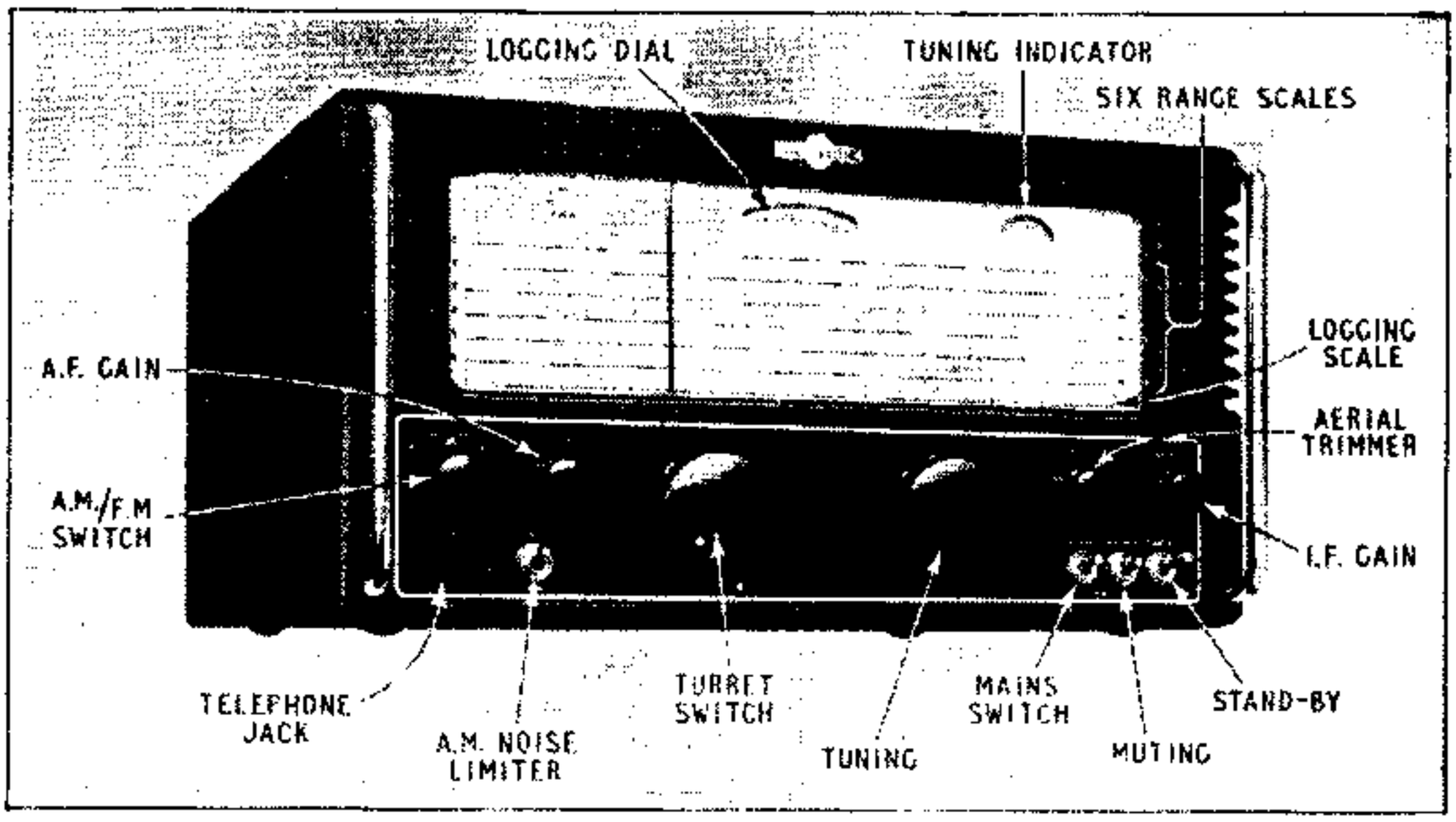
A.M./F.M. Communications Receiver

Review of Eddystone Model 770R, Covering 19 to 165 Mc/s



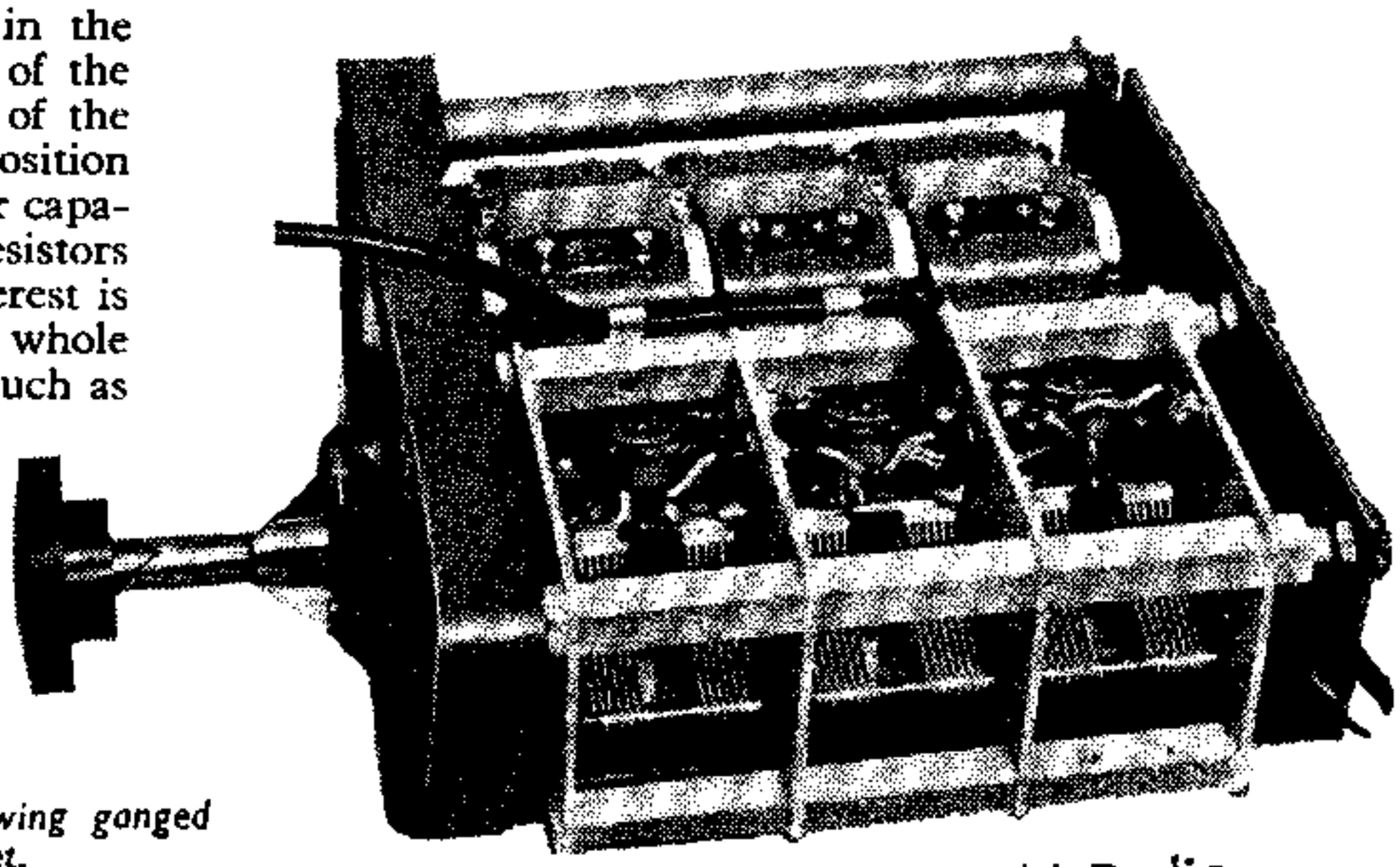
NINETEEN valves, of which all but two are miniature, and three germanium crystal diodes are used in the new Eddystone Model 770R wide range, v.h.f. communications receiver. The types of these valves, their circuit positions and functions will be found in the valve table. This set is believed to be the only British-made receiver now available giving continuous tuning over such a wide v.h.f. range as 19 to 165 Mc/s. There are six ranges and the extent of each, together with some of the services likely to be found in the various bands, are outlined in the frequency tables on the following page.

