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VOLUME 13
NUMBER 12
JULY
1960

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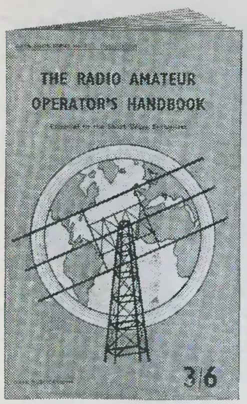

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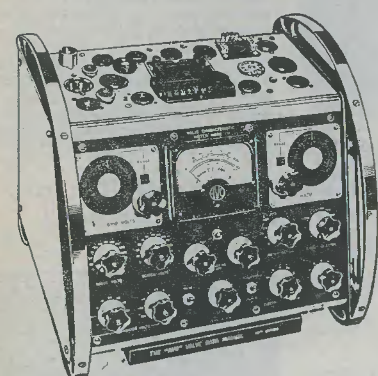

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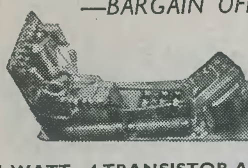

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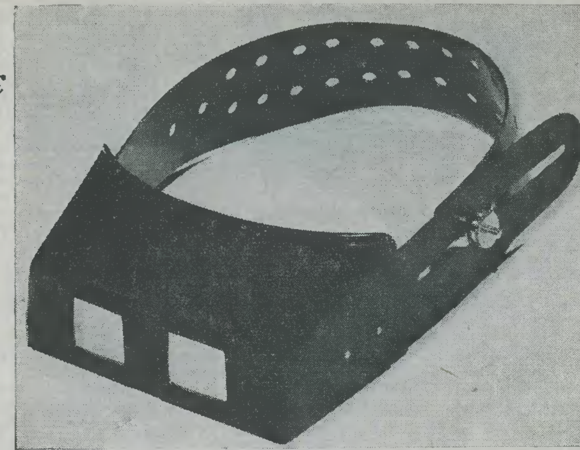

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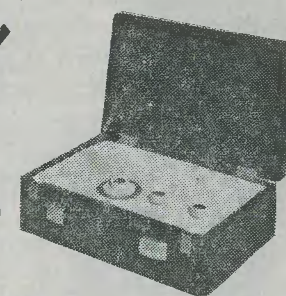

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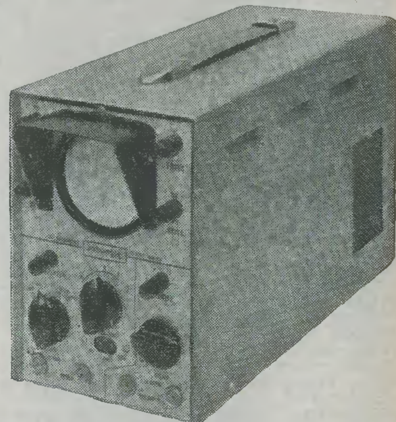

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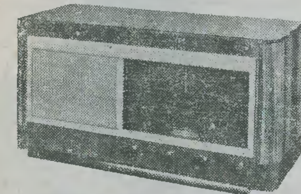

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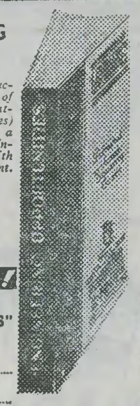

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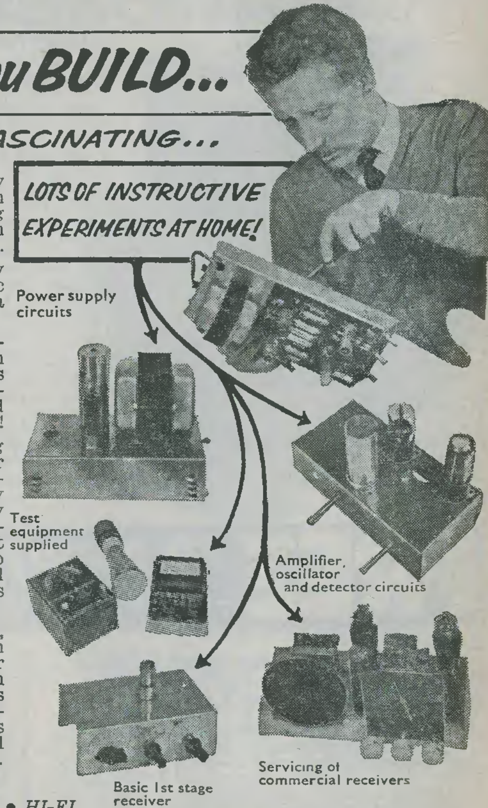

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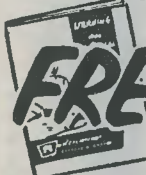

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AVANTIC SPA21 25 watt (per channel) combined Stereophonic Amplifier and Pre-amplifier suitable for direct operation from magnetic Pick-up and high impedance Tape Replay Head. Dimensions $14\frac{1}{2}$″ x 14″ x 4″.
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AVANTIC SP21 Stereophonic Pre-Amp. Control Unit designed for use with the DL7-35 Power Amplifier. Power requirements 6.3V at 1.3A A.C., 250V at 5mA D.C. Dimensions $14\frac{1}{2}$″ x 9″ x 4″.
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AVANTIC PL621 20 watt monaural Amplifier, frequency response 10 c/s-30 Kc/s 1dB. L.S. impedance 4, 8, or 16 ohms. Dimensions 14″ x $8\frac{1}{2}$″ x $7\frac{7}{8}$″.
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AVANTIC BM611 self-powered VHF-FM/MW-AM Radio Tuner, incorporating A.F.C. Ranges: VHF 88-108 Mc/s continuous: M.W.545–1600 Kc/s continuous. Sensitivity: M.W. 20μV for 100mV peak to peak output at 30% modulation: VHF 6μV for full limiting. Dimensions $14\frac{1}{2}$″ x $10\frac{1}{2}$″ x 4″.
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TRADE NEWS. Manufacturers, publishers, etc., are invited to submit samples or information of new products for review in this section.

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suggested circuits

No. 116 An Add-on Vibrato Unit for Guitar Amplifiers

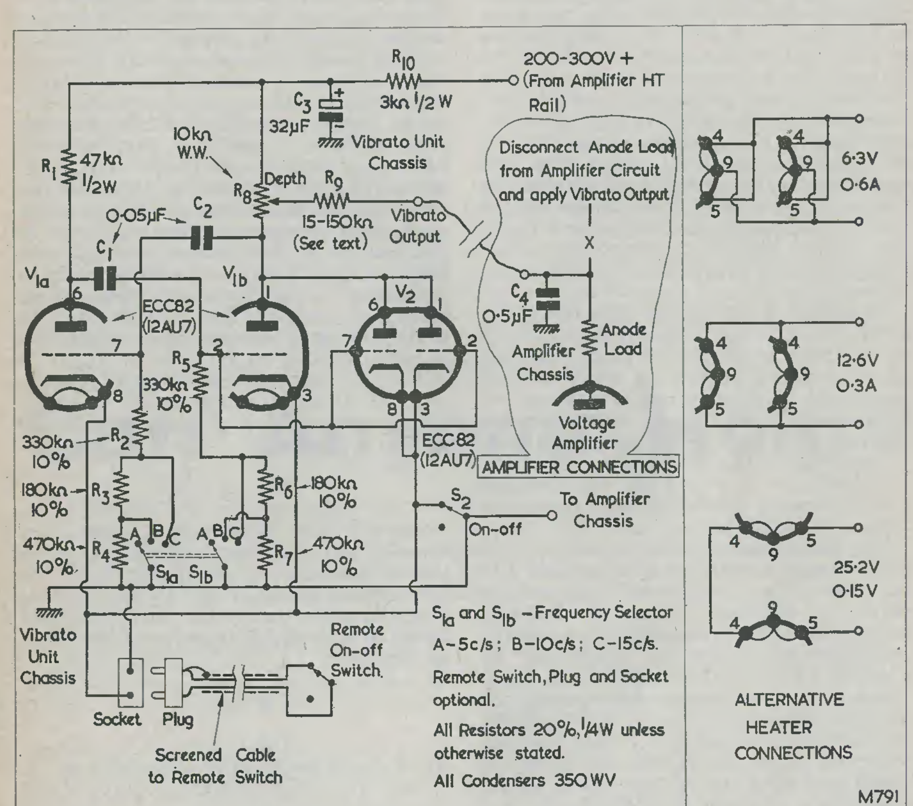
The Circuits presented in this series have been designed by G. A. FRENCH, specially for the enthusiast who needs only the circuit and essential data

The electric guitar, which employs magnetic pick-ups mounted close to the strings so that their vibrations may be amplified and reproduced over a loudspeaker, is a well established member of the present-day range of musical instruments. It has the advantages that the sound provided can be raised to any desired volume level and that, by making use of suitable gain and tone controls, special playing techniques not feasible with a conventional guitar can be executed. It is possible, however, to add yet a further facility to the performance of which the electric guitar is capable, this facility consisting of the introduction of amplitude vibrato in the associated amplifier.[1] The use of vibrato adds a further dimension to the music from the instrument, providing a noticeable brilliance and interest which is not evident with conventional amplification.

This month's article discusses the circuit of an add-on device which is capable of being fitted to most guitar amplifiers and which provides vibrato at three differing frequencies at a continuously variable depth. The device functions by varying, at the vibrato frequency, the anode supply potential of an early voltage amplifier valve in the guitar amplifier, thereby modulating the amplitude of the signal which the valve handles. In order to check the principle of operation, the prototype unit was tested by coupling it to a voltage amplifier valve in a typical amplifier reproducing guitar music. The unit was found to work efficiently, providing at its full depth control setting a vibrato level considerably greater than would normally be required. At lower depth control settings the effects produced by the vibrato unit were, to the writer's aural sense, of a particularly pleasing quality.

