Rebuilding an Ex-RAF RECEIVER, Type 1155

By J. COOK

THE long suffering R1155 receiver has been adapted in many and various ways (vide articles in this magazine and others) but usually, one way or another, the performance and facilities fall short of those associated with the later types of communication receiver, as exemplified by the RCA-AR88, Hallicrafter SX28A or Eddystone 680, etc. Hence it is that, very often, the 'Ham' or short-wave enthusiast eventually scraps his R1155 and divests himself of some of his hard earned cash in purchasing one of these more advanced types of receiver.

In the author's case, however, it was decided that a really first-class communications receiver could be produced at a fraction of the cost using an R1155 as the basis. Moreover, it was considered uneconomic to utilise a separate domestic receiver for local 'quality' reception, so that the same equipment was required to fulfil this function also — despite the difficulty that, normally, communications receivers are too complicated to be operated by non-technical members of the household.

It was thus that the receiver described in this article was evolved. The basis is an entirely re-built R1155 together with ancillary equipment comprising: converter for 5 to 10 metres, TRF unit with simplified control for medium-wave reception, TRF unit for television sound reception, dual speaker unit incorporating filter network and power pack unit supplying entire outfit. Whilst, perhaps, sounding ambitious the equipment can, nevertheless, be built up gradually. In any case, not all the above-mentioned facilities may be desired by the constructor. Economies can be effected, also, by replacing comparative luxuries such as the push-pull output stages by a single output tube, etc.

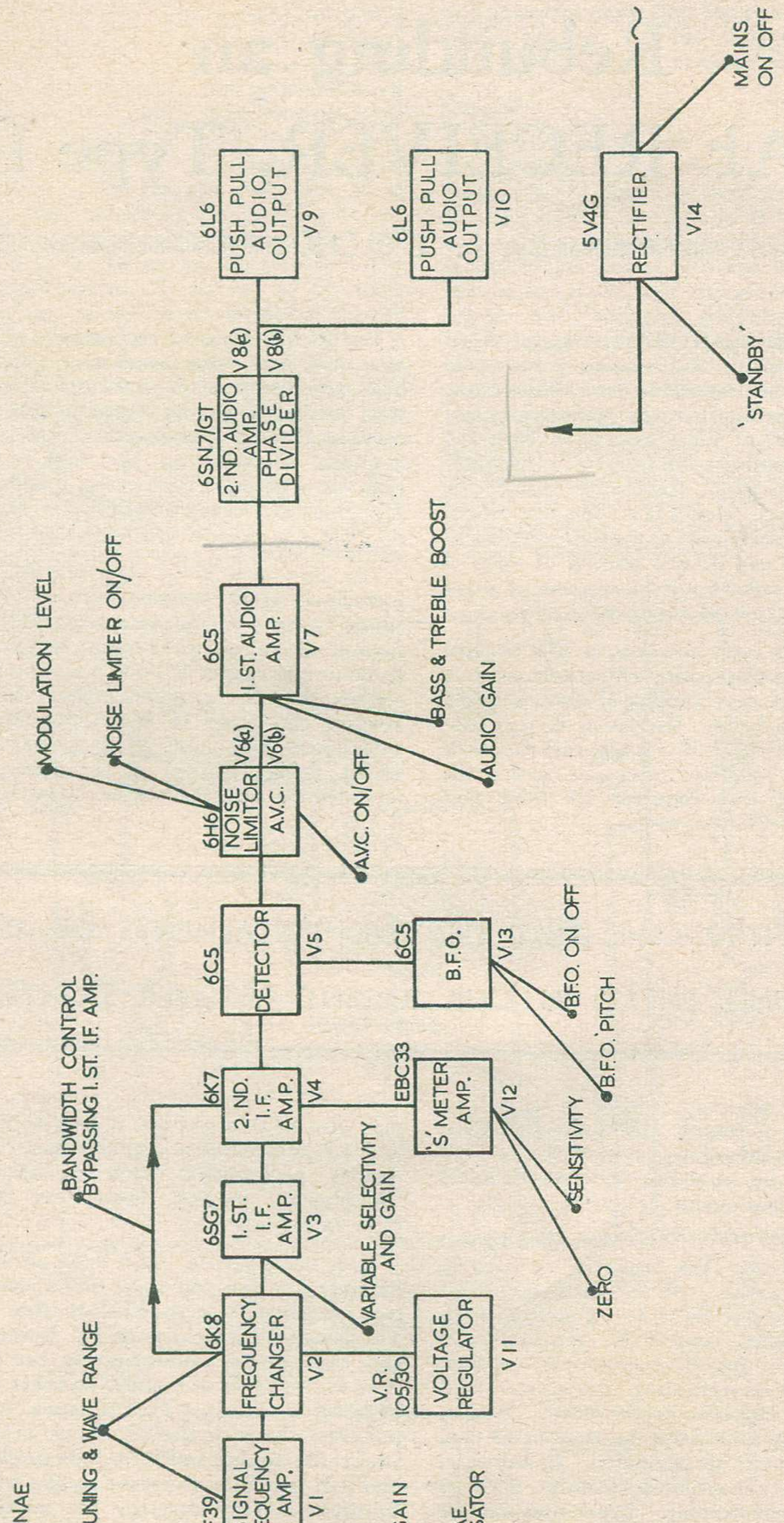
The performance of the completed receiver is of a very high order combining, as it does, the high sensitivity of a communications receiver with the high quality reproduction of a TRF receiver feeding a push-pull Triode, Class 'A,' amplifier. Results on the higher frequencies with the converter unit, using double frequency changing, are exceptionally good also.

