Improving the War-surplus HRO Receiver

By E. H. TROWELL (G2HKU)*

COMPARING the writer's HRO (an old "glass valve" model) with a modern receiver indicated that all was not well with the r.f. gain and signal-to-noise ratio at 14 Mc/s and above. It was therefore decided to modernize the receiver using B7G type miniature valves to obtain reduced length of connecting leads and the improvement in inter-electrode capacities now available in modern valves.

R.F. Valves

The two 6D6 r.f. valves, with their *gm* of 1.6 mA/V, were replaced by a pair of Osram Z77 which have a *gm* of 7.5 mA/V. The resulting increase of r.f. gain was tremendous, so much so in fact, that one could hardly approach the receiver without it "taking off" on its own! A considerable amount of time was spent in endeavouring to overcome this instability by more decoupling and additional screening, without much success. Consulting the General Electric Company's Valve Division with an outline of the work in hand and results obtained, brought forth information that the Osram Z77 was designed as a wide band television amplifier and was thus not considered suitable for use in the HRO r.f. stages.

At this point the National Company of U.S.A. provided the writer with a copy of the latest HRO 60 Instruction Manual together with some helpful advice. This Manual showed that the National Company had chosen 6BA6s for their r.f. valves. Although the HRO 60 layout is, of course, different from the war-surplus models it was decided to rebuild the "front end" in line with the latest design.

Fig. 1 shows the original HRO circuit diagram, which is basically the same for all models using glass or metal valves up to 1946, and the lettering conforms with the Instructional Manual for this series.

Modernization Procedure—R.F. Stages

To commence the modernization unsolder all connections to V1 and V2 and remove the valveholders. Using these as a template mark off two pieces of aluminium sheet and mount a ceramic B7G valveholder complete with screen in the centre of each and position each holder so that pins 1 and 7 are nearest to the coil box. Next, remove the grid top cap connection to each valve and thread the wire back on itself, through the coil box

*4a Clyde Avenue, Sheerness, Kent.