Ideally, the vibrato unit should be coupled to a valve which is outside any negative feedback loop which may be present in the associated amplifier. In practice, however, the unit will function satisfactorily if the valve to which it connects happens to be inside a loop, provided that the feedback involved is not of a very high order. So far as the writer is aware, it is doubtful if the feedback level in the average guitar amplifier would be sufficiently high to prevent the unit from operating with adequate results. (The voltage amplifier valve to which the prototype unit was connected during test was within a feedback loop.) The technical correctness, or otherwise, of amplitude modulating a valve within a feedback loop represents an argument which is qualified by the fact that a musical instrument amplifier is not in the same category as a straightforward high fidelity amplifier, in the sense that the function of the latter is to reproduce signals which have been originated elsewhere.

The vibrato unit should be constructed in the form of a small add-on unit obtaining heater and h.t. power from the guitar amplifier. The vibrato frequency and depth controls are mounted on the chassis of this unit. The unit can be brought into operation by an on-off switch mounted on its chassis, or by a remote on-off switch. If the latter is employed, vibrato can be turned on and off with the aid of a foot-operated switch, or a switch fitted to the guitar itself.



The Circuit

The circuit of the add-on vibrato unit accompanies this article. The basic oscillator which provides the vibrato frequency consists of a square wave multivibrator, in which $V_{1(a)}$ forms one triode and $V_{1(b)}$, in parallel with both sections of V_2, the other. Feedback is provided in conventional fashion by C_1 and C_2, whilst $S_{1(a)}$ and $S_{1(b)}$ switches differing values of resistance into the condenser discharge circuits in order to provide varying running speeds for the multivibrator.

The reason for having $V_{1(b)}$, and the two sections of V_2 in parallel, is that the relatively heavy combined anode current drawn by these three triodes ensures the existence of a high change in anode potential between one half-cycle and the next, whilst allowing the use of the low-value series resistor, R_8. It is necessary for R_8 to have a low value because it passes the anode current of the controlled valve in the guitar amplifier. The circuit, as shown, should function with all voltage amplifier valves likely to be encountered, even when such valves draw currents of the order of 4mA or so. (In some instances where the voltage amplifier valve draws a low current it may be possible to dispense with V_2. This point is discussed later.)

The varying voltage on the anodes of $V_{1(b)}$ and V_2 forms a square wave, and this is integrated by R_9 and C_4 before being applied to the anode load of the voltage

[1] Controlled vibrato is the main feature in the "Vibromajor" musical instrument amplifier system manufactured by Grampian Reproducers Ltd. The "Vibromajor" was introduced at this year's London Audio Fair.

amplifier. The value of R_9 is experimental, since it controls the depth of the vibrato modulation as well as the amount of integration given to the square wave. It would be advisable to commence with a value around 30kΩ, increasing or decreasing this in the light of experience. A variable panel control of depth is provided by potentiometer R_8, its slider tapping off a square wave of the desired amplitude.

It is intended that h.t. for the add-on vibrato unit be obtained from the smoothed h.t. line in the amplifier. Since the unit draws approximately 7mA at 200 volts and 11mA at 300 volts, it is advisable to avoid connecting to any decoupled h.t. points which are fed via relatively high values of series resistance. The filter C_3, R_{10}, which prevents the appearance of the square wave on the amplifier h.t. line, serves the secondary function of providing additional h.t. decoupling and smoothing for the controlled voltage amplifier valve. In most cases, best results will be given by connecting the vibrator unit to the h.t. supply line in the amplifier which immediately follows the smoothing choke or resistor.

As shown in the diagram, the end of the controlled valve anode load resistor which is remote from anode should be disconnected from its supply point (and any associated decoupling condensers) and re-connected to the upper plate of C_4. C_4, apart from the function it performs in the integrating filter, will then operate as a decoupling condenser. C_4 should be mounted on the amplifier chassis close to the anode load resistor to which it connects.

The only remaining parts of the circuit to discuss are the switching arrangements. As has already been mentioned, $S_{1(a)}$ and (b) switch in different values of discharge resistor, thereby varying the frequency of the multivibrator. Switch S_2, which may be mounted on the add-on unit chassis itself, disables the multivibrator by opening the cathode connection to all four triodes. Alternatively, a remote switch employing the plug and socket connections shown in the circuit may be fitted. If the remote switch is used, it is advisable to fit the double-core screened cable (with screening earthed at the unit end only), as shown in the diagram, this guarding against the possibility of pick-up of the multivibrator pulses by the amplifier input lead.

Multivibrator Frequencies

The three frequencies selected by $S_{1(a)}$ and (b) (5, 10 and 15 c/s), are nominal and may vary slightly with different valves owing to spread of cut-off voltage. In order to assist readers interested in selecting other frequencies, the component values in the multivibrator circuit are calculated in the following manner.

The multivibrator is nearly symmetrical and it is sufficient to discuss the method of finding the values for one side only, such values then being repeated on the other side. A suitable choice for demonstrating the method of calculation is given by considering C_2 and its associated discharge resistors. The time occupied by the half-cycle in which $V_{1(a)}$ is cut off is equal to the time taken for C_2 to discharge such that the grid of $V_{1(a)}$ rises just above cut-off. At the instant at which $V_{1(a)}$ cuts off, C_2 carries a charge equal to the applied h.t. potential. When $V_{1(b)}$ (and its parallel triodes) conducts, its anode falls to a potential controlled by the value of R_8 and the anode current of the valves. For an h.t. potential of 225 volts (corresponding to some 250 volts applied to R_{10}) the anode of $V_{1(b)}$, when conducting, is 65 volts (measured on the prototype) above chassis. Thus, the left-hand plate of C2 falls, at the moment of change-over from one valve to the other, to 225 minus 65 volts (=160 volts) below chassis. The potential on the left-hand plate then rises as the condenser discharges through R_8 and the grid leak of $V_{1(a)}$, the next half-cycle commencing when the potential reaches cut-off level in $V_{1(a)}$. At 225 volts anode potential the latter is of the order of 20 volts (from published curves).

The discharge time of a condenser into a resistor is given by

$$t = CR \log e \frac{E_1}{E_2}$$

where t is time in seconds, C and R are capacity and resistance in farads and ohms (or microfarads and megohms), E_1 is the commencing potential and E_2 the finishing potential across the resistor. In this instance E_1 is 160 volts and E_2 is 20 volts, whereupon we may say:

$$t = CR \log e \frac{160}{20}$$

$$\sim CR.2$$

At 15 c/s the length of time occupied by t is $\frac{1}{30}$ sec. (i.e. a half-cycle) or 0.033 sec. We may, therefore, say:

$$0.033 \sim CR.2$$

$$\therefore CR \sim 0.0165.$$

Suitable values to obtain this product of C and R are 0.05μF and 330kΩ, and such values are employed in the circuit for C_2 and R_2 (the latter forming the grid leak of $V_{1(a)}$ when $S_{1(a)}$ is in the 15 c/s position). The high resistance employed in the grid leak makes it possible to ignore the relatively low value of R_8, through which C_2 also discharges.

The calculated values for $V_{1(a)}$ grid leak for 10 and 5 c/s operation are 500kΩ and 1MΩ respectively. The preferred values shown in the diagram for R_3 and R_4 give grid leak resistances of 510kΩ and 980kΩ for the appropriate positions of $S_{1(a)}$, such values being sufficiently close to the calculated values for practical purposes.

Installation

The vibrator add-on unit may be mounted at any convenient point close to the associated guitar amplifier. Unless it is entirely screened, the unit should not, however, be allowed to approach the input stage wiring too closely, or pick-up of the square wave pulses may occur. Apart from C_4 and the remote on-off switch, all the components shown in the diagram should be mounted on the add-on unit chassis.

As was stated above the value of R_9 is experimental, it being recommended that a value of some 30kΩ be used initially. For smoothest vibrato, R_9 should be given a value which is sufficiently high to allow the greatest vibrato depth desired to be obtained at all multivibrator frequencies when R_8 is nearly fully advanced. With some amplifiers it may be found that more than sufficient vibrato depth is available even when R_9 has the maximum value of 150kΩ specified in the circuit. When this occurs it is possible either to increase R_9 above 150kΩ or to dispense with V_2 and find a new, lower, value for R_9.

Currents and Voltages

In concluding, it will be helpful to list the currents and voltages applicable to the unit. Some of the figures given here have been referred to above.

The heater requirements of the unit are 6.3 volts at 0.6A, 12.6 volts at 0.3A, or 25.2 volts at 0.15A, according to the manner in which the heaters are connected. When connected in a series chain the highest heater potential above chassis should not exceed 150 volts.[2]

The h.t. requirements of the unit, as measured on the prototype, are 7mA at 200 volts and 11mA at 300 volts.

For an input voltage of approximately 250, the anodes of $V_{1(b)}$ and V_2 change from 225 volts in the non-conductive state, to 65 volts in the conductive state. These figures were obtained from the prototype with no controlled valve connected.

[2] The maximum limiting heater-cathode voltage quoted by Mullard for the ECC82 is 180 volts, and the 150 volt figure assumes a maximum cut-off potential, allowing for spread, of 30 volts. This potential would be assumed by the cathodes above chassis when the on-off switch is opened.

Can Anyone Help?