PRESENTING THE FIRST OF TWO INSTALMENTS OF THE WINNING ENTRY IN OUR RECENT RECEIVER CONTEST

Construction

The first step is to strip the R1155 chassis mercilessly of all components except the handles, tuning gang with its associated dial and slow-motion assembly, wave-range switch, the three coil units for ranges 3, 4 and 5 mounted above the chassis, the 'Jones' socket nearest the side of the chassis, the three IF coil units and complete sub-chassis coil unit. The latter two items, whilst being retained as a whole, should be modified as described later. The tube holders may also be retained but it may be found easier and advantageous to replace them with better quality components such as those of the 'Amphenol' variety. instead of the paxolin type employed.

It is necessary to cut a hole of the requisite diameter in the top right hand corner of the control panel to accommodate the 'S' meter. The meter illustrated is of $2\frac{1}{2}''$ diameter and, in this case, it was found best to cut the hole as near to the edges as possible in order to clear the adjacent controls. The antenna trimmer is mounted alongside the 'S' meter in the position where the tuning indicator was originally fitted and it is therefore necessary to fit a plate, similar to those already carrying the audio gain and BFO pitch controls, to carry this components. A plate, measuring 6″ x 3″ and drilled for an 1 1/8″ octal tube holder, is required to be fitted



R.C. 678.

Block Diagram showing each stage with associated controls.

THE VALVE LINE-UP

Number on diagram	Function	Tube used (preferred type)	Alternative Type
V1	Signal Frequency Amplifier	EF39	6K7
V2	Frequency-Changer	6K8	ECH35
V3	1st. IF (Regenerative) Amp.	6SG7	
V4	2nd. IF Amplifier	6K7	EF39
V5	Infinite Impedance Detector	6C5	
V6(a), V6(b)	AVC and Noise-limiter	6H6 (metal)	
V7	1st. Audio Amplifier	6C5	6SJ7 (see remarks)
V8(a), V8(b)	2nd. Audio Amp. and Phase Divider	6SN7/GT	
V9, V10	Push-pull, Class 'A,' Triode connected amplifiers	Two 6L6 (metal)	Various
V11	Voltage Stabiliser	VR105/30	
V12	'S' Meter Amplifier	EBC33	6Q7/GT or metal
V13	Beat Frequency Oscillator	6C5	
V14	Rectifier	5V4/G	

to the chassis, below the 'S' meter and in line with the other two tube holders, to carry V8 and the output transformer. Another plate measuring 2 9/10″ x 2 4/10″ is fitted in place of the two 'Jones' sockets which have been removed to accommodate the two antenna input sockets and the two output jacks. Additional holes will be necessary to carry the selectivity, negative-feedback (if required), BFO on/off, HT on/off, noise-limiter bias, SF gain and 'S' meter zero controls. These modifications will be more clearly appreciated from Fig. 1. Dimensions are not indicated as they depend to a great extend on the size of the components used—small components are generally desirable in order to fit them in the available space. A small aluminium chassis, 2 4/10″ x 5″ x 1¼″ is fitted above the receiver deck to house the beat frequency oscillator (in its original position) by means of angle brackets bolted to the existing holes.

It is a good plan to protect the tuning gang with a cover of some sort whilst the above modifications are being carried out in order to avoid the danger of filings lodging between the vanes—such an occurrence would be more than a nuisance! Finally, before the drill is laid aside, a word of warning. In order to avoid confusion between this receiver, when it is operating, and an electric toaster—it is both necessary and desirable to arrange for additional ventilation for the 13 tubes housed in such narrow confines. This can be accomplished easily by cutting a series of holes in two rows in the back and sides; a chassis cutter is a good tool for this purpose. At the same time, the fitment of rubber feet to the base of the cabinet will be found very useful to help clear the many cables under the cabinet, thus making a neat installation.

Before proceeding with the wiring side of the construction, it is assumed that the constructor will adhere to the good rules of radio; *i.e.*, short and direct wiring, substantial earthing, use of heavy gauge wire, etc. Further mention of these points will not, therefore, be made except where especial attention is necessary. It should be noted that neither side of the heater circuit is taken to chassis as a 3-volt potential will now exist between either of these points and chassis due to the centre-tapped transformer used. This arrangement reduces the chances of heater borne hum being introduced as, also, does twisting the heater wires together. These wires must be capable of carrying the load current without any drop as it must be borne in mind that up to 3 amps passes at some points.

