The Design of the R1155*

GENERAL CIRCUIT ARRANGEMENT AND AMATEUR BAND APPLICATIONS

THOUGH of vintage 1940, the R1155 has remained one of the most popular "surplus" receivers for Amateur-band operation, largely because it is still easy to buy. Intended originally for aircraft operation as the companion unit for the well known T1154 transmitter—discussed in some detail in the December 1955 issue of "The Short Wave Magazine"—the design of the R1155 is basically very good. (It was prototyped by the Royal Aircraft Establishment, Farnborough, and manufactured under contract in large quantities by several well known radio firms.) In Service use, the receiver was found to be easily adaptable for ground-station working.

A great many Amateurs have since made the same discovery, and today there are few operators in this country who are not aware of the R1155, even if they do not own one. It is also of interest to add that the design of the Radiovision "Hambander," in its time another very successful receiver, was largely inspired by the R1155.

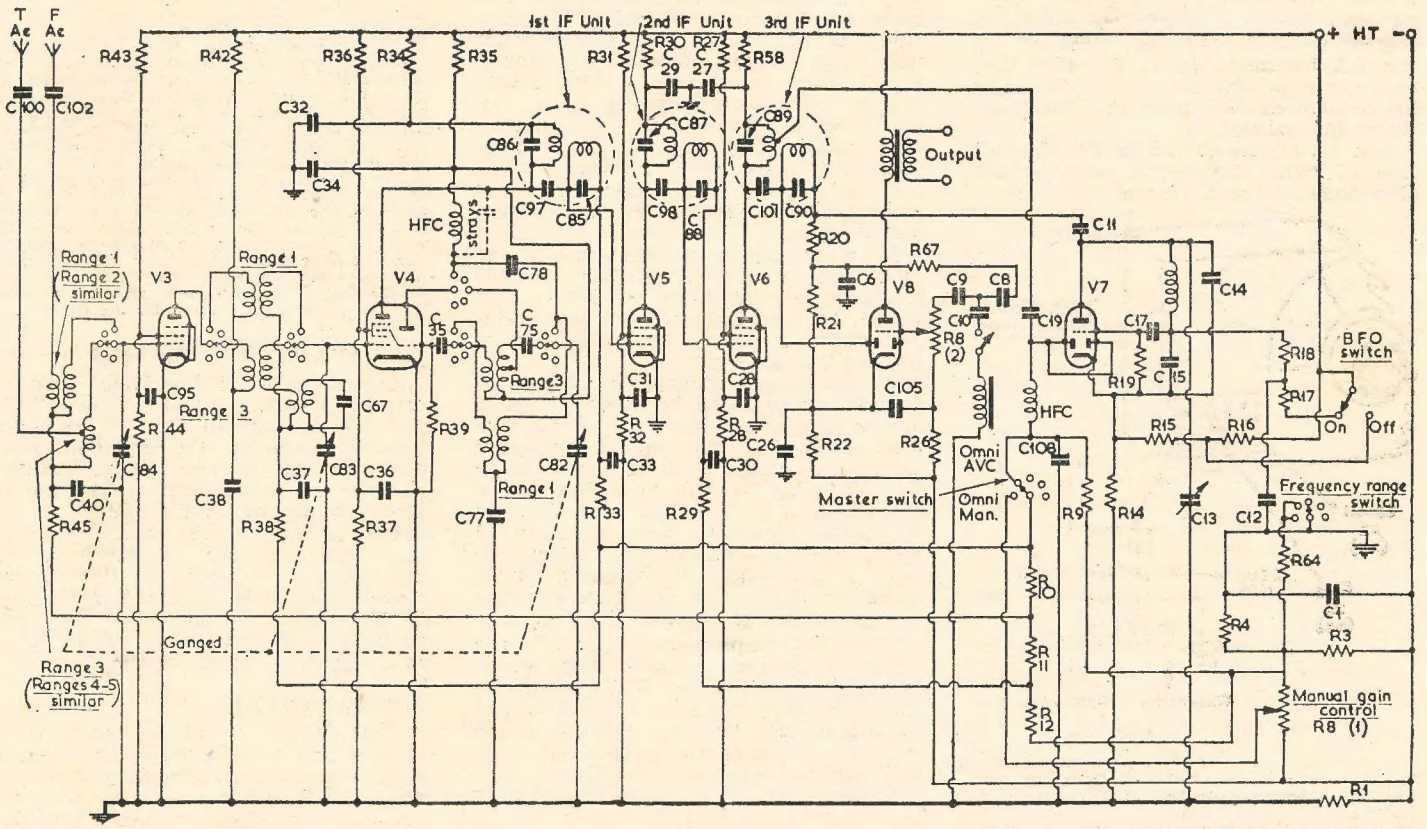
CIRCUIT ARRANGEMENT

The diagram of Fig. 1 is a simplified version of the communication circuits of the R1155—in the airborne application, it also provided direction finding and homing facilities by a direct-reading course meter, but those functions are not discussed here because they are of no practical interest from the Amateur Radio point of view.

To make it easy for those possessing an R1155, and wishing to know more about its interior, the circuit nomenclature used in Fig. 1 follows that of the Service Manual on the receiver.

The communication circuitry amounts to r.f., f.c. and two i.f. stages into a detector-output valve, with separate valves for a.v.c. operation combined with b.f.o., and a "magic eye" visual tuning indicator. (The latter is not