Requests for information are inserted in this feature free of charge, subject to space being available. Users of this service undertake to acknowledge all letters, etc., received and to reimburse all reasonable expenses incurred by correspondents. Circuits, manuals, service sheets, etc., lent by readers must be returned in good condition within a reasonable period of time.

Transformer Paper and Empire Cloth.—C. J. Baker, 17 Ferndale Road, Thurmaston, Nr. Leicester, wishes to locate a firm willing to supply him with small quantities of these materials. These are required for inclusion within two self-constructed output transformers.

* * *

Admiralty Receiver P104.—S. R. Hardcastle, Rigton Grange, East Keswick, Nr. Leeds, requires information on converting this crystal controlled receiver to variable tuning covering the 2 metre Amateur Band.

* * *

Admiralty Receiver P104.—F. B. Mawbey, "Cambria", Westdene Avenue, Allenton, Derby, would like to receive details of the range of crystals required for this receiver also the circuit and operating instructions.

* * *

Advance Signal Generator Type B3-C and BC221-T.—Rev. M. D. Phillips, O.S.B., Science Dept., Ampleforth College, York, would be very grateful if any reader could supply him with the circuit and instruction data for these two instruments.

* * *

Circuit for Portable Mains TV.—S. A. C. Gregory, G.R.S.F., R.A.F. Waddington, Lincoln, Lincs, wishes to obtain details or a circuit diagram of such a t.v. receiver using all miniature valves and a 1CP1, or similar, c.r.t. (If any reader has constructed a design of this nature the Editor would also be greatly interested.)

AP2548A Vol. 1—T1154/R1155.—R. F. Taylor, 103 Shakespeare Road, London, W.3, would like to obtain the above instruction manual, willing to purchase.

* * *

S38C Hallicrafter Receiver.—E. G. Hudson, 7 Porchester Road, London, W.2. would like to borrow or purchase the circuit and manual of this receiver.

* * *

Decca Radiogram No. 45387/6.—K. J. Bland, 144 Southchurch Road, Southend, Essex, wishes to borrow or purchase the manual and circuit of this radiogram. Valve line-up is MV14, 7D8, 10D1, 9D2, 9D2 and 15D2.

* * *

Bendix Receiver Type RA10-DA.—D. Kane, 9 Derrychara Drive, Enniskillen, N. Ireland, wishes to obtain the circuit and manual of this equipment. Can exchange photostat of the CR100 circuit.

* * *

Bendix Receiver Type RA10-DA.—E. Ferbrache, "Penpol", Saumarez Road, Castel, Guernsey, Channel Islands, would like to obtain the circuit and manual together with any details of modifications to the coil pack for Amateur Band coverage.

* * *

McMurdo Silver Corporation Receiver 15-17.—E. A. Bilton, 26 Beulah Hill, London, S.E.19, would like any details of this receiver which has 6 wavebands covering from 7 to 2,000 metres continuous, b.f.o., and a 15 valve line-up.

UNDERSTANDING TELEVISION

PART 30

By **W. G. MORLEY**

The thirtieth in a series of articles which, starting from first principles, describes the basic theory and practice of television

In last month's contribution in this series we discussed line linearity controls, and described in detail deflector coil assemblies as employed in domestic television receivers. The available space did not, however, allow us to complete our consideration of this subject and the current article commences by dealing with assemblies employing "castellated" cores. After this we carry on to picture distortion caused by ringing in the line output stage.

"Castellated" Core Assemblies

During the time that 70 degree tubes were employed in this country, deflector coil assemblies of the type we have just considered were discontinued by many manufacturers owing to the simpler construction offered by assemblies employing "castellated" cores. Fig. 181 illustrates the construction of an assembly employing "castellated" cores. The method of assembly here consists of fitting two sets of rectangular-shaped coils (one set for line and the other for frame deflection) into the slots of the core. The ends of the coils are then, by means of suitable forming jigs, bent round so that the assembly may be fitted over the neck of the cathode ray tube. The front ends of the coils are, also, usually given a slight flare in order that the assembly can be positioned well forward. Due to the use of "castellated" cores, whose teeth bring the source of deflecting field close to the neck of the tube, much less care has to be taken with coil shaping; and this fact is of considerable advantage in manufacture. Deflection coils using "castellated" cores were largely discontinued when 90 degree cathode ray tubes were introduced, owing to the difficulty of bringing the cores in the assembly sufficiently far forward to obviate corner cutting.

In nearly all recently manufactured deflection yokes, whether of the type shown in Fig. 177 (*a*) or Fig. 180, the cores employed are made of Caslam, Ferroxcube or Ferramic.[1] When rings of the type shown in Fig. 177 (*b*) are made from Ferroxcube or Ferramic, they are normally manufactured in the form of a complete ring which is then broken into two halves by cracking at opposite points. Frequently, V-forms, at 180 degrees to each other, are moulded into the ring during its manufacture to ensure that subsequent cracking occurs at the desired points. The two halves of a cracked ring have to be kept together, and are employed together in the completed deflector coil assembly. Very early versions of the assembly of Fig. 180 did not employ Caslam or ferrite cores. Instead, iron laminations were employed, or a core was provided by winding many turns of insulated soft iron wire around the coil assembly. "Castellated" cores were normally manufactured using Caslam or Ferroxcube.

The frame deflector coils on early 90 degree versions of the assembly of Fig. 177 (*a*)

[1] These materials were briefly discussed in "Understanding Television", part 27, April 1960 issue.

were almost always wound on formers which were then fitted over the two half-rings of the core. Later versions (notably those employed for 110 degree deflection) have the frame coils wound direct on to the magnetic material itself.

Series or Parallel Connection

The pairs of line and frame coils employed in practical deflector coil assemblies may be connected in series or in parallel, according to the requirements of design. The series method of connection has the slight advantage that both coils of a pair must pass the same current whereupon, given equal turns, the deflecting forces offered by each must be equal. If, on the other hand, two coils of equal turns are connected in parallel, it is possible for different coil resistances (due to varying winding wire diameters) to cause more current to flow through one coil than through the other, and the deflecting forces become unequal in consequence.[2] In practice, however, parallel-connected sets of coils are used quite frequently, without the introduction of too many difficulties on this count.

Bonding Wire

The wire employed in flared line coils is almost always of the bonding type. Bonding wire employs a conventional enamel insulation over which is applied an additional outer covering, approximately 0.0005in thick, of a thermosetting resin, or glue.[3] A coil employing bonding wire is wound in a mandrel which gives it the required shape (or is shaped in a jig after winding). A current is then passed through the wire of the coil in order to raise its temperature; and this causes the resin covering to flow slightly and to "cure". When the coil is cooled, after this process, the resin is set hard, with the result that the coil is "bonded" in the required shape. Occasionally, bonding wire is employed in the frame coils, as well as the line coils, of assemblies such as that of Fig. 180 in order to improve their rigidity. Some manufacturers of "castellated" core deflector coil assemblies used bonding wire for the line coils (providing them also with a marked flare at the forward end) but this practice was not common.

Velocity Modulation

We have, earlier, discussed the fact that shock excitation of the leakage reactance in the line output transformer can cause ringing to occur in its windings, the result of which is that an alternating current at the ringing frequency is superimposed on the sawtooth current applied to the line deflector coils.[4] The ringing current has highest amplitude immediately after the shock excitation of the flyback period, this amplitude reducing as the scan period progresses. We shall now consider the visible distortion on the reproduced picture caused by such ringing currents.

Fig. 182 (*a*) illustrates the waveform of a

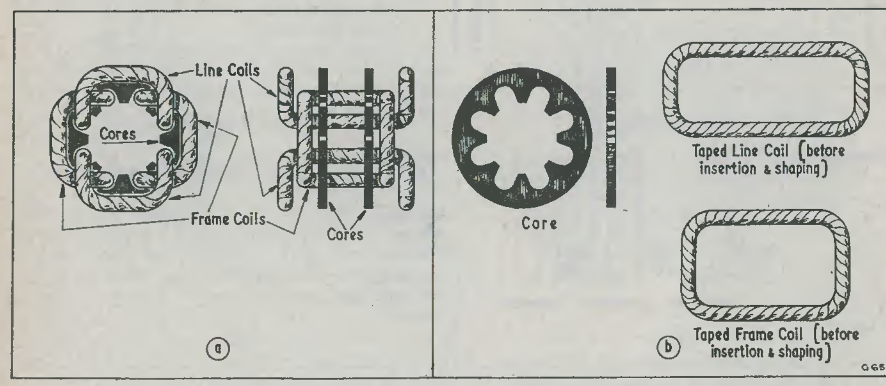


Fig. 181 (a) A deflector coil assembly employing "castellated" cores. A circular clamp, not shown here, would be fitted around both cores to make the assembly rigid. (b) The main component parts of the deflector coil assembly of (a)

[2] Unequal resistances are liable to cause more difficulty in frame deflector coils than in line deflector coils due to the lower frequency of the applied frame sawtooth current. The impedances offered by line deflector coils (at line frequency) contain a large reactive component which will tend to mask dissimilar resistances.

[3] The term "thermosetting", as opposed to "thermoplastic", defines the ability of a material to "cure", or become permanently hard, with the application of heat. Thermoplastic materials soften with the application of heat and may be moulded into new shapes, which they retain on cooling.