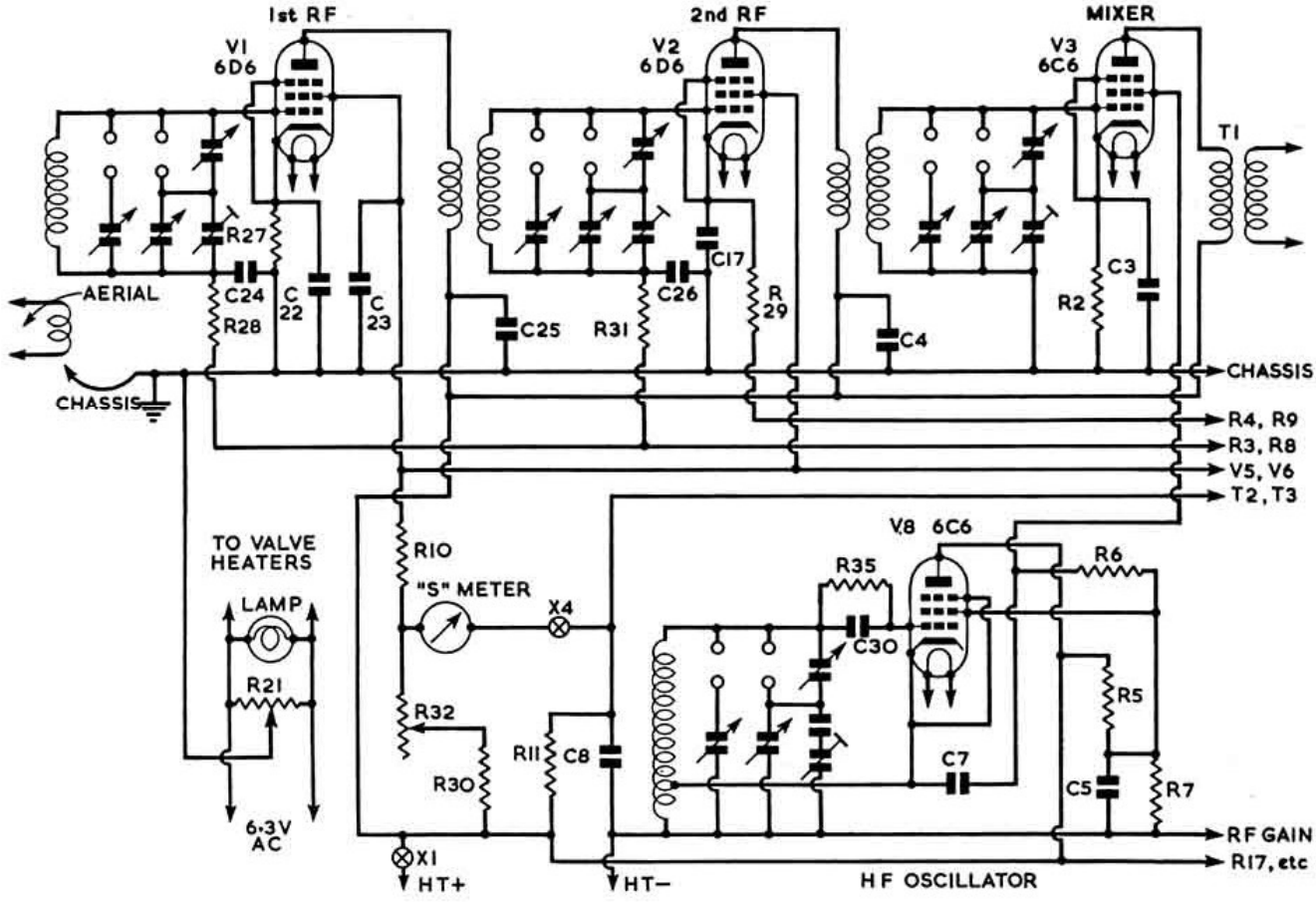

Fig. 1. The original "front end" of the National HRO.

C3, 4, 5, 17, 22, 23, 25, 0.1μF; C7, 24, 26, 0.01μF; C8, 0.25μF; C30, 0.0001μF; R2, 5K ohms; R5, 50K ohms; R6, 7, 100K ohms; R10, 15K ohms; R11, 250-2500 ohms; R21, 64 ohms; R27, 29, 300 ohms; R28, 31, 500K ohms; R30, 0-2000 ohms; R32, 1000 ohms; R35, 20K ohms; T1, crystal filter; X1, h.t. switch; X4, 'S' meter switch. Component designations are the same as in the HRO Manual.

and out of the slot under the chassis adjacent to V1 and V2, and connect to the appropriate pin as shown in Fig. 2.

All fixed condensers should be replaced as the wiring progresses making sure that the connecting wires are as short and direct as possible paying particular attention to condensers CA, CB, CC and CF. The valve base centre pin should be earthed as directly as possible.

During the course of these modifications it was discovered that some existing earth points showed several ohms resistance. Further investigation revealed rust between the shakeproof washers and the chassis, so each earth point was thoroughly cleaned before being used again and new locking washers fitted.

After completion of the new r.f. stages the receiver should be checked for instability, especially above 14 Mc/s. If any is present the physical layout of condensers and resistors can be changed slightly, making sure that grid and anode leads are well separated. A point worth noting here is that the performance of the 6BA6 valves seems to vary with different manufacturers and this variation is, of course, most noticeable on 21 Mc/s and above. Two new 6BA6s of different makes were checked on a valve characteristic meter and one had a higher transconductance than its rated value. This valve caused considerable instability which was cured by replacement with a valve of correct value. There should be a marked improvement in r.f. gain and a check on the r.f. amplifier alignment, as outlined on page 15 of the HRO Manual, should be carried out.