* Reprinted from "The Short Wave Magazine," May 1957.



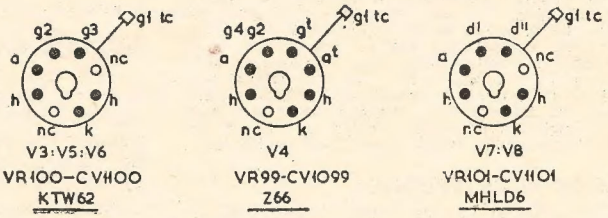


Fig. 1. Simplified diagram of the R.1155 communications circuits, discussed in the text. T.Ae is the "trailing" (long wire) aerial connection, which goes to Pin 2 of the Plug P1 (see Fig. 2) and F.Ae is the "fixed" aerial, corresponding to any short wire of 25-40 feet, going to Pin 1; in certain circumstances, better results will be obtained by trying either one of these. The KTW62 at V3, V5, V6 is now obsolete, as is the MHLD6 at V7, V8, but supplies are available from "surplus" sources. The Z66 at V4 is a current-production type (G.E.C.). Pluggable equivalents of these valves in current production are the W61 (or earlier KTW61) for V3, V5, V6, with the DL63 for V7, V8. The IF of the R.1155 is 560 kc, on the HF side of signal frequency, with a selectivity factor of 5 kc.

C1—2.5 μF.
C6, C11, C17—100 pF.
C8, C9, C19, C102—0.001 μF.
C10—0.004 μF.
C12, C26, C27, C28, C29, C30, C31, C32, C33, C34, C36, C37, C38, C40, C105—0.1 μF.
C13—75 pF. semi-variable (see text).
C14—0.0016 μF.
C15—0.00455 μF.
C35, C108—200 pF.
C67—0.002 μF.
C75—537 pF.
C77—0.00617 μF.
C78—15 pF.
C82, C83, C84—Main tuning gang assembly.
C85, C86, C87, C88, C90—300 pF.
C89—600 pF.
C95—0.5 μF.
C97, C98—2 pF.
C100—200 pF.
C101—4 pF.
R1—2,000 ohms.
R3—1,200 ohms.
R4—120 ohms.
R8(1), R8(2)—50,000/500,000 ohm dual potentiometer (see text).
R9—2 megohms.
R10, R11—150,000 ohms.
R12, R16, R27, R31, R36, R43—27,000 ohms.
R14, R22—1,000 ohms.
R15—30,000 ohms.
R17—1,500 ohms.
R18—10,000 ohms.
R19, R20, R39—56,000 ohms.
R21—470,000 ohms.
R26, R29, R33, R38, R45—100,000 ohms.
R28, R32, R35, R37, R44, R67—22,000 ohms.
R30, R34, R42, R58—2,200 ohms.
R64—200 ohms.
Note.—Circuit nomenclature as Service Manual.

shown in Fig. 1.) The audio output, while being adequate for headphones, is not sufficient for a speaker.