[4] "Understanding Television", part 27, April 1960 issue.

sawtooth current, as would be applied to the line deflector coils, with a ringing current superimposed. It will be of interest to examine in detail the exact effect produced by the ringing frequency on a single line of the reproduced picture. Fig. 182 (*b*) shows the first part of the sawtooth waveform, where ringing current amplitude is at maximum, with various points identified by reference letters. If we examine the waveform of Fig. 182 (*b*) between points A and B we see that the deflection current is changing at a greater rate than the average rate of change for the whole waveform. Between points C and D, on the other hand, the rate of change of deflection current is slower than the average. Between points E and F the rate of change of deflection current is, once again, greater than the average; whilst, between points G and H it is, once more, less than the average. The effect is repeated for the sections between points J and K, and L and M, respectively, and continues for further cycles at the ringing current until the amplitude of the latter becomes so small as to be negligible. In the diagram the first cycle of the ringing current causes the greatest alteration to the rate of change of deflection current, and the alterations in rate of change reduce progressively as the scan period advances.

The effect of the ringing current on the motion of the spot tracing out the line on the cathode ray tube screen is illustrated in Fig. 182 (*c*), the reference letters in which correspond to those in Fig. 182 (*b*). Between points A and B the rate of change of deflection current is greater than the average, with the result that the velocity with which the spot traverses the screen between these two points is similarly greater than average. Between points C and D the rate of change of deflection current is lower than the average, and spot velocity falls below average velocity in consequence. The same effects appear between points E and F, G and H, J and K, and L and M, the velocity of the spot as it traverses the screen being alternately increased and decreased.

It will be observed that the spacings in time between the pairs of points A and B, C and D, etc., are all equal. Since, therefore, between points A and B the spot travels more quickly than the average, it will cover

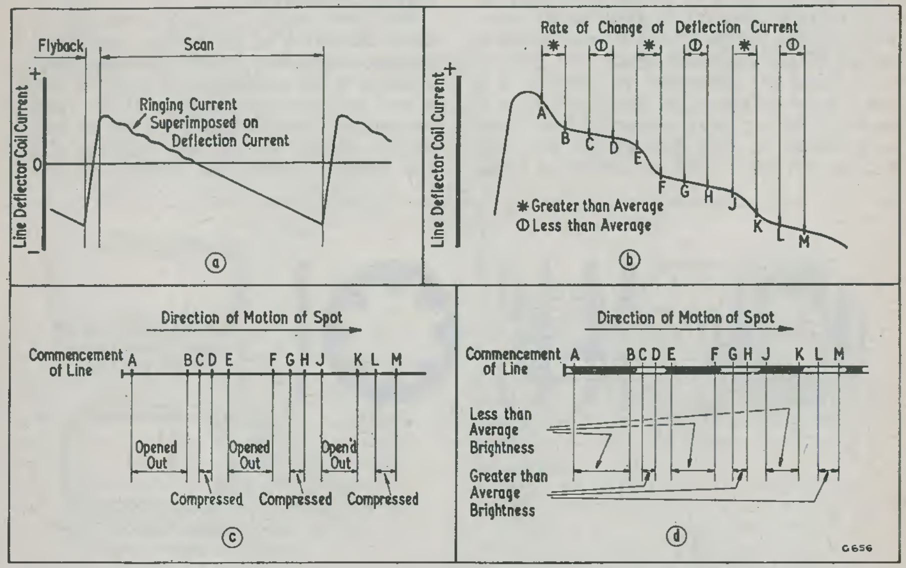


Fig. 182 (*a*) *A ringing current superimposed on the line deflection current.* (*b*) *When the superimposed ringing current is examined in close detail, it can be seen that it varies the rate of change of deflection current at the ringing frequency.* (*c*) *Variations in rate of change of deflection current cause corresponding changes in spot velocity, with the result that alternate sections of the line are "opened-out" and compressed.* (*d*) *When the spot travels at greater than average velocity it causes less excitation of the screen phosphors than occurs when the spot travels at slower than average velocity. The resultant effect is shown here*

a greater distance than the average for the period of time concerned. Also, since between points C and D the spot travels slower than the average, it will traverse a smaller distance than the average for the period of time concerned. Fig. 182 (*c*) demonstrates this state of affairs, indicating that between points A and B the line is "opened out" whilst, between points C and D, it is compressed. Similar results are shown, also for points E and F up to L and M, the alternate expansions and compressions reducing as the scan period advances.[5] (Fig. 182 (*c*) may, perhaps, give the impression that, along the line, there are instants of sharp transition from faster than average to average velocity, and from average to slower than average velocity, but this is not, of course, true. In actual fact, the changes from faster than average to average, and from average to slower than average within the ringing cycle are gradual, these following the alteration in rate of change of scanning current shown in Fig. 182 (*a*).

Since the ringing current superimposed on the deflection current varies the velocity of the spot as it traverses the cathode ray tube screen, the process is described as *velocity modulation* of the scan.

The visual result of velocity modulation due to line output stage ringing on the reproduced lines of the picture is most evident when the area over which the modulation takes place is at a constant contrast level. It will be similarly evident on a blank raster.[6] The effect on a single line is illustrated in Fig. 182 (*d*), this diagram retaining the same reference letters as were used in Figs. 182 (*b*) and (*c*). Between points A and B of Fig. 182 (*d*) the spot on the cathode ray tube screen travels faster than average with the result that, since there is less excitation of the screen phosphors, the section of line it traces out has lower than average brightness. Between points C and D the spot on the cathode ray tube screen is travelling slower than average, with the result that, since there is greater excitation of the screen phosphors, the section of line it traces out has higher than average brightness.

Fig. 182 (*d*) illustrates the visible results of velocity modulation on one line of the picture. Exactly the same result will be evident on all lines in the raster, because the ringing current modulating each line will be initiated by the preceding flyback period. In consequence, if the whole raster is examined the result of the velocity modulation is that shown in Fig. 182 (*e*), wherein alternate vertical stripes of less than average and greater than average brightness appear, these being most manifest at the left hand side of the raster. Such stripes are called *striations*.

As was just mentioned, the visual result of velocity modulation is most evident when it occurs in an area of constant contrast, or on a blank raster. Due to the characteristics of the screen phosphors, or to subjective effects in the observer (or to a combination of both), the visual result tends to be most noticeable at certain (usually somewhat advanced) average brightness levels; and it is conventional practice to check for the presence of velocity modulation with a blank raster, adjusting average brightness level until any striations which may be present become most pronounced. Unless the modulation is severe, striations tend to be masked when they occur in areas carrying picture detail. They can, however, be distressingly obvious in such areas when the transmitted scene is panned by the camera, since small details visibly change in width as they pass through the distorting area.[7]

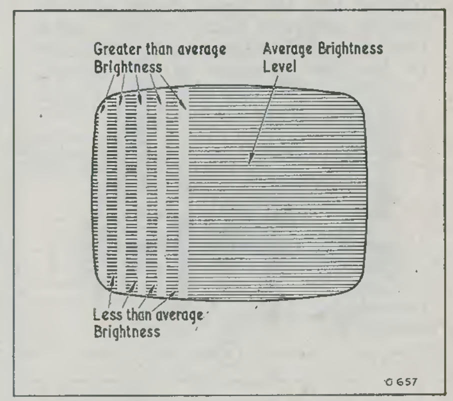


Fig. 182 (*e*) *The overall effect of the ringing current on a blank raster. The striations shown here may be compared with the ringing current of* (*a*)

In quite a few commercially manufactured television receivers a degree of velocity modulation of the line scan has been permitted which allows at least one striation to

[5] It should be noted that, if the amplitude of the ringing current were sufficiently high, it could cause the spot to actually change direction between pairs of points corresponding to C and D, G and H, and L and M, in Fig. 182 (*b*). Such oscillation of the spot as it traversed the screen would, of course, cause excessive distortion on the reproduced picture and would only occur, in practical receivers, under fault conditions.

[6] The term "raster" defines the scanning pattern reproduced on the screen of the cathode ray tube. A "blank raster" is the raster given when no signal is applied to the modulating electrode of the tube.

[7] "Panning" (probably derived from *panorama*) describes the slow horizontal movement of a camera across a scene to provide a panoramic view.

be visibly evident at the left hand side of the picture during a blank raster, or when this part of the picture is at constant contrast level. Such distortion is not usually noticed by the lay viewer, and readers will be able to adjudge, from their own experience of the

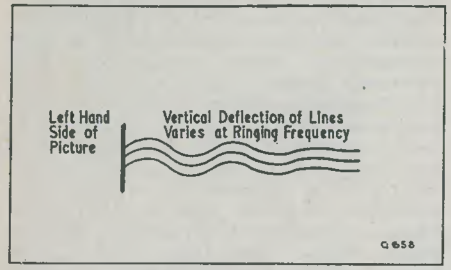


Fig. 183. When line flyback voltages are coupled into the frame deflection coils vertical deflection varies at the ringing frequency of the latter, causing distortion to the line structure in the manner illustrated here

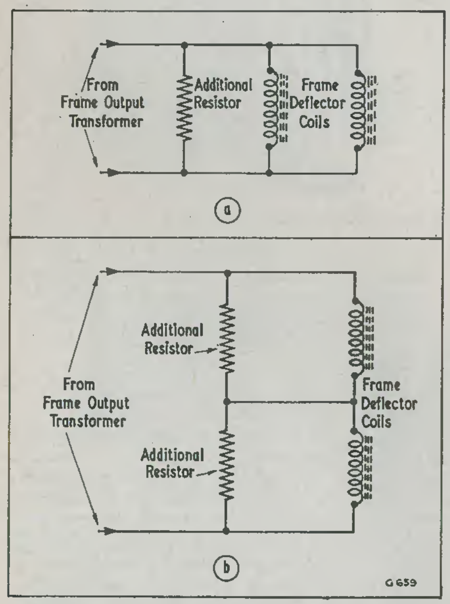


Fig. 184. Distortion due to cross-talk couplings may be reduced by connecting an additional resistor or resistors across the frame deflector coils. A single resistor is employed when the coils are parallel-connected, as in (a); whilst two are used when the coils are series-connected, as in (b)

reproduction offered by various domestic receivers, the level below which such distortion is tolerable. It should be mentioned that, in some receivers, the visible results of velocity modulation are negligible or, even, undetectable.