The 770R has an i.f. of 5.2 Mc/s and provides for the reception of a.m. and f.m. telephony and c.w. telegraphy. No marked departures from well-tried techniques are attempted, but considerable ingenuity is evident in the planning of the circuit and range-changing mechanism of the front-end, comprising the r.f., mixer and oscillator stages. This is, of course, the real heart of a receiver of this kind and its general performance depends almost entirely on the design of this part of the set. Its very satisfactory behaviour on all ranges, but especially on the 114-to-165-Mc/s one, is a tribute to the design of the front-end unit.

The r.f., mixer and oscillator stages in the 770R are a single unit, and a good idea of the general arrangement can be seen in one of the illustrations. The set employs a six-position rotary-coil turret, three ganged split-stator capacitors, valve-holders and sundry small resistors and capacitors. The main feature of interest is that virtually no r.f. wiring is used in the whole unit; the positioning of the main items, such as coil turret, tuning capacitors and valveholders, is such that their interconnecting points fall so close together that the soldering tags alone form the wiring. Moreover, little real wiring is employed inside the coil turret itself. As shown in the

VALVE TABLE

Circuit Position	Type	Function
V1	6AK5/EF95 (CV850)	Pentode r.f. amplifier.
V2	6AK5/EF95 (CV850)	Mixer.
V3	6AK5/EF95 (CV850)	Oscillator.
V4-V7	6BA6 (CV454)	I.F. Amplifier.
V8	6AU6 (CV2524)	F.M. limiter.
V9	6AL5 (CV140)	F.M. discriminator.
V10	6AL5 (CV140)	Noise limiter and a.g.c.
V11	6AU6 (CV2524)	"S" meter valve on a.m. Tuning indicator on f.m.
V12	6BA6 (CV454)	Beat frequency oscillator (BFO)
V13	6AU6 (CV2524)	Noise amplifier (muting).
V14	12AU7 (CV491)	Muting stage.
V15	12AU7 (CV491)	A.F. amplifier and phase inverter.
V16-17	6AM5 (CV136)	Push-pull output stage.
V18	VR150/30 (CV216)	Voltage stabilizer.
V19	5Z4G (CV1851)	Full-wave h.t. rectifier.
CD1	Germanium	A.M. detector.
CD2-3	Germanium	Noise detectors (muting)



Right : Front-end unit of Eddystone 770R showing ganged capacitors, valveholders and (in rear) coil turret.

illustration of two of the turret coil assemblies, the higher-frequency coils are self-supporting and are soldered direct to the inside extensions of the external contact studs. Any trimmers included have the shortest possible leads to their respective points.

Turret Mechanism

The actuating mechanism of a coil turret for v.h.f. use is a vitally important feature of its design, as it is most essential that at all times the turret comes to rest in exactly the same position on any one range. A fractional displacement would either add to or subtract from the total inductance in the circuit and cause changes in tuning of sufficient magnitude to render the range scales, if calibrated directly in frequency as they are in the 770R, quite useless. Moreover, as facilities are provided for accurately logging the tuning positions of stations, any unreliability in the turret positioning would become immediately apparent when a previously logged station's position is sought after changing ranges. Apart from small initial variations in tuning caused by oscillator drift (which cannot be entirely avoided by voltage stabilization alone), no abrupt changes in the tuning position of a station was noticed by going from range to range and back to the original. We looked for these effects most searchingly on the highest frequency range and, finding none, conclude that the coil turret mechanism is above reproach in this respect.