Mixer Stage

Following the HRO 60 line-up it was decided to replace the 6C6 mixer with a 6BE6. This is a valve of interest due to its special structural arrangement whereby a change in signal grid voltage results in hardly any change in cathode current. Hence an r.f. voltage on the signal grid results in negligible modulation of the cathode current. This means very little degeneration or regeneration of the signal input or i.f., output, an important feature in any mixer, especially so in a communications receiver.

A B7G ceramic valveholder, complete with shield, should be mounted and positioned as outlined for the r.f. stages and connected as in Fig. 2. The original 6C6 grid top cap connection should be removed and the wire redressed similar to the r.f. grid leads, taking care to keep it as short as possible.

H.F. Oscillator

Fitting the 6C4 triode (Fig. 2) to replace the 6C6 oscillator in Fig. 1, requires removal of the original valveholder and replacement with a B7G ceramic type, together with the top cap grid connection modification previously described. Particular attention must be paid to short, direct wiring and decoupling condensers.

It will be noted that the mixer injection is taken from the oscillator coil via C7A. The normal practice is to take this injection from the oscillator coil cathode tap via C7 (shown dotted). The reason for using the former

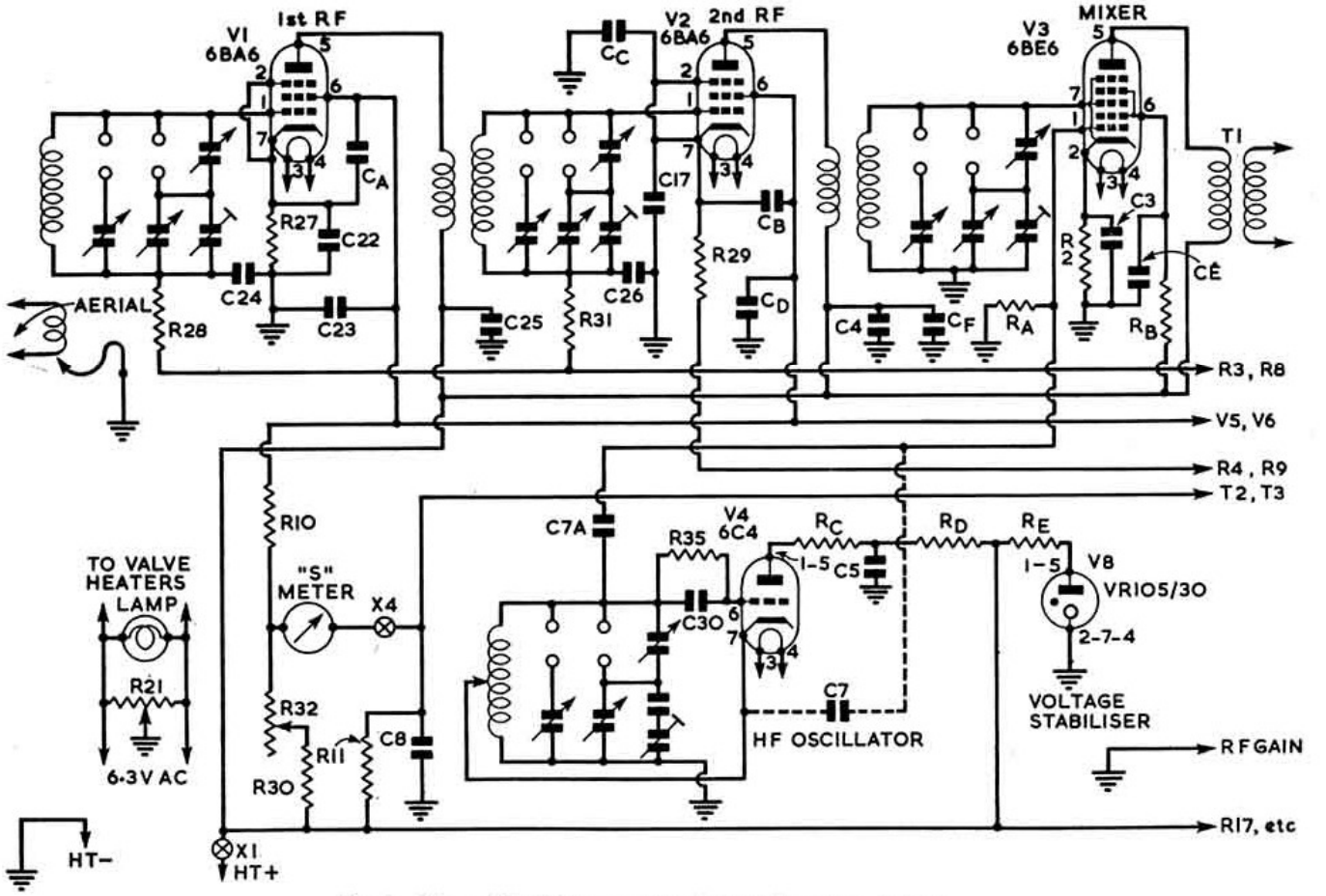

Fig. 2. The modified " front end " of the HRO used by G2HKU.

C3, 7, 24, CE, 0.01μF; C4, 5, 25, 0.1μF; C7A, 10pF; C8, 0.25μF; C17, 22, 23, CD, 0.05μF; C26, CA, CB, CC, CF, 0.005μF disc ceramic; C30, 0.0001μF ceramic; R2, 220 ohms; R10, 15K ohms; R11, 250-2500 ohms; R21, 64 ohms; R27, 100 ohms; R29, 500 ohms; R28, 31, 500K ohms; R30, 0-2000 ohms; R32, 1000 ohms; R35, RA, 22K ohms; RB, 33K ohms; RC, 22 ohms; RD, 2.2K ohms; RE, 5K-8K ohms, 10 watts; T1, crystal filter; X1, h.t. switch; X4, 'S' meter switch.

