the IF transformers are overcoupled by switching in extra windings, producing an overall bandwidth of 10kHz — suitable for high quality reception.

As communications receivers are frequently associated with transmitters, standby switches are a standard fitting. This switch on the 940 controls the cathode circuit of the first IF amplifier and has an extra pair of contacts to control a transmitter on/off relay.

A carrier level meter monitors the changes in the screen grid current caused by AGC action on the the second IF stage. Although not a true 'S' meter, it nevertheless provides a useful indication of signal strength. As automatic gain control is normally switched off for single sideband and code reception, communication receivers also have manual RF and IF grid bias gain controls. The 940 manual control is a 10k pot in series with the cathodes of the four valves in these stages.

Two detectors

Although there are several differences in detail, and at first glance they look complicated, the AGC and detector circuits of the 6AL5/EAA91 double diode are basically conventional. V7A is a delayed AGC rectifier, fed from the anode of the second IF valve V6. However instead of the usual 2-3 volts of delay found in domestic receivers, the 940 has no less than 45 volts! This is an illustration of how the gain of a large receiver differs from a domestic model. To have any less delay would result in internal noise creating sufficient AGC voltage to desensitise the controlled stages.

V7B is a diode detector used for AM transmissions. But the circuit incorporates a *noise limiter*, a device not found in domestic receivers. Bangs and crashes from static, and impulse noise from automotive ignition can be very tiresome. Noise limiters provide some relief and the 940 uses D1, a silicon diode for this. R45, R46 and C49 filter the voltage developed across the load of V7B to provide a bias voltage proportional to the strength of the received signal. When a noise pulse exceeds the bias, D1 ceases to conduct and no signal is passed on to the audio amplifier.

The product detector V8, a 6BE6/EK90, functions much like a superhet mixer, with the inner grid and screen grid used in a beat frequency oscillator which is tuneable either side of 450kHz. When used as a beat frequency oscillator (BFO) to make CW transmissions audible, the oscillator and incoming signals are mixed together to create a heterodyne at the anode of V8.

The other use of the product detector is the related function of reception of single sideband transmissions (SSB), frequently used for radiotelephone traffic. By eliminating the carrier and one sideband from the transmission, there can be considerable savings in power and spectrum space. The remaining sideband can convey all the necessary information, but it must again be demodulated by a carrier recreated by a local oscillator (the BFO) in the receiver.

No loudspeaker

Although not primarily intended for high fidelity listening, the Eddystone 940 has a good quality audio system. V9 is a 12AU7/ECC82 double triode, operating as a voltage amplifier and split load phase inverter. This drives a push-pull pair of 6AM6/EL91 medium sized output pentodes, producing a rated audio output of 2.5 watts.

As was quite common with valve communications receivers, there is no internal loudspeaker. Instead, there is provision for either an external 2.5-ohm speaker, a pair of headphones or a 600-ohm audio line.

Faultfinding

As would be expected with equipment of the quality of the 940, reliability is very high and it is a rarity for Eddystone-made components to fail. However minor items such as valves, bypass capacitors and resistors can fail and normal servicing methods, especially voltage checks, will normally soon locate faults.

Two unusual resistor-related problems were found in the receiver illustrated. First, the cascode amplifier did not seem to be contributing any gain. As the socket is completely hidden under the wavechange switch, voltage measurements were not possible. By unplugging the valve, and measuring from above the chassis, it found that there was no voltage present on pin 2. Resistor R6 was open, and R8 was twice its rated value.

After repairs, operation with manual RF/IF gain was normal, but very poor with AGC. R44 had become open circuited, removing the 45-volt delay from the diode V7A and permitting noise to operate the AGC.

After servicing and realignment with the aid of a Marconi 2022 precision frequency synthesised RF generator, performance of the 940 was measured. Even at 27MHz it can still meet the original signal to noise specification. After 30 years, that is *quality*. ❖