The tuning system of the 770R is the same basic type as used in other Eddystone communications receivers. It provides an overall reduction of 140 to 1, embodies a flywheel to counteract frictional drag of the gears, and gives a smooth and free action. It is heavy enough to carry the pointer some distance along the scales by spinning the knob sharply. The weight is

FREQUENCY TABLE

Range	Frequency coverage (excluding overlaps)	Remarks
1	114 to 165 Mc/s	Aircraft, amateurs.
2	78 to 114 Mc/s	F.M. broadcast, land mobile, aero navaids.
3	54 to 78 Mc/s	Television, aero navaids.
4	39 to 54 Mc/s	Television, U.S. amateurs.
5	27 to 39 Mc/s	Amateurs, aero navaids, meteorological aids.
6	19 to 27 Mc/s	Broadcast, amateur, marine.

nicely chosen and does not give the impression of taking charge of the tuning, as sometimes seems to occur when the flywheel is too heavy. The pointer is a long pendant one and embraces seven 12-in long horizontal scales, six of which are calibrated linearly in frequency; the seventh is the logging scale marked 0-2,500 and having 25 divisions. Each division represents one complete revolution of a subsidiary logging dial which is visible through an aperture in the top centre of the main dial. This dial has a 360-degree scale and is engraved 0-100. In effect it expands every scale to the equivalent of 32 ft. Quite small changes in frequency can thus be observed on the logging dial.

A.M./F.M. Arrangements

Owing to the rather high i.f. used (5.2 Mc/s) four i.f. stages have been included to satisfy the requirements of high sensitivity coupled with a wide band-