During practical work on television receivers, striations on the reproduced picture caused by velocity modulation should not be confused with striations caused by amplitude modulation of the cathode ray tube beam at the line output stage ringing frequency. In the latter case, stray couplings between the line output stage and the video amplifier cause the ringing frequency voltage to be superimposed on the signal applied to the modulating electrode of the cathode ray tube. Since the strap couplings cause the amplitude of the beam current to be varied at the ringing frequency, the visible result can be almost exactly the same as that shown in Fig. 182 (*e*). The striations caused by amplitude modulation of the beam tend, however, to spread across a greater width of the picture than do striations caused by velocity modulation; and they can, in any event, be identified by the fact that they disappear if the modulating electrode of the cathode ray tube is temporarily bypassed to chassis via a condenser having a value around 0.05μF. In early television receivers the stray couplings which caused striations were most frequently the result of capacitive coupling between the lead to the modulating electrode of the cathode ray tube (this lead being unscreened to keep its capacity to chassis low) and the line output stage and line deflector coil wiring. In modern receivers (in which most of the line output stage components and wiring are screened) such couplings may still occur between the lead to the modulating electrode and the leads (if unscreened) to the line deflector coils. Stray couplings via other paths can also, of course, occur.

Cross Talk

Apart from velocity modulation of the line scan, shock-excitation by the line flyback pulse can cause a secondary form of distortion in the reproduced picture. Such distortion occurs when, due to stray couplings, ringing voltages appear across the frame deflector coils and become superimposed on the frame sawtooth waveform. These ringing voltages have a frequency dictated by the inductance and stray capacities of the frame coils. The result is that vertical deflection of the cathode ray tube beam varies at the ringing frequency, causing the lines at the left hand side of the picture to take up the appearance shown in Fig. 183. The stray couplings are mainly capacitive and nearly always appear in the deflector coil assembly itself, whereupon protection against the distortion may be considered as being a function of deflector coil assembly design. The fault is frequently referred to as *cross-talk* in the deflector coil assembly.[8]

A common device for reducing cross-talk consists of connecting parallel resistors across the frame deflector coils, as shown in Figs. 184 (*a*) and (*b*). These resistors have values which are much lower than the impedance of the coils on their own at the frequencies associated with the flyback pulse, but which are sufficiently high compared with the impedance of the coils at frame scanning frequencies to prevent undue loss of frame scanning efficiency. Thus, the voltage at the ringing frequency developed across the frame deflector coils is reduced because of the lowered overall impedance.

Since the coupling which causes cross-talk distortion is largely due to the stray capacities between the line and frame coils in the deflection assembly it is obviously desirable to keep these to a low level; and it is helpful in this respect to connect all metalwork in the assembly (including, sometimes, the core) to chassis. The further reduction of stray capacities by such expedients as increasing spacing between the two sets of coils is usually rather difficult to achieve, this being especially true of the more modern deflection assemblies, which have to be very compact at their forward ends.

The stray capacities existing in a deflector coil assembly form a complex network. It is feasible, at a first approximation, to reduce them to the case where a capacity couples each terminal of one set of coils to each terminal of the other set of coils, a typical example being illustrated in Fig. 185 (*a*), wherein we have a pair of series connected line coils and a pair of parallel connected frame coils. If the pulse voltages at the extreme ends of the line coils are approximately equal in amplitude, no undue ringing voltages should appear on the frame coils when opposing pairs of capacities (such as C_{S1} and C_{S2}) have the same value. Such a set of circumstances may be achieved in practice by so positioning the line and frame coils that they are exactly symmetrical about each other. Since accurate symmetrical positioning of the pairs of coils relative to each other is, in any case, necessary to prevent picture shape distortion, the almost complete balancing out of stray capacities is automatically achieved by the normal manufacturing processes for the deflector coil assembly.

In practice, the pulse voltages appearing at the two end terminals of the line deflector coils are often markedly unequal in amplitude, the voltage on the terminal which connects into the line output transformer winding nearer the boosted h.t. reservoir condenser tap having the lower amplitude. This circumstance is illustrated in Fig. 185 (*b*). The unbalance in voltages will cause ringing voltages to appear across the frame deflector coils even when the stray capacities

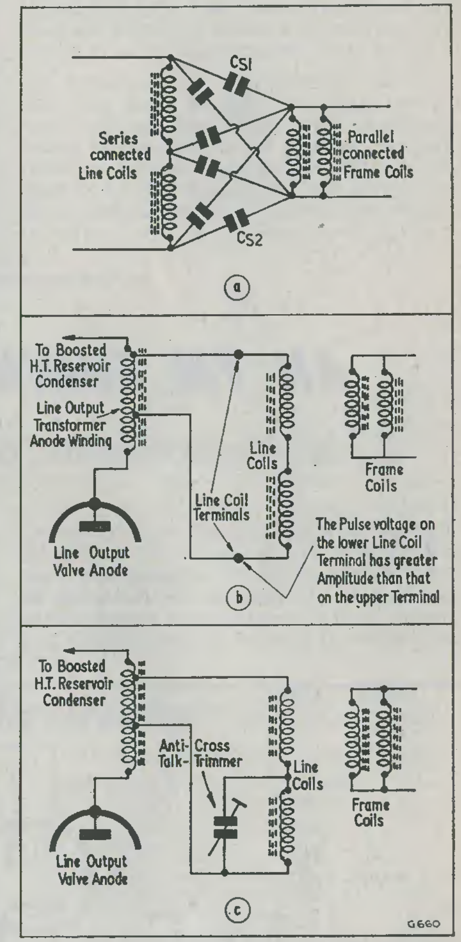


Fig. 185 (a) The stray capacities between line and frame coils may, at a first approximation, be presented in the manner shown here. (b) In practice the flyback pulse voltages on the line coil terminals may have widely different amplitudes. (c) The effect of unbalance in the pulse voltages at the end terminals of the line coils may be neutralised by unbalancing the stray capacities with the aid of a trimmer connected across the lower line coil

[8] "Cross-talk" defines the degree of unwanted coupling between two circuits, or systems, handling different signals.

are symmetrically balanced out. If the consequent ringing voltage appearing across the frame coils is sufficiently high to cause distortion on the picture it may be reduced by connecting a trimmer across the lower section of the line deflection coils, as shown in Fig. 185 (*c*). This trimmer upsets the state of balance in the capacities coupling together the two sets of coils, and it may be adjusted to neutralise the unbalance between the pulse voltages at the end terminals of the line coils.

Some commercially manufactured receivers have, in the past, used adjustable trimmers with high voltage insulation between plates in the circuit position shown in Fig. 185 (*c*), but more modern receivers employing this anti-cross-talk device fit fixed condensers having values applicable to the average requirements of the particular production run of receivers being manufactured. Typical values for the condenser lie between 30 and 150pF. Anti-cross-talk condensers are not fitted to deflector coils assemblies having parallel-connected line coils.

The Sync Separator

We have now completed our examination of the time bases and deflection arrangements employed in practical television receivers. The next subject to be dealt with is the sync separator, whose function is to remove the synchronising information from the transmitted signal and to convert this into suitable pulses of correct polarity for application to the line and frame scanning generators.

We shall commence a detailed description of this section of the modern television receiver in next month's issue.

AN FM TUNING INDICATOR

by T. WINCHCOMBE, Grad. Brit.I. R.E., G3BCW

THIS ARTICLE DESCRIBES AN FM TUNING indicator suitable for use with phase discriminators or balanced ratio discriminators. It provides an indication of correct tuning when the mean voltage on the audio take-off point of the discriminator is at chassis potential. The circuit can employ readily available "Magic Eyes" such as the Y63, 6U5 or EM34. (The latter should have a separate series 1MΩ resistor for each anode.)

The pattern on the eye consists of two shadows, one due to zero volts and the other due to the discriminator output. When the two shadows coincide the receiver is correctly tuned.

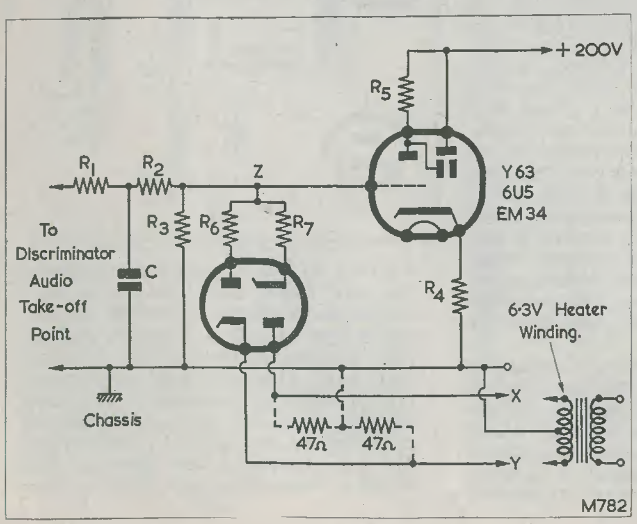


Fig. 1. Circuit of the tuning indicator. The two 47Ω resistors are employed to provide an effective centre-tap for the heater supply where the existing winding is not already so provided

The circuit of the indicator is shown in Fig. 1 and the method of operation is as follows. The eye is cathode biased to give a shadow angle of about 45 degrees with zero input. This enables a positive or negative input to be displayed by an opening or closing of the shadow respectively. The discriminator output is fed to the grid via the high resistance of R_1 and R_2. The diode forms a shunt switching circuit operated from the centre tapped 6.3V heater line. During the half cycle when X is positive and Y is negative the diodes conduct, equal voltage drops appearing across R_6 and Rs so that point Z is at chassis potential and ha$_7$ a low impedance to chassis. Any input from the discriminator during this half cycle is dropped across R_1 and R_2, the shadow therefore indicating zero volts.