Since the R1155 is a general-coverage receiver, it suffers (from the Amateur viewpoint) by reason of having no bandspread. This means that the 7 and 14 Mc. bands cover only a few notches on the dial. Moreover, the 21 and 28 Mc. bands are not tuned at all, nor is 160 metres—a very severe disadvantage. The short-wave coverage is 3.0 to 18.5 Mc., meaning that the R1155 can be operated as it stands only on the 3.5, 7 and 14 Mc. Amateur bands. It is very good on 80 metres.

Effective bandspread can be obtained by putting a small 10 or 15 pF. variable capacity in parallel with the oscillator tuned circuit; as this capacity will only sweep a small proportion of any one h.f. tuning range, tracking will not be seriously affected, though of course calibration will be put out.

To get on to 15 and 10 metres a converter arrangement is necessary, while for Top Band it is possible either to employ another converter, or to modify the m.f. tuning range 3 (600-1500 Kc.) to cover 1800-2000 Kc., as explained in the September 1956 issue of "The Short Wave Magazine."

The i.f. of the R1155 is 560 Kc., h.f. side of signal frequency, with adjustable dust-iron core i.f. transformers.

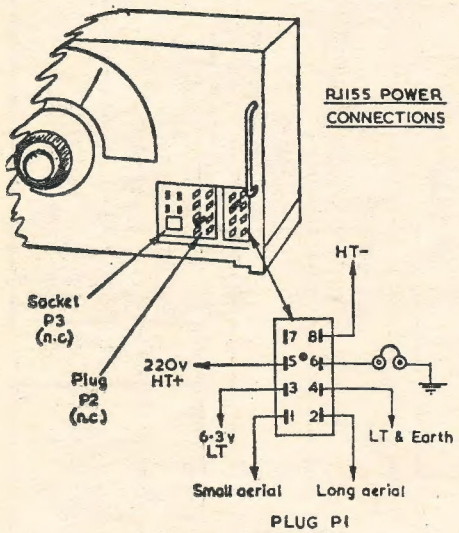


Fig. 2.

This sketch is to locate the R1155 power plug and its connections, looked at from the front (as the receiver is viewed). To operate the set as a normal communications receiver, socket P3 and plug P2 are ignored, connections as shown being made to P1. The headset can be connected across pins 6-4 or 6-8 if pin 4 is earthed, as shown here. Pin 7 connects h.t. plus to V1, V2 which are the d.f. valves, not used at all in the communications application; these circuits are only brought in when the main (right-hand) panel switch is moved to the "balance," "visual" and "00" positions.

VALVE SUBSTITUTION

The original valve types were: VR100 for V3, V5, V6, equivalent to the CV1100, which is the old Osram KTW62, replaceable by the later G.E.C. W61 (KTW61). V4 used a VR99, also named CV1099 and actually a Z66, still in the current G.E.C. range; and for V7, V8 the type was a VR101 (CV1101) which is the original Osram MHLD6, now obsolete, but replaceable by the G.E.C. DL63 double-diode triode. (The equivalents mentioned here are directly pluggable, without re-wiring of any sort being necessary.) The "magic-eye" is a V1103, which is the same as the G.E.C. Y63 in the current range.

Unless the receiver is bought as "brand new, unused, in original packing," one of the first things to do is to give it a new suit of valves.

A.V.C. AND B.F.O.

When the master switch is in the "omni" position, the gain of V3-V4-V5-V6, together, can be controlled by potentiometer R8(1), the resistor network being so arranged that (at 220v. h.t.) any negative voltage from about —4 up to —30 volts is given by the slider of R8(1).

With the master switch at "a.v.c.," the gain of stages V3-V6 inclusive is controlled automatically by the level of the incoming signal, with R8(2) as the manual audio gain control.

Since in the actual design R8(1) and R8(2) are ganged together to the one knob marked "volume control," from a study of the circuit it is evident that with the master switch at "omni," R8(1) only is operative—with R8(2) out of circuit—while with a.v.c. on, audio gain R8(2) alone is available. This means that there is no manual control of **audio** gain, by itself, when a.v.c. is off, the output being in effect controlled by R8(1), as a "manual a.v.c." knob.

It is for this reason that one of the modifications sometimes advocated is the physical separation of R8(1) and R8(2), so that they can be used independently; in fact, this modification is not really necessary.