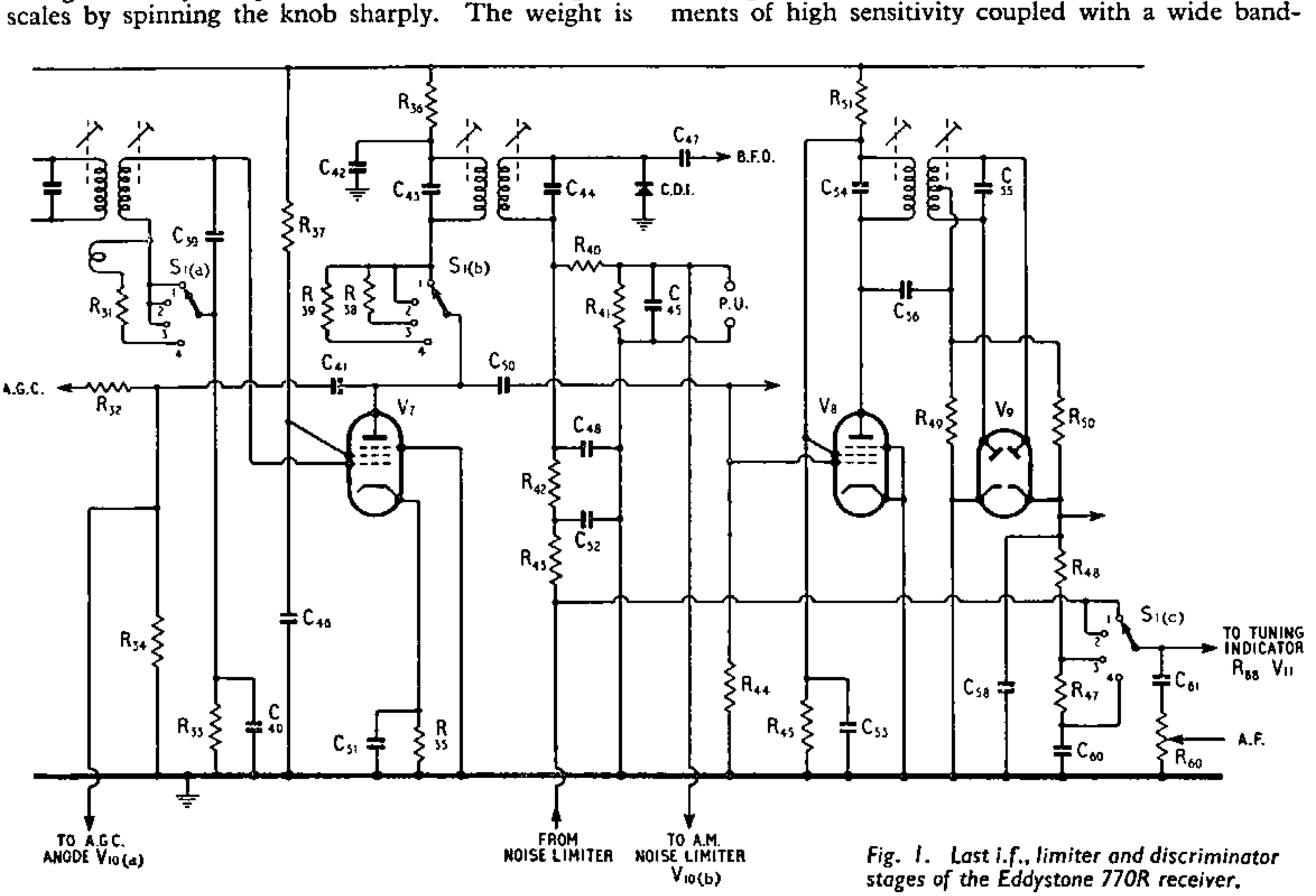


Fig. 1. Last i.f., limiter and discriminator stages of the Eddystone 770R receiver.

width for f.m. reception. For f.m. there is in addition a limiter and a Foster-Seeley discriminator. For a.m. reception there are no fewer than 10 tuned circuits and a crystal diode detector. Some interesting features (see Fig. 1) can be found in that part of the circuit, which includes the last i.f. stage V7 limiter V8 and discriminator V9. The switches S_{1a} to S_{1c} are part of a larger switching system, which might be called the "services switch," as it changes over from a.m. to f.m., adjusts bandwidth to suit each type of service and in the "CW" position switches on a BFO. S_{1a} and S_{1b} are for bandwidth adjustment of the i.f. amplifier at this point, the markings on S_{1a} indicating the four positions of the switching system; (1) CW, (2) AM, (3) NFM and (4) FM. NFM is narrow-band f.m. and is used for certain types of transmission for which the frequency deviation need not exceed ± 15 kc/s compared to the ± 75 kc/s of wide-band f.m.

In the top right-hand corner of the main dial is a small aperture disclosing a tuning indicator. It serves a twofold purpose; it functions as a single-strength meter for c.w. and a.m. transmissions, registering on the carrier level, and is used as a tuning indicator for f.m. It has a red-line centre zero on which the pointer is aligned for correct tuning on f.m. and a 0-9 "S"-scale for a.m. It is sometimes said that an f.m. signal can be tuned in correctly by adjusting for minimum background noise, but this region is generally far too broad for satisfactory tuning. The meter indicator of the 770R is very sensitive to small changes in tuning and enables the desired accuracy to be achieved in a simple manner.

Details of the circuit associated with this indicator are given in Fig. 2, which includes the switch S_{1d} for changing over the indicator's functions from tuning indicator to "S" meter as required. It forms part of the main S_1 switching system. The remainder of the circuit is reasonably straightforward.

A push-pull output stage is used, preceded by a phase-splitter and a.f. amplifier. Negative feedback is employed. An output transformer provides matching for an external loudspeaker of 2.5 to 3 ohms; a loudspeaker is not included in the set. Provision is made for headphones and—unusual in a set of this kind—for a gramophone pickup.