method is twofold. In the first case taking the mixer injection from C7 resulted in slight "pulling" of the oscillator above 20 Mc/s. Secondly, TVI was present when the HRO was tuned between 14100 and 14300 kc/s. This trouble was reduced by by-passing the heater of the 6C4 to earth with 0.01μF mica condensers but was not entirely cleared. Another means of mixer injection was tried by connecting pin 6 of the 6C4 direct to pin 1 of the 6BE6. This resulted in a clear TV screen but reduced output from the mixer and caused oscillator instability above 16 Mc/s. Using the method shown in Fig. 2, there is no trace of any oscillator pulling, instability or TVI. The value of C7A is about optimum but can be varied if found necessary.

Voltage Stabilizer

The VR105/30 voltage stabilizer (V8, Fig. 2) can be mounted horizontally on a bracket under the chassis either between the oscillator and mixer valves, with its base nearest the coil box, or to the rear of the chassis. If an OB2 miniature stabilizer is available it could be mounted between the oscillator and mixer valves in the normal manner. In this way the heat from it would be kept away from the coil box and oscillator components.

General

Re-alignment of the r.f. amplifier and h.f. oscillator stages should be carried out as described on page 12 of the HRO Instruction Manual. Particular attention must be paid to observing that the h.f. oscillator circuit operates at a higher frequency than the r.f. amplifier. The intermediate frequency is 456 kc/s. Newcomers to the National HRO will find that of the two amateur bands covered by each general coverage coil set, the signal-to-noise ratio will be best on the highest frequency amateur band, i.e., Type JD coil set (covering 1.7 to 4 Mc/s) will be better on 3.5 Mc/s than type JC coil sets (covering 3.5 to 7.3 Mc/s).

Routine voltage checking during the course of this modification revealed that the heater voltage measured *across the valveholders* was 5.9 volts. An adjustment of the mains transformer and the changing of the "S" meter bulb for one of a lower current consumption remedied this minor point.

In conclusion it may be stated that, although these modifications may seem drastic the improvement obtained is well worth the time and trouble spent in carrying them out.