Signal Frequency Amplifier and Frequency Changer

These two stages utilise EF39 and 6K8 tubes respectively, their bases being enclosed in the main coil switching unit. Two antenna input sockets are mounted on the front panel; one is provided for use with a long wire antenna whilst a co-axial socket is used for di-pole antenna or converter input. In the latter instance it is absolutely necessary for the input to be properly screened. A series capacitor is included in the antenna input and may be conveniently mounted outside the coil compartment.

The majority of the SF stage components are housed in the smaller of the two compartments and a number of modifications are necessary. The switch wafer, nearest the audio stages, which controls the primary of the input coil should be altered as follows:—

Upper series of contacts: The input from the antenna capacitor is connected to the key contact to feed coils on ranges 3, 4 and 5. Remaining wires are removed.

Lower series of contacts: The key contact is wired to chassis whilst remaining connections are unchanged.

The SFA coils for ranges 3, 4 and 5 are mounted

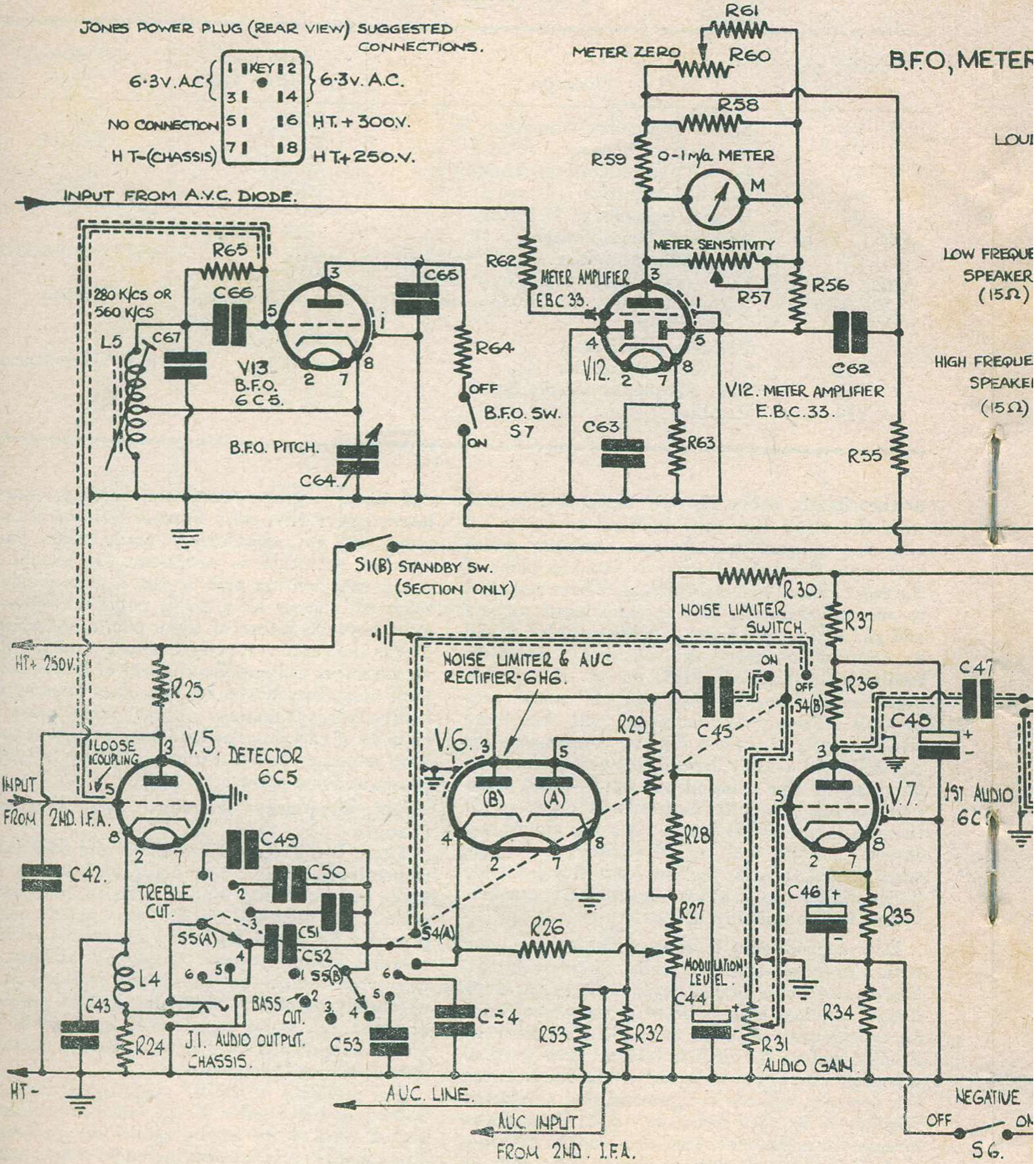
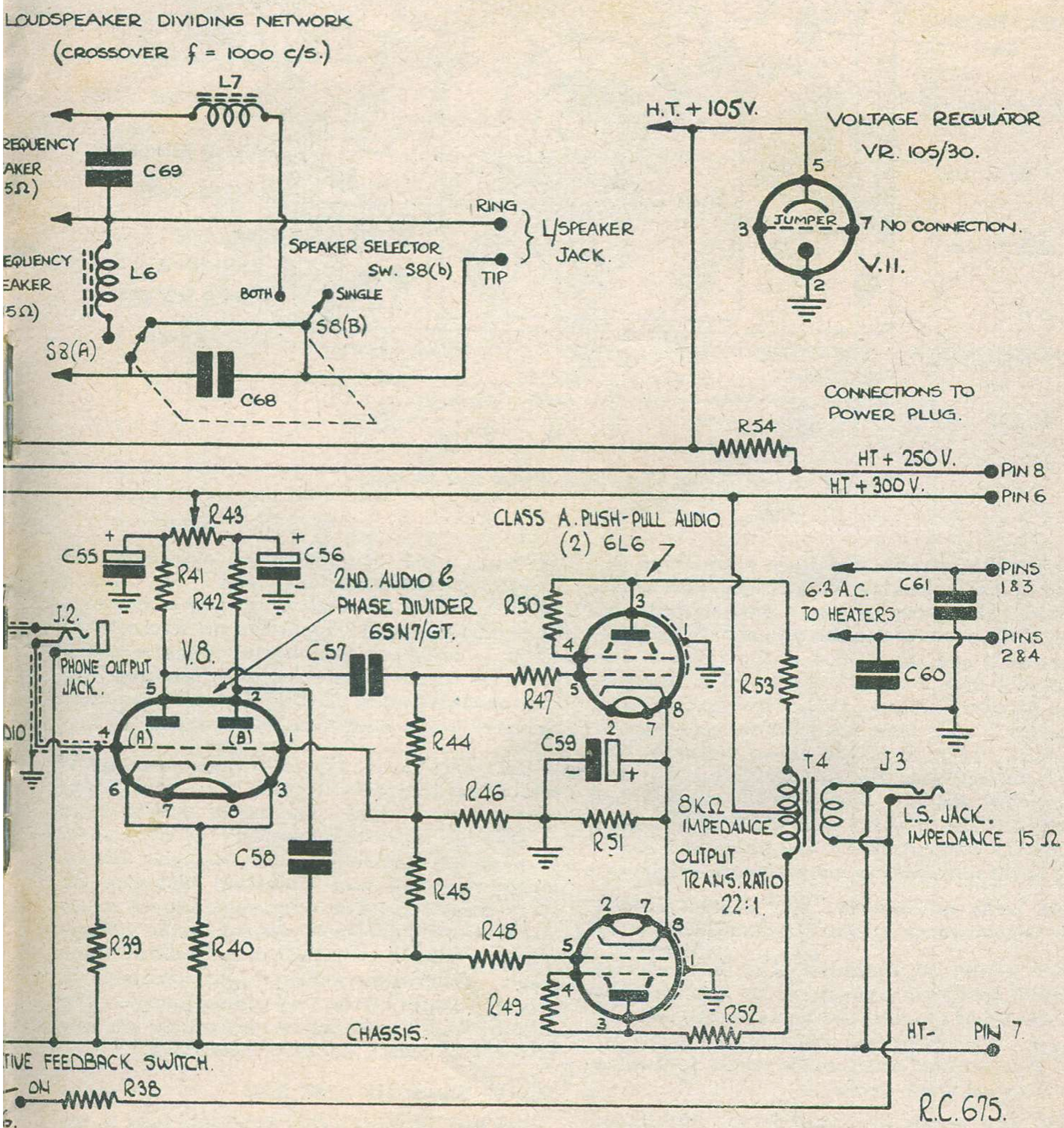