On the next half cycle the diodes do not conduct, offering a very high impedance. There is now 2.2MΩ from point Z to earth so that almost all the discriminator output appears at the grid of the "Magic Eye", the shadow indicating the magnitude and sense of this voltage. This is illustrated in Fig. 2.

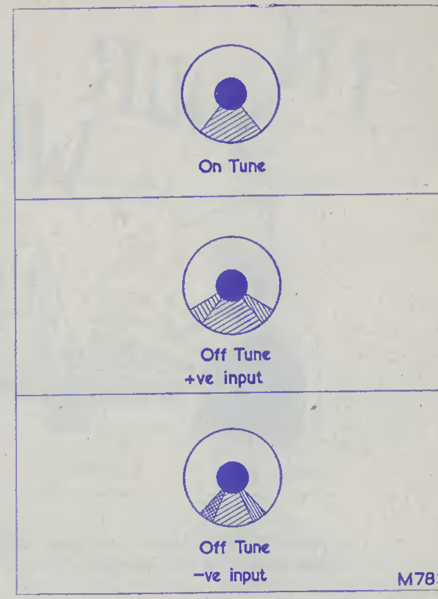


Fig. 2. Indications given by the "Magic Eye" for different tuning conditions

A matched pair of germanium diodes may be employed if this is desired, instead of the double diode valve shown in Fig. 1. The diagram also shows how two 47Ω resistors may be connected across the heater winding to provide an effective centre-tap if the heater winding, itself, is not already so provided. The function of the filter formed by the components R_1 and C is to prevent 50 c/s a.c. being fed to the audio stages of the associated receiver. Should any difficulties be experienced due to hum injection into the a.f. stages, the value of C should be increased.

Third International Conference on *Medical Electronics*

OLYMPIA, LONDON, 21st–27th JULY, 1960

The Electronics and Communications Section of the Institution of Electrical Engineers, in association with the International Federation for Medical Electronics, are organising the Third International Conference on Medical Electronics which will be held at Olympia from 21st–27th July, 1960.

The Conference is planned to bring together members of the medical and electrical engineering professions so that each will gain a better understanding of the problems of the other; besides sessions for experts there will also be less specialised meetings to enable those who have no deep insight of the subject to increase their background knowledge. With the many recent advances both in electronics and medicine, it is generally recognised by members of both professions that discussions on medical electronics can do much to stimulate progress.

The scope of the Conference is indicated by the following preliminary subject list:

- Instrumentation for Medicine and Biology
- Medical Electronics in Space Research
- Isotopes and Radiology
- Ultrasonics and Microwave Radiation
- The Respiratory System
- Digestive System, Metabolism and Biochemistry
- The Circulatory System
- Electronic Aspects of Sight, Hearing and Locomotion
- The Motor and Nervous Systems

In view of the international nature of the Conference it is planned to provide simultaneous translation facilities.

In conjunction with the Conference, the Institution is promoting an International Scientific Exhibition which will be held at Olympia at the same time as the Conference, and where the research organisations, universities, hospitals and industrial organisations from all over the world who are working in this important field can display their latest developments.

IN YOUR WORKSHOP

This month Smithy the Serviceman and his able assistant, Dick, discuss several ideas from readers together with the techniques of Short wave alignment

"IF", REMARKED DICK DISPASSIONATELY, "you intend going off for a crafty weekend at Brighton after work today, you'll have to sleep on the sands with a case as tiny as that."

For once, Smithy's assistant, no doubt stimulated by the sunny summer weather and the imminence of holidays, had arrived at work before his chief. In consequence, he felt sufficiently privileged to pass comment on the diminutive leatherette-covered case that Smithy carried as he entered the Workshop.

"The fact", replied Smithy, placing the case on his bench, "that your family has kicked you out of the house a little earlier than usual this morning is no excuse for passing comments on my latest toolbox. And the further fact", continued Smithy primly, "that I happen to carry a small case to work on a sunny Friday morning does not imply . . ."

"A toolbox, did you say?" interrupted Dick. "Let's have a look."

Smithy decided to forego any further comment on his assistant's opinion of middle-aged predilections, and opened the case.

Portable Foam-suspension Case

"Here you are," said the Serviceman. "What could you have better than this for carrying micrometers, vernier gauges and similar delicate instruments around with you?"

His assistant gazed, impressed, at the inside of Smithy's case (Fig. 1 (*a*).)

"Well, that's a neat idea," he remarked. "Everything suspended in foam! How's it made?"

"Oh, the construction is quite simple," replied Smithy. "You first of all make two similar halves for the case. In this instance the two halves are 11in x 8in x ½in deep internally, and consist of a "frame" of ½in x ½in wood, with a piece of thin plywood or hardboard at the bottom. (Fig. 1 (*b*).) The two halves are then covered with the leatherette and hinged along one edge to form the case. Finally, catches and a handle are fitted to the outside."

"That seems a very easy process," commented Dick.

"It is," said Smithy. "I knocked this particular box up in a couple of evenings at home. It took me about an hour or so on the first evening to do the woodwork and apply the leatherette, after which I left the case alone till the next evening to allow the glue which secured the leatherette to set good and hard. I then screwed on the hinges, handle and catches, fitted the foam, and the job was complete."

"Ah, yes, the foam! Which is, of course, the whole secret of the case?"

"It is," confirmed Smithy. "The foam is ordinary polyurethane, or similar plastic, foam which you can buy at the popular chain stores, and the idea is to fit it into the case halves so that the top surface of the foam is level with the edges."

"I see," remarked Dick. "With the result that, when you close the case, the two lots come together and the whole inside volume is 100% foam."

"You've got it," said Smithy. "With my case the internal depth of each half was ½in and so I was able to fill this nicely with two layers of foam ¼in thick. You may be able to get ½in, or thicker, foam if you hunt around, but the readily available ¼in foam did the job for me. And it doesn't want to be the foam with a sticky surface on one side, incidentally; what you want is just the plain stuff. A spot of glue here and there will hold it in place quite reliably."

"Sounds simple enough," commented Dick.

"What I like most about the case," continued Smithy, "is that, due to its extreme resilience, the foam takes up the form of whatever items you put in the case and holds them completely suspended. So you can use the case for valves, ferrite rods, or anything else which is fragile, apart from tools.

"Of course, the size of the case doesn't have to be the same as that I've made for myself. Provided that the two lots of foam come together when the case is closed, the dimensions may be whatever you choose. I should add, just to illustrate the capabilities of the box, that one with dimensions similar to mine, and containing two crumbly biscuits, was posted from Abingdon to London. And the biscuits were intact when it was opened at London!"

"Well, that certainly seems to be a good proof of its efficiency," remarked Dick. "It really takes the biscuit!"[1]

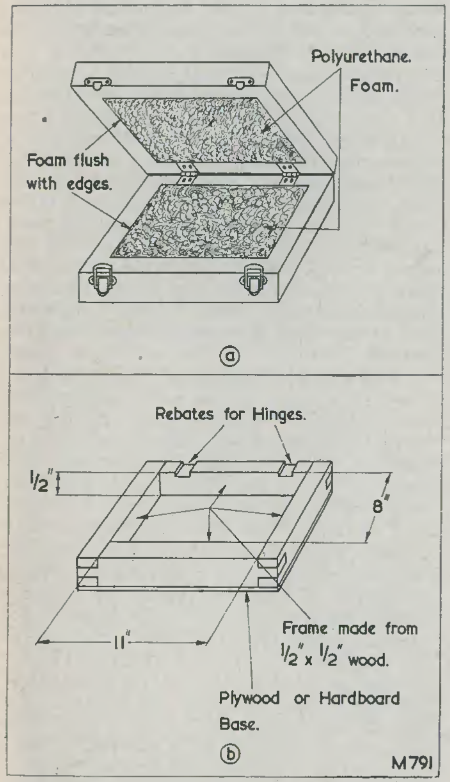


Fig. 1 (a) The overall appearance of the foam suspension case. (b) Both halves of the case framework are the same and are constructed as shown here. Any suitable alternative to the corner jointing illustrated may be employed

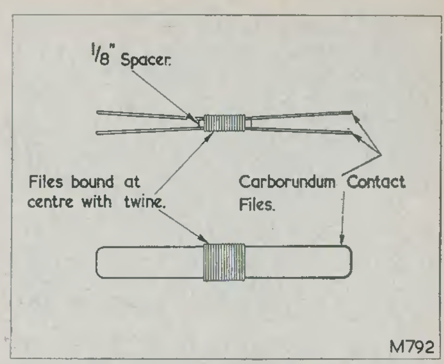


Fig. 2. A wire-end cleaning device. The files may be secured together at the centre with a clamp instead of the twine, if desired. The files are opened out slightly by bending after being secured together

Wire-End Cleaner

Smithy's assistant glanced at the Workshop clock, then looked away hastily.

"Any other bright ideas?" he asked quickly.

"Why, yes, I think I have," said Smithy a little absentmindedly. He fished in his pocket. "Ah, here it is. This is a neat little wire-end cleaner. (Fig. 2.) It's so simple that it needs hardly any explanation. It consists of two carborundum contact files approximately 4½in long by ½in wide, tied or clamped, together at their centre with a ⅛in space in between. To use the cleaner you simply press the files together at either end, like a pair of tweezers, and draw the wire between them."