Acknowledgements

Whilst it must not be construed that the National Company are in any way in agreement with these modifications, the writer would like to pay tribute to their kindness and assistance so readily given on various occasions.

Bibliography

The National HRO seems to have attracted much attention in the course of its career and given below is a list of reading matter dealing with various modifications which may prove of some assistance.

"Souping-up a War Surplus HRO," Rockwell (W3AFM), *QST*, February, 1949.

"Modernizing the Pre-war HRO," Windom (W8GZ), *QST*, June, 1949.

"Low Noise Receiver Design," Longerich (W2GQY/4), and Smith (W5LHD), *QST*, March, 1955.

"Pep-up Your Old Receiver," Lorenzen (W3BLC), *QST*, April, 1956.

"H.F. Converter for the HRO," (21 Mc/s converter), Spray (G3FXA), *Short Wave Listener*, February, 1953.

"Some HRO Modifications" (21 Mc/s bandspread), Ward (VQ4FB), *Short Wave Magazine*, December, 1954.

"Modifying the HRO," Hill (G6HL), *Short Wave Magazine*, October, 1948.

"Modifications to the HRO" (A.c.-d.c. operation), Trowell (G2HKU), *Radio Amateur*, September 1953.

"An Improved R.f. Stage for the HRO," Trowell (G2HKU), *Radio Amateur*, November, 1953.

"The HRO and TVI," Varney (G5RV), R.S.G.B. BULLETIN, August, 1949.

"Bandspread on 21 Mc/s for the HRO," Mason (GM6MS), R.S.G.B. BULLETIN, February, 1953.

"Improving the National HRO," Derrick (GM3OM), R.S.G.B. BULLETIN, April, 1955.

Beam Tetrodes as Zero Bias Tetrodes

ALTHOUGH it is now ten years since the original information was released by R.C.A. on the zero bias triode connection of 807s for audio use, no information on the use of other beam tetrodes in this manner has, as far as is known, been published.

Recently a modulator was built using 6L6s connected in this manner—drive was applied to the screen grids with the control grids connected via 20 K ohm resistors. Using 450 volts h.t. and a 6V6 driver valve the output was higher than obtained from normal AB2 operation, and the valves (with speech input) ran cooler.

KT66s have been used with an anode voltage of 600, using the no-choke power supply suggested by GI3ZX for s.s.b. p.a. (R.S.G.B. BULLETIN, April, 1955). Using the same 6V6 driver valve adequate modulation for 150 watts input was easily obtained. The speech amplifier was of course supplied from a well smoothed source.

6V6s have also been tried, using 350 volts h.t. and it seems probable that the system can be used with almost any beam tetrodes normally available.

The requirements in all cases are similar to those of 807s:

(1) High voltage low impedance drive.

(2) Conservatively rated transformers.

(3) A h.t supply for the modulator valves which will cope with a 15 to 1 variation on current with minimum voltage change.—G3IHI.

London Audio Fair, 1957

AUDIO equipment for the high fidelity enthusiast will be shown and demonstrated in luxury surroundings at the 1957 Audio Fair to be held at the Waldorf Hotel, Aldywch, London, W.C.2 on April 12, 13, 14 and 15, from 11 a.m. to 9 p.m. each day. Two floors of the hotel will be used. On the ground floor, manufacturers will display their products in booths, rather like a shop window. The designers of much of the equipment will be available to meet and talk to the public and answer questions. Upstairs in what are normally bedrooms, visitors will be able to hear equipment in operation in ideal surroundings. More than 50 manufacturers of audio gear will be taking part.

Admission to the Fair will be by ticket only, obtainable from any gramophone, radio or music dealer.

Improving the RF26 and 27 Units

MR. R. PALMER (G5PP) states that step 7 in modifying the RF26 and 27 units on page 263 of the December 1956 BULLETIN should have read: "Replace the r.f. stage *screen* resistor with one of 5K ohms."