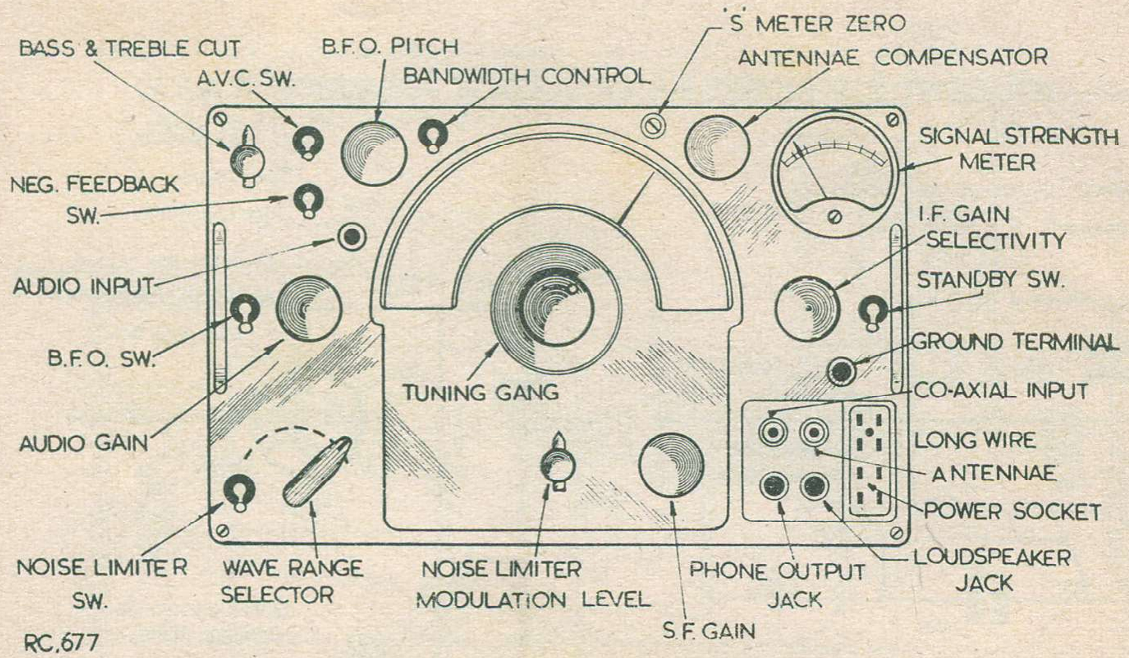
Fig. 2b. Circuit of the BFO, Meter Amplifier, Detector, Noise Limiter, Voltage Regulator, and Audio Stages of the Receiver. Component values are given on page 228. The circuit of the Signal Frequency Section is given on page 227.

TER AMPLIFIER, DETECTOR, NOISE LIMITER, VOLTAGE REGULATOR & AUDIO STAGES.



Frequency Coverage of the Receiver

Range 1	18.5—7.5 *Mcs*	(16.2—40 *metres*)
2	7.5—3.0 *Mcs*	(40—100 *metres*)
3	1,500—600 *kcs*	(200-500 *metres*)
4	500—200 *kcs*	(600—1,500 *metres*)
5	200—75 *kcs*	(1,500—4,000 *metres*)



Showing revised layout of Control Panel (not to scale)

on top of the chassis and their connections are made to pins appearing through apertures in the chassis. The group of three pins nearest the edge of the receiver are the primary connections for range 4 and the nearest of these pins is disconnected from its earthing tag. The opposite three pins are connected to the secondary winding of range 4 and, here, the blue covered wire is removed. In each of the above instances, the corresponding pins for the remaining two LF ranges are similarly treated. No changes are required to the three HF coils which are mounted within the compartment. The alterations necessary to the remaining switch wafer are as follows :

Upper series of contacts : Key contact nearest inter-compartment screen is grounded.

Lower series of contacts : The key contact nearest screen is connected to the antenna capacitor and provides the input for the two HF ranges. Remaining key contact, on the reverse side of wafer, and contacts for ranges 3, 4 and 5 are removed from circuit.