[1] The originator of the foam-suspension container is Mr. L. H. Brown, Abingdon, Berks.

Dick examined the cleaner.

"The files are quite flexible", he remarked, "and they seem to be made of some sort of resin bonded paper stuff about 25 'thou' thick, with a carborundum surface."

"Quite honestly, I don't know what they're made of," confessed Smithy. "Anyway, they certainly work very well in this little gadget."

"What sort of wire does it clean?"

"Oh, cotton covered, enamelled and the like," said Smithy, "and I've found that it works very well with the tough synthetic enamels. It's excellent, also, for very quickly cleaning dirty resistor and condenser lead-outs."

"Which," chimed in Dick, "have to be especially clean before you attempt to solder them to things like printed circuits and so on."[2]

"You've got it," confirmed Smithy. "And that, so far as acceptable bright ideas and gadgets are concerned represents the lot for now."

"I assume, nevertheless," commented Dick, "that you're still interested in hearing about any further ideas, gadgets or techniques."

"Oh, definitely," replied Smithy. "Information about such things is always very welcome."[3]

Burnt Out Resistors

"And now" said Smithy briskly, having just caught sight of the clock himself, "it's definitely time we got down to some work."

"Well, there's just *one* little question which has been worrying me recently," said Dick quickly. "I bumped into it again, only yesterday, on the last job I did here."

Smithy looked impatient.

"It's already quarter of an hour after starting time", he said severely. "So it had better *be* a little question!"

"It is," said Dick soothingly. "What's happened is that I've recently had a real spate of open-circuit resistors in the sets I've been servicing. It's so bad I'm beginning to lose my faith in the things!"

"Never lose faith," chuckled Smithy. "What's the cause of the open circuits?"

"That's just the trouble," replied Dick. "I can't find out! Nearly all the resistors which have gone open circuit were small wire-wounds having fairly high values. None of these had cooked up at all so far as I could see; also, there was nothing in the circuit which could have caused an overload. Most of the resistors were in receivers which were almost band new."

"You do get a rush of this sort of thing every now and again", remarked Smithy. "And some high value wire-wounds *do* have an occasional tendency to go open circuit all on their own. It's due to the fine wire with which they're manufactured; and I wouldn't be at all surprised if someone were to tell me that this wire was attacked by the cement with which the resistor is impregnated. I should add that brand new wire-wounds are particularly liable to go open circuit if they're left unused for very long periods of time. When they're used fairly shortly after their manufacture, the heat they dissipate finally cures the impregnant in the cement, and kills any chemical action that might be hanging around."

"I have a mental picture", said Dick gloomily, "of a receiver hanging around in a shop unsold and unused for several months, and with all its wire-wounds being gradually eaten away to nothing!"

"Here, hang on," said Smithy alarmed. "The effect is nowhere as serious as all that! I'm just talking about the effects I have bumped into myself with a small number of wire-wound resistors. Though I must confess that, whenever I get open circuit wire-wounds with high values and with dissipations up to 5 watts or so, I usually try to replace them with carbon composition components of the same wattage rating. It may be, after all, that the latter type stand up better to current surges caused by faulty circuit conditions but, in any event, they seem to me to be more reliable."

"Fair enough," said Dick. "Another snag I've bumped into in the same category has been burnt-out cathode bias resistors on things like audio output valves. In this case, however, the resistors have been very obviously burnt out. Once again, I haven't been able to find the cause."

"I've had a few like that myself", said Smithy, "and I always suspect a short circuit, either in the valve itself or in its grid coupling condenser. If possible, I check the valve for internal shorts in a valve tester, thumping it while it's under test. Or, if the valve tester is not available, I thump it whilst it's in the receiver to see if it exhibits any faults there. Obviously, the presence of a burnt out cathode resistor means that the valve must have passed a pretty hefty current at some time; whereupon there is often no point in checking the valve too carefully, as it needs replacing anyway. Another point is that, if I can't locate reasonably quickly the intermittent short which caused the resistor to burn out, I *always* replace the grid coupling condenser. This I do on the grounds that I'm removing something which is *extremely* suspect, and because the replacement cost to the customer for this component is small. You've got to change the burnt-out cathode resistor, so very little extra work is needed to replace the coupling condenser as well. And, now, we really must get on with some work!"

With which final pronouncement, Smithy took off his jacket and applied himself resolutely to the work waiting on his bench.

Short Wave Alignment

Reluctantly, Dick turned to his own bench, whereupon he fitted the cabinet to a television receiver whose chassis (bearing the open circuit wire-wound resistor) he had repaired the previous evening. He checked it over and, satisfied with its perormance, took it from his bench and carried it over to the "Repaired" rack.

The next receiver Dick picked out was a Long, Medium and Short wave receiver of the average domestic variety. He carried this set to his bench, plugged in an aerial and switched it on. Reception on Medium and Long waves was perfectly normal and Dick's face screwed into a frown.

"There's nothing wrong with this one," he called out.

Smithy glanced over his shoulder at the receiver.

"Have you tried the Short wave band?"

"Short waves? I didn't know anyone even listened to Short waves these days!"

"The owner of that set does", said Smithy. "As a matter of fact I recognise it as belonging to a friend of mine who warned me it would be coming in for repair. He does a little Short wave listening every now and again."

"On an ordinary domestic receiver?"

"Why not? He's quite happy listening to the stronger commercial and amateur stations. I haven't broken it to him that the whistles he hears on many of the stations are due to second channel interference and that they wouldn't be present on a more specialised receiver having an r.f. stage. He's quite happy playing around with the set as it is."

"Very well," said Dick, switching the receiver to the Short wave band.

About a minute later Dick's voice became audible again.

"Smithy," he called out, "I know that the Short wave bands are pretty quiet on wavelengths longer than 30 metres or so during the day, but should that part of the band fade into complete silence?"

"You should hear one or two stations," replied Smithy.

"Then", said Dick firmly, "I've got an intermittent tuning condenser."

"Nonsense," said Smithy without even turning his head. "It would have been intermittent on Medium and Long waves as well."

"Well, there's *something* intermittent," said Dick. "Listen! I'm turning the tuning condenser now, starting around 15 metres. As you can hear, the set is quite lively. As I tune to longer wavelengths the set still copes O.K. until I get to 30 metres or so. And after that there's not a sausage."

"Tune back," commanded Smithy.

"Right! I'm now coming back. I'm at 30 metres, still nothing. 25 metres, dead as a doornail. I've now reached 20 metres and —there!—the set's as lively as a cricket again. I *told* you there was an intermittent. I bet that the set will stay lively until I tune down past 30 metres again."

"I have no doubt that it will," commented Smithy drily. "Try a new frequency changer."

With a rather surprised expression, Dick obeyed Smithy's instructions. As soon as the new valve had warmed up he spun the tuning dial again. The set received stations over all points of the band.

Dick sat still for a few moments pondering this phenomenon. Suddenly he smacked the bench with his fist.

"Well, I am a chump!"

"I was wondering", chuckled Smithy, "when the penny would drop."

"Why, it's obvious! The oscillator section of the old frequency changer had got tired of life with the result that, whilst it could keep chugging over on the Medium and Long wave bands, it would only work at the high frequency end of the Short wave band. That is, when the Short wave oscillator tuned circuit had minimum capacity across it. Once the oscillator had started working it would continue to do so until I had tuned it down to 30 metres or so, whereupon the efficiency of the oscillator tuned circuit became too low to maintain oscillation. I would then have to tune to quite a shorter wavelength than 30 metres for the tuned circuit efficiency to become sufficiently high for it to commence oscillating again."

"That's about it," said Smithy. "And now you've cleared the snag I would be obliged if you would give the Short wave trimmers a bit of a tickle-up. I promised my friend I'd do that."

"Okey-dokey," said Dick obligingly. "Let's get the signal genny warmed up."

The next five minutes passed uneventfully, the peace of the Workshop being interrupted only by the 400 c/s wail from Dick's receiver as he applied the signal generator output to it. After he'd finished, he coupled one of the Workshop aerials to his set. His face fell as he turned the tuning dial of the receiver.

"It's worse than it was when I started alignment!" he wailed.

[2] The wire-end cleaner was also submitted by Mr. L. H. Brown, who states that the carborundum contact files may be obtained from cycle and car accessory stores at 1s. 3d. each.

[3] Payment is made for all ideas employed in "In Your Workshop".—*Editor.*

The long-suffering Serviceman sighed heavily. With an air of resignation he laid his soldering iron down on the bench and traversed the well trodden path over to his assistant's side. Dick moved to one side whilst Smithy checked the alignment.

"You know, you *are* a bit of a muggins," said Smithy in a matter-of-fact tone. "To start with, you've lined the signal circuits up on the second channel signal—that is, on the high side of the oscillator—at the high frequency end of the band; and even then you aren't spot on. At the low frequency end the signal frequency circuits are below the oscillator, so that you have a vast area in between where there isn't a vestige of tracking between the two tuned circuits whatsoever. With the result that the set is pretty near as insensitive as human ingenuity can make it."

"This seems to be one of my off mornings," remarked Dick dismally.