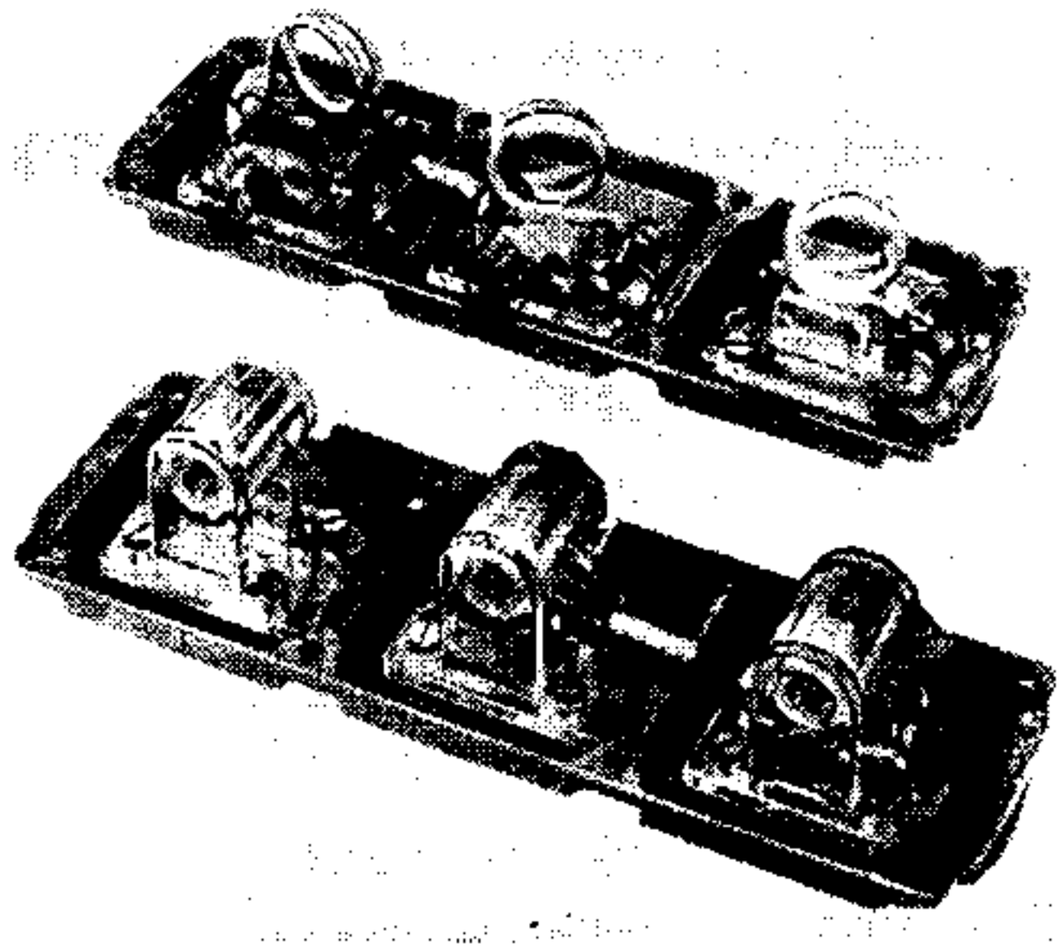
One other circuit detail, which, however, is common to most communications receivers, is a stand-by switch. It de-sensitizes the set in the stand-by position and also closes a pair of spare contacts to be used, if required, to control a nearby or remote transmitter via a relay.

Performance

The impression given by the set is that it has about as much sensitivity as can usefully be employed. The selectivity in the CW and AM positions is adequate for all v.h.f. requirements; and it must be judged on this basis. It leaves a little to be desired on the 19- to 27-Mc/s band, but these frequencies may be regarded as rather outside the normal scope of this receiver.

During our tests we dodged from range to range, noting station tuning positions and often coming back to them time and again; it was a form of monitoring and covered the whole v.h.f. range of the receiver. The set seems ideally suited for this type of work which could form one of its principal rôles.