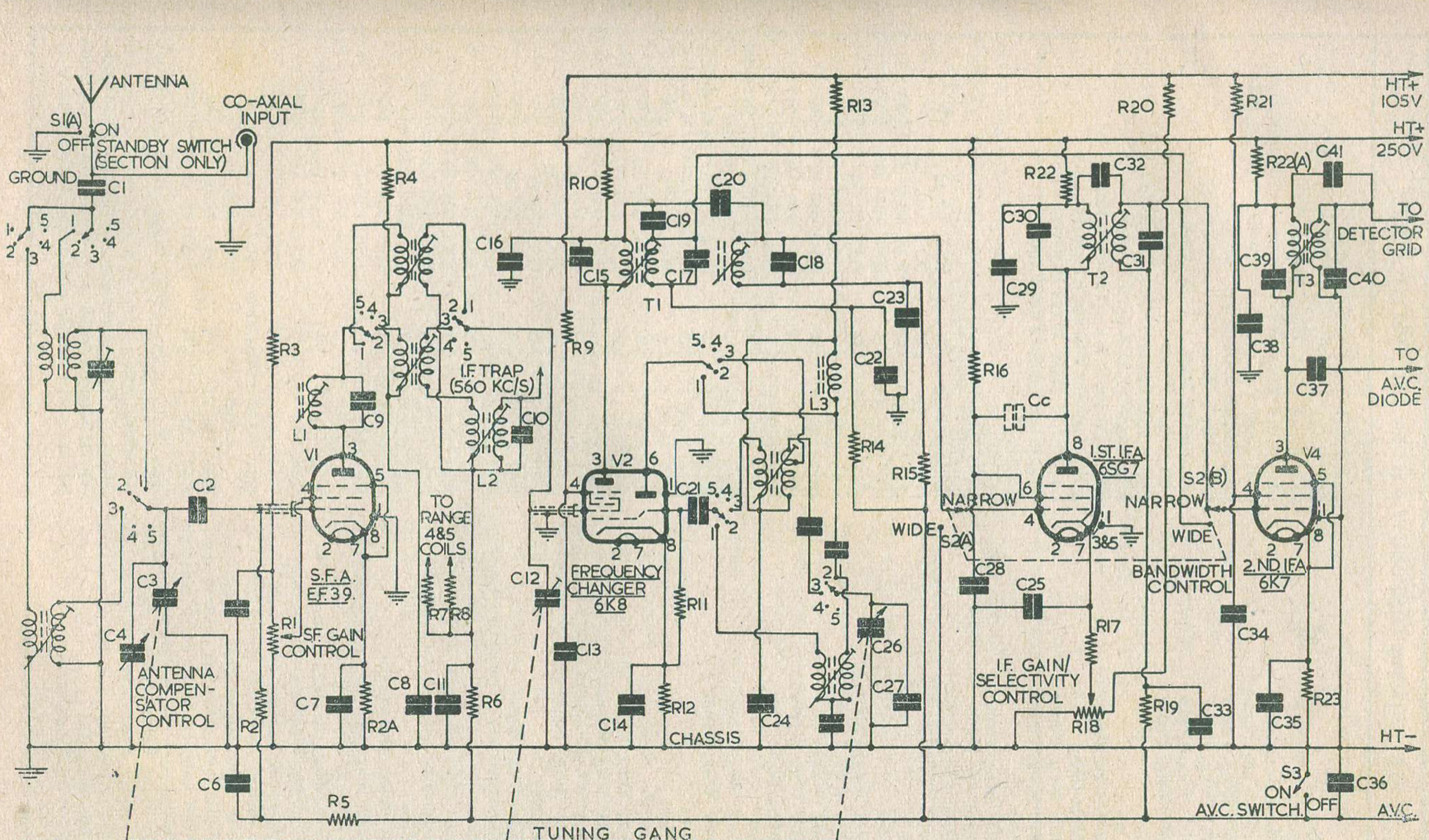
The grid circuit filter unit in the SFA input (mounted on top of the LF range coils) is dispensed with although one component, the 160pF capacitor, is retained to maintain the tracking characteristics and is mounted under the chassis near the appropriate switch wafer. The lead from it to the tube grid is screened. However, the anode circuit filter, mounted in the middle of the larger compartment remains unaltered.

Two controls are provided for this stage. One is the variable antenna compensator C4 located on the front panel and it allows one to trim the SF stage when using different antennaes and also to correct the tracking errors. The other, a variable resistor R1, controls the gain of the stage by regulating the HT applied to the screen of the EF39—a most essential feature when receiving powerful signals to prevent the 'blocking' (or cross modulation) of the first detector (frequency changer) which might otherwise occur.

The triode-hexode type of frequency-changer is retained as the performance is quite satisfactory up to about 14 Mcs. The use of the converter is desirable above this frequency in any case in view of the double frequency-changing (better image rejection) and additional high-gain SF stage employed. The frequency-changer screen and local oscillator anode are fed by the voltage-regulator tube to assist the general stability of the stage. The switch wafers remain unaltered in this, the larger of the two compartments. The biassing and decoupling arrangements are new and will, of course, necessitate rewiring.

The IF Stages (IF—560 Kcs)

The first IF (6SG7) tube is located next to the main coil unit and in line with the SFA and frequency-changer tubes. It is with this stage that the first important departure from the original occurs, for this tube is made regenerative to give a degree of variable selectivity together with its single signal reception properties. This simple device gives very useful results by rejecting, in many cases, unwanted signals which may break through the first tuned circuits. Better results still may be obtained with a crystal filter circuit but the method used saves the considerable



RC676.

Fig. 2a. *Circuit of the SFA, Frequency Changer and two IF Stages. Note: Only coils for ranges 1 and 3 are shown. Coils for ranges 4 and 5 are similar in design to those of range 3, and range 2 coils are similar to those for range 1. Certain switch sections, used to shunt out idle coils, are also omitted in the interests of simplicity, no modifications to the original being necessary in these sections.*