In the a.v.c. circuitry, the degree of bias is proportioned between V3-V6 in such a way as to give a sort of "graduated control," in the interests of good signal-noise ratio. That is to say, while V4, V5 take the full a.v.c. bias volts, V3 gets half this voltage, and V6 only one-tenth. The a.v.c. delay is about 13 volts, and the resulting a.v.c. characteristic is such that a change in input signal of 80 db. only produces a variation in output level of 8 db.

The triode section of V7 provides the b.f.o., the Colpitts oscillator being tuned to half-i.f., i.e. 280 Kc. What should be the variable pitch b.f.o. control is C13 in the circuit diagram. In the R1155 it is fitted not as an independent control, but for screwdriver ("fixed") adjustment. An obvious improvement here is to put in a condenser which can be knob controlled.

OUTPUT END

The maximum attainable audio output is 100 mW. which is ample for a headset, but, as already mentioned, means that an additional l.f. valve must be fitted for speaker operation—see under "Power Supply".

In the output side of the set there is incorporated an l.f. filter or noise limiter consisting of a choke with condensers C8, C9, C10, controlled by a switch. The purpose of this is to suppress all audio frequencies below 300 cycles, which it does most effectively; it works very well on high-level peaky noise and "sharsh."

Also on the output side there is a tuning indicator V10—not shown in the circuit of Fig. 1—which is driven off the a.v.c. line (the full a.v.c. is always applied to the magic-eye tube, irrespective of whether a.v.c. or manual gain controls are used); hence, it could easily be replaced by an S meter unit operating on the principle of that described elsewhere in this issue.

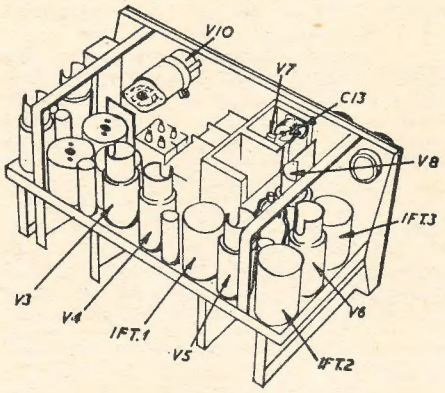


Fig. 3.

Outline sketch of the R1155 (chassis, rear view) to locate main items shown in the circuit at Fig. 1. Valves and canned coils not marked here are for the d.f. function of the receiver, and could well be removed, together with the connections to the "balance," "visual" and "00" positions of the main panel switch. V10 is the magic-eye tuning indicator (not shown in the Fig. 1 circuitry) and is driven off the receiver a.v.c. line, its grid being connected to the top end of R9 in Fig. 1. V10 could be replaced by the current G.E.C. type Y63, which is pluggable, or the magic-eye assembly removed altogether and replaced by an S meter. All elements marked in this sketch correspond to the Fig. 1 nomenclature, and are as given in the Service Manual on the R1155.

THE AUXILIARY CIRCUITS

The circuitry of the R1155 also incorporates three further valves (V1, V2 and V9, not shown in Fig. 1) which are additional to the communications section of the receiver. These auxiliary circuits are there only to provide for direction finding and homing. In the sketch at Fig. 3, the circuit elements associated with the d.f. functions are unmarked; they can, in fact, be removed altogether, to leave more space on the main chassis, since they play no part in the operation of the R1155 as a communications receiver.

POWER SUPPLY

The R1155 is not self-powered—in Service use, a complicated arrangement of h.t. and l.t. generators, driven off the aircraft main electrical line, was involved—so that another "modification" called for is the provision of a standard type of a.c. power pack. This should give about 60 mA. at 220 volts h.t., with 6.3 volts at 3 amps. or so for l.t.

In some modifications a 6V6 (or G.E.C. KT63) as output audio amplifier is built on to the same chassis as the power pack, to form a complete unit operated externally to the main receiver. In this case, the grid connection for the output amplifier can be taken off pin 6 of the power plug P1—see Fig. 2.

The sketch at Fig. 2 locates the power inlet plug and its pin connections. The other two entries, plug P2 and socket P3, can be ignored; they are the connection points for the d.f. function of the receiver, including the remote reading visual course indicator.

FURTHER INFORMATION FROM THE SERVICE MANUAL

As an aid to readers, the following information is extracted from the Service Manual.