The noise limiter suppresses ignition interference



Two of the coil units removed from the turret.

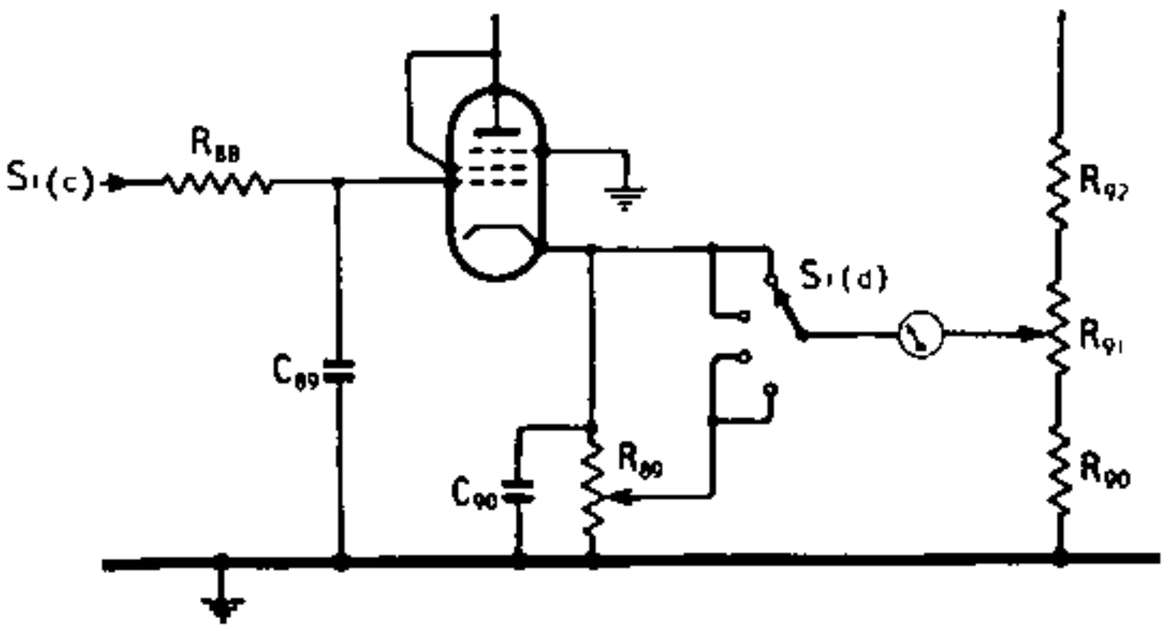


Fig. 2. The f.m. tuning indicator and a.m. "S" meter are combined in one stage.

on a.m. transmissions quite effectively, but seems to cut rather deeply into the upper frequency response. Indeed, it forms a useful way of suppressing most of the set noise when the full gain is employed and especially so when the BFO is used, which, as seems inevitable, adds considerably to the general background noise. However, this is not peculiar to the 770R.

The following extracts from the maker's specification serve to give some idea of the receiver's qualities.

Sensitivity.—Better than 5 μV on all ranges for a 15-db signal/noise ratio and 50 mW output.

Selectivity.—CW and AM; 40 db down, 50 kc/s off resonance. Narrow band FM; 40 db, 80 kc/s away from resonance. Wide-band FM; 40 db down, 175 kc/s off resonance.

Noise Factor.—Not greater than 14 on Range 1, decreasing to less than 5 on Ranges 5 and 6.

Image Ratio.—Better than 20 db at 165 Mc/s and correspondingly greater at the lower frequencies.

Frequency Stability.—Drift less than 0.001 of 1 per cent C, and less than 0.001 of 1 per cent for a 5-per cent change in mains voltage.

As the receiver covers the 21-, 28- and 145-Mc/s amateur bands it might have some appeal in this direction provided the price does not prove too great an obstacle.

The makers are Stratton and Co., Ltd., Eddystone Works, Alvechurch Road, West Heath, Birmingham, 31.