TABLE SHOWING COMPONENT VALUES AND SPECIFICATIONS

Capacitors

C1, 200pF Mica
C2, 160pF Mica
C3, Section Main Gang
C4, 20pF Variable air-spaced
C5, 0.5μF 350V Wkg, Paper
C6, 0.1μF 250V Wkg, Paper
C7, 0.1μF 250V Wkg, Paper
C8, 0.1μF 350V Wkg, Paper
C9, 160pF, Mica
C10, 0.002μF Mica
C11, 0.1μF 250V Wkg, Paper
C12, Section Main Gang
C13, 0.1μF 350V Wkg, Paper
C14, 0.1μF 250V Wkg, Paper
C15, 300pF Mica
C16, 0.1μF 350V Wkg, Paper
C17, 300pF Mica
C18, 300pF Mica
C19, 8pF Mica
C20, 2pF Mica
C21, 200pF Mica
C22, 0.1μF 250V Wkg, Paper
C23, 0.1μF 250V Wkg, Paper
C24, 0.1μF 350V Wkg, Paper
C25, 0.1μF 250V Wkg, Paper
C26, Section Main Gang
C27, 15pF Mica
C28, 0.1μF 350V Wkg, Paper
C29, 0.1μF 350V Wkg, Paper
C30, 300pF Mica
C31, 300pF Mica
C32, 2pF Mica
C33, 0.1μF 250V Wkg, Paper
C34, 0.1μF 350V Wkg, Paper
C35, 0.1μF 250V Wkg, Paper
C36, 0.1μF 250V Wkg, Paper
C37, 50pF Ceramic
C38, 0.1μF 350V Wkg, Paper
C39, 600pF Mica
C40, 300pF Mica
C41, 4pF Mica
C42, 0.5μF 350V Wkg
C43, 250pF Mica
C44, 4μF 500V Wkg, Electrolytic
C45, 0.1μF 350V Wkg, Oil
C46, 25μF 25V Wkg, Electrolytic
C47, 0.1μF 350V Wkg, Oil
C48, 8μF 500V Wkg, Electrolytic
C49, 400pF Mica
C50, 0.002μF Mica
C51, 0.1μF 350V Wkg, Oil
C52, 0.25μF 350V Wkg, Oil
C53, 0.001μF Mica
C54, 0.01μF Mica
C55, 8μF 500V Wkg, Electrolytic
C56, 8μF 500V Wkg, Electrolytic
C57, 0.1μF 350V Wkg, Oil
C58, 0.1μF 350V Wkg, Oil
C59, 50μF 50V Wkg, Electrolytic
C60, 0.5μF 250V Wkg, Paper
C61, 0.5μF 250V Wkg, Paper
C62, 0.1μF 250V Wkg, Paper
C63, 0.1μF 250V Wkg, Paper
C64, 75pF Variable Air-spaced
C65, 0.01μF 350V Wkg
C66, 100pF Mica
C67, 300pF Mica
C68, 7.5μF Paper
C69, 7.5μF Paper
C70, 16μF 500V Wkg, Electrolytic
C71, 8μF 500V Wkg ,Electrolytic
C72, 16μF 500V Wkg, Electrolytic
C73, 0.1μF 500V Wkg, Paper
C74, 0.1μF 500V Wkg, Paper
Cc, See Text

Resistors

R1, 50k Ω variable wire
R2A, 220 Ω ½W
R3, 27k Ω ½W
R4, 2.2k Ω ½W
R5, 100k Ω ½W
R6, 150k Ω ½W
R7, 220k Ω ½W
R8, 220k Ω ½W
R9, 470 Ω ½W
R10, 2.2k Ω ½W
R11, 47k Ω ½W
R12, 270 Ω ½W
R13, 470 Ω ½W
R14, 100k Ω ½W
R15, 100k Ω ½W
R16, 47k Ω ½W
R17, 150 Ω ½W
R18, 2.5k Ω variable wire
R19, 100k Ω ½W
R20, 47k Ω ½W
R21, 470 Ω ½W
R22 and R22(A), 2.2k Ω ½W
R23, 270 Ω ½W
R24, 150k Ω ½W
R25, 22k Ω ½W
R26, 220k Ω ½W
R27, 10k Ω variable wire
R28, 40k Ω ½W
R29, 47k Ω ½W
R30, 30k Ω ½W
R31, 0.5M Ω variable carbon
R32, 1M Ω ½W
R33, 1M Ω ½W
R34, 30 Ω ½W
R35, 6.5k Ω ½W
R36, 100k Ω ½W
R37, 18k Ω ½W
R38, 2k Ω ½W
R39, 560k Ω ½W
R40, 900 Ω ½W
R41, 42k Ω 1W ± 10%
R42, 42k Ω 1W ± 10%
R43, 10k Ω variable wire (pre-set)
R44, 0.25M Ω ½W ± 5%
R45, 0.25M Ω ½W ± 5%
R46, 0.22M Ω ½W
R47, 4.7k Ω ½W
R48, 4.7k Ω ½W
R49, 100 Ω ½W
R50, 100 Ω ½W
R51, 375 Ω 5W
R52, 50 Ω ½W
R53, 50 Ω ½W
R54, 7k Ω 10W
R55, 10k Ω ½W
R56, 50k Ω 1W
R57, 250 Ω variable wire (pre-set)
R58, 600 Ω ½W
R59, 240 Ω ½W
R60, 550 Ω variable wire (pre-set)
R61, 400 Ω ½W
R62, 1M Ω ½W
R63, 1k Ω ½W
R64, 50k Ω ½W
R65, 100k Ω ½W
R66, 1k Ω 10W

Note :Tolerances ± 20% unless otherwise stated.