"Well, it can't be helped," said Smithy philosophically. "I think the best thing I can do is to give you a dem of how I would line up a Short wave band in a set of this nature myself; bearing in mind the fact that the signal tuned circuits are relatively inselective and that the best way of combating second channel signals is to make the set as sensitive as possible to the *correct* signals. Before I start, though, I'd better quickly review the sort of tuned circuits you're going to align. (Fig. 3 (*a*).) The signal tuned circuit will have one gang of the tuning condenser across it, the only component in series being the a.g.c. decoupling condenser. This condenser will have a capacity lying between 0.01 and 0.1μF, 0.05μF being a favourite. In occasional cases the coil may be returned direct to chassis without a condenser at all, either because a.g.c. is applied to the signal grid of the frequency changer via a grid leak (Fig. 3 (*b*)) or because no a.g.c. is applied to the frequency changer on Short waves."

"No a.g.c.?"

"That's right. Probably the set designer found that a.g.c. variations caused embarrassing shifts in oscillator frequency and made Short wave tuning difficult. So he cut out a.g.c. to the frequency changer on the Short wave band, leaving it applied to the i.f. valve only."

"Well, that's a turn-up for the book."

"It is, rather," agreed Smithy. "Anyway, let us proceed. The oscillator tuned circuit will have the second gang of the tuning condenser across it and there will be a padding condenser, which will almost certainly be fixed, in series, this having a value lower than the ag.c. condenser in the signal frequency circuit. A padding con-

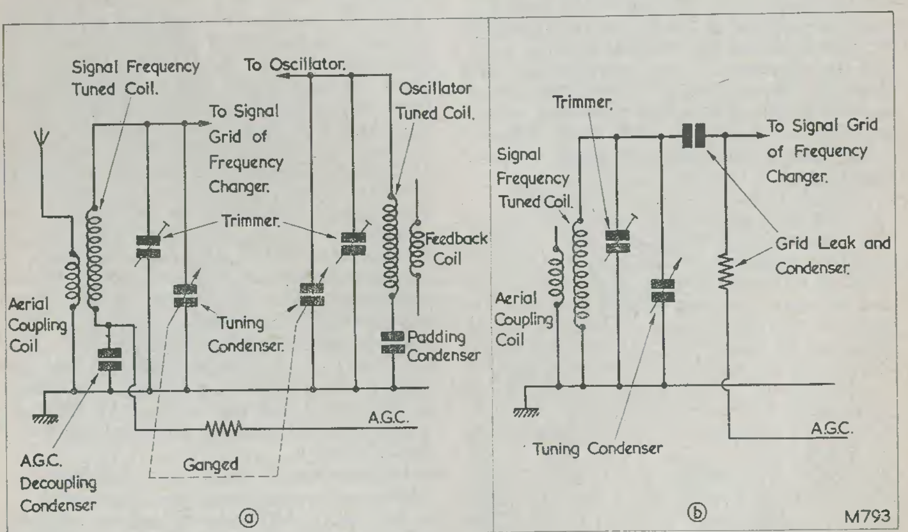


Fig. 3 (a) The tuned circuit connections provided on the Short wave band of a typical domestic three-waveband receiver. The signal frequency and oscillator tuned coils will almost certainly have dust cores in later sets. The oscillator tuned coil may be connected either to the oscillator anode or the oscillator grid. (b) In some receivers, the signal frequency tuned coil may be returned direct to chassis, a.g.c. being applied via a grid leak. Typical values for the grid leak and condenser shown here are 1MΩ *and* 500*pF respectively*

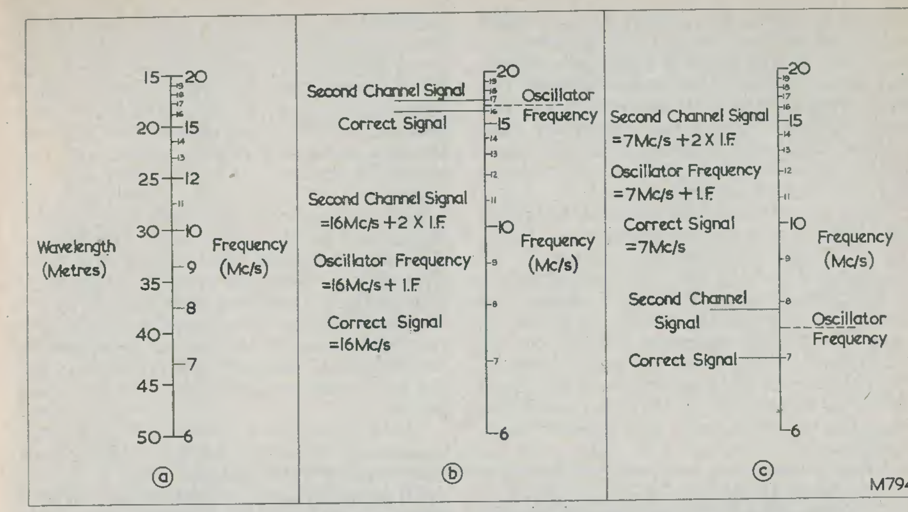


Fig. 4 (a) The usual Short wave range of a domestic receiver is 50 *to* 15 *metres, or* 6 *to* 20*Mc/s. A linear wavelength scale is assumed here. (b) Smithy elected to trim Dick's receiver at* 16*Mc/s (or* 18.75 *metres); and he took care to ensure that he applied the correct, and not the second channel, signal to the receiver. This diagram shows graphically the close spacing (in terms of tuning capacity) between correct and second channel signals at the high frequency end of the Short wave band. (c) Padding was carried out at* 7 *Mc/s (or* 42.9 *metres), attention being paid again to ensure that the correct and not the second channel signal was fed to the receiver. In this diagram, and in (b), it is assumed that the receiver i.f. is of the order of* 465 *kc/s*

denser will still be present in the oscillator tuned circuit even if there is no a.g.c. condenser in the signal tuned circuit."

"Why not a variable padder?"

"Because," replied Smithy, "a fixed condenser with a carefully chosen value will cover most discrepancies between coils from set to set. There is the further point that the padding condenser will usually be of the order of 0.002μF, and you would need a pretty expensive variable component to get a value of this order. I should add that both signal and oscillator coils may also have adjustable dust cores, and that these can assist in padding operations.

"The usual range", Smithy carried on, "you find in sets of the type we've got here is something like 50 to 15 metres, i.e. 6 to 20 Mc/s. (Fig. 4 (*a*).) I'll stick to Mc/s rather than metres from now on as it makes it easier to explain the alignment process. To which we shall now proceed.

"The first thing to do is to get the oscillator lined up correctly at the high frequency end of the band. Unless the service manual says otherwise I usually pick a spot around 16 Mc/s or so for this operation. (Fig. 4 (*b*).) I set the receiver tuning condenser scale to exactly the frequency on which I intend to start business. I then hitch the signal genny with a fairly high output to the aerial terminals, set it to approximately the same frequency, and swing its tuning dial. The signal genny modulation should then come through at two points on its tuning dial, these being spaced nearly 1 Mc/s apart. One of these signals will be below the receiver oscillator frequency and the other will be above; and the reason they are spaced nearly 1 Mc/s apart is because the interval between them will be twice the i.f. in the set."

"So a set with 465 kc/s i.f.s would respond to signals spaced at two times 465 kc/s. That is, 930 kc/s?"

"That's the idea," said the Serviceman. "Now, the signal you want is the lower frequency one of the two. So what you do next is to set the signal genny to the lower of the two signals and see what this is in terms of Mc/s. If it is exactly the same frequency as that on the receiver dial, the oscillator is spot-on. If it isn't, you adjust signal genny tuning ever so slightly in the desired direction, and reset the oscillator trimmer to bring it in at full strength again. You keep doing this until the signal genny frequency is exactly the same as the reading on the receiver tuning scale. The important thing in this process is not to lose the signal as you adjust the oscillator trimmer, or you may accidentally hop on to the second channel. Whilst I've been talking I've been carrying out this procedure on your receiver, Dick, and now 'walked' the signal generator and oscillator trimmer together until the latter is on its correct setting. I'll just make certain that I'm still on the correct signal."

Smithy experimentally adjusted his signal generator to give an output above and below the frequency to which he had set it. Its modulation could be heard at a setting nearly 1 Mc/s above the figure he had chosen, but there was no response below. Satisfied, he reset the signal generator to the correct frequency. Next, he increased receiver volume to maximum and adjusted the signal generator attenuators so that the modulation was just audible from the receiver loudspeaker.

"Aren't you going to short out the a.g.c. line?" asked Dick.

"There's not much point", replied Smithy, "so long as you use a signal generator output which is so weak it's just audible. If I *did* short out the a.g.c. line I'd do so at the detector, incidentally, to avoid upsetting conditions near the signal tuned circuit. But, quite honestly, I don't think it's necessary if I run the receiver at maximum sensitivity.

"We march on! My next job is to align the signal frequency trimmer."

"I tried that", complained Dick, "and it made the oscillator go off tune."

"That's very possible," remarked Smithy. "The oscillators in many of these domestic sets 'pull' like billy-o on the Short wave band. But there is a technique to overcome *that* little trouble. This consists of continually rocking the receiver tuning, or the signal generator tuning, very slightly on either side of the signal, and of adjusting the signal frequency trimmer at the same time. You then get maximum sound each time you pass through the correct tuning point, and you adjust for greatest volume of that maximum sound."

Smithy proceeded to rock the receiver tuning across the signal generator signal, carefully adjusting the signal frequency trimmer for maximum volume of the burst of sound which occurred each time the tuning condenser passed the correct tuning point. As the volume of this sound increased he reduced signal generator output accordingly. He soon announced that the job was completed.

"Well, that didn't take long," said Dick, impressed. "I've got an idea that the set sounds more lively already."

"It probably does," said Smithy. "What's more, it's lively on the correct signal and not on the second channel. Now, if the coils have no dust cores your job is finished and, assuming no faults