The frequency ranges are:—
Range 1—18.5 to 7.5 Mc.
(no d.f. on this range)
„ 2—7.5 to 3 Mc.
„ 3—1500 to 600 Kc.
„ 4—500 to 250 Kc.
„ 5—200 to 75 Kc.

On Range 4 the aerial should be loaded by 80 pF. There is an i.f. wave trap in the signal grid circuit of the first mixer. Standard type i.f.t. are used with capacity coupling between coils to give a bandpass of 5 Kc. The Colpitts b.f.o. circuit is tuned to 280 Kc. 3 Kc. and second harmonic injection is used.

FAULT FINDING

The following is the official component tests for the points named:—

Components	Test Points	Resistance or Voltage
I.F. Coils:		
L19 P.	V4 anode to R34, C32	2 ohms
L19 S.	V5 grid to R33, C33	
L20 P.	V5 anode to R30, C29	
L20 S.	V6 grid to R29, C30	
L21 P.	V6 anode to R58, C27	
L21 S.	V7 diode to R20, C11	
B.F.O. Coil, L22	Fixed plates C13 to R18	5 ohms
Limiter diode choke L28	V6 diode limiter	130 ohms
A.V.C. choke L25	V7 diodes to C108, R68	130 ohms
L.F. filter choke L29	S5 switch to earth	2,020 ohms
Output transformer L30	(P.) V8 anode to pin 5 power plug	1,528 ohms
	(S.) pin 6 power plug to earth	1,063 ohms
Aerial circuit:		
Range 1 input	V3 grid to C40 junction	less than 1 ohm
„ 2 „		less than 1 ohm
„ 3 „		less than 3.5 ohms
„ 4 „		less than 11 ohms
„ 5 „		less than 78 ohms
V4 input circuit	V4 grid to C37, R38 junction	less than 1 ohm
Range 2	Switch to R2	less than 1 ohm
„ 3	„ „ R3	less than 3.5 ohms
„ 4	„ „ R4	less than 11 ohms
„ 5	„ „ R5	less than 78 ohms
Oscillator anode coil	Range 3—C34, R35 to C75	2.5 ohms
	„ 4—C34, R35 to C74	4.5 ohms
	„ 5—C34, R35 to C73	8.5 ohms
V4 oscillator circuit	V4 osc. grid cond. C35 (ZF12 contact) to joint R35, C34	
Range 1	Switch to R1	infinity
„ 2	„ „ R2	infinity
„ 3	„ „ R3	1,600 ohms
„ 4	„ „ R4	1,650 ohms
„ 5	„ „ R5	0.5 ohm
H.F. Ranges 1 and 2	ZF12 to ZF6, Ranges 1 and 2	0.5 ohm
	Ranges 3, 4 and 5	infinity
Oscillator anode coil taps	ZR6 to C35 or ZR12:	
	Range 1	infinity
	„ 2	infinity
	„ 3	1,600 ohms
	„ 4	1,600 ohms
	„ 5	1.5 ohms
Output transformer	Withdraw meter plug, measure between pin 6 and C93	1,528 ohms
L.T. volts	Withdraw meter plug, measure across plug 4 and 5	6-7.5 volts
H.T. volts	Measure across plug 4 and 6	200 volts
Standing bias: V3, V4, V5, V6	M.F. R12 and chassis. Remote V/C to omni-max.	—3 volts
	H.F. R12 and chassis. Remote V/C to omni-max.	—1.5 volts
D.C. resistance across H.T. pos. & H.T. neg.	Withdraw meter plug, measure between pin 6 and chassis	11,000 ohms
A.F. oscillator	Withdraw meter plug, measure between pins 7 and 8, using A.C. volt ranges	"slow," 28 volts "high," 35 volts
Colour Code Wiring	Red—H.T. positive Yellow—H.T. negative Blue—L.T. positive Green—grids Black—earth.	
Switches	W is aerial input, X is grid V3, Z is grid and oscillator V4.	
Valves	V3 is R.F. amplifier, variable mu tetrode. V4 is 1st mixer, triode hexode. V5 is 1st I.F., V6 is 2nd I.F., V7 is B.F.O. and A.V.C. V8 is detector, output, meter limiter. V9 is meter switching.	