Switches

S1(A), S1(B), Double pole, Double throw, Toggle.
S2(A), S2(B), Double pole, Double throw, Toggle.
S3, Single pole, Single throw, Toggle.

S4(A), S4(B), Double pole, Double throw, Toggle.
S5(A), S5(B), 2-pole, 6-way, Rotary.
S6, Single pole, Single throw, Toggle.
S7, Single pole, Single throw, Toggle.
S8(A), S8(B), Double pole, Double throw, Toggle.
S9(A), S9(B), Double pole, Double throw, Toggle.

Inductances
L1, L2, L3, As original.
L4, RF Choke, effective at 560 kcs 17.0mH Eddystone.
L5, As original, or 560 kcs coil tapped one-third from grounded end.
L6, L7, 3,400μH, DC resistance < 20 Ω.
L8, LF Choke, 13H at 100mA (DC resistance 200 Ω).
L9, LF Choke, 20H at 100mA (DC resistance 470 Ω).

Transformers
T1, IF Coil modified as per text.
T2, T3, IF Coil as original.
T4, Output transformer, ratio 22:1 (Wharfedale W.12).
T5, Mains transformer, 350-0-350V 200mA, 6.3V CT 5A, 5V 3A (Varley EP60)
T6, Heater circuit, booster transformer—if necessary 6V 1.5A

Miscellaneous
M, Moving-coil meter, 0-1mA FSD, 2½″ flush mounting, 75 Ω.
J1, J2, J3, Jacks.
Note : Specifications and/or types of component used in author's receiver are shown in brackets.

cost of the crystals and gets over the mechnical difficulty of finding space and mounting satisfactorily—not to mention the difficulty of obtaining suitable 560 kcs crystals.

However, this stage is only necessary when high selectivity and sensitivity are required ; this is not normally the case when receiving strong signals for, under such circumstances, this stage of the receiver serves only to suppress the sidebands and introduce distortion which would seriously impair the high-quality performance of which the audio stages are capable of producing. In view of this fact, a switch has been introduced to cut the first IF amplifier out of circuit in order to offer a comparatively wide bandwidth when required. It will be observed from the circuit diagram that an additional 560 kcs coil has been introduced into L3 in order to feed V4 direct when the selectivity switch is in the " wide " position. This coil is mounted between the two existing coils in L3 and should be of a similar type. IF transformers for 560 kcs can sometimes be obtained on the surplus market but if the constructor has difficulty in obtaining this item he is best advised to pile wind a coil on a similar former using the data supplied by an Abac chart or, alternatively, by adapting a standard 465 kcs inductance removing turns by trial and error. All leads to and from the selectivity should be carefully screened and earthed—preferably at each end. The stage is made regenerative by soldering a short length of wire to the plate terminal of the tube socket and running it near the grid terminal. The capacitance, so introduced, is indicated by Cc in the circuit diagram. Regeneration is controlled by reducing the gain of the tube and R18 a variable cathode bias control services this function. The nearer the tube is operated to the point of oscillation, the greater will be the selectivity. Bias voltage is obtained from the voltage regulated line to ensure smooth and constant regeneration characteristics. Incidentally, without the capacitance Cc, the amplifier should be perfectly stable and show **no** tendency to oscillate at full gain.

The second IF stage uses a 6K7, selected because high gain is not necessary at this point and, as indicated above, functions as the sole IF amplifier when the selectivity switch is in the " Wide " position. Screen voltage is supplied from the voltage regulator. The centre tap on the primary of the last IF transformer is not required and the lead may be removed. It will be noted that in this, and the previous stages, the biassing arrangements of the original circuit have been dispensed with and individual cathode biassing is used ; thus the receiver chassis is no longer ' live ' in respect to the power pack chassis.

Detector

An infinite impedance detector (6C5) was chosen because it combines the high signal handling capabilities of the diode detector with low distortion (good linearity) and, like the plate detector, does not load the circuit to which it is connected. An RF choke is included in the cathode lead to suppress any RF which might otherwise appear in the output—this component should, of course, be effective at 560 kcs. The tube base is located alongside the third IF transformer in order to keep the input leads as short as possible.

Beat Frequency Oscillator

As already described, the BFO (6C5) is mounted on a separate chassis which provides increased stability and screening. Coupling to the second detector is by the small capacitance formed by running an insulated wire from the grid of the BFO close to the detector grid prong on the tube socket. Very little coupling is needed for satisfactory operation ; the remainder of the coupling lead must be screened. The oscillator coil may be the original component (tuned to 280 kcs) or a 560 kcs IF coil and should be mounted nearest the front panel with the tube immediately to the rear.

(To be concluded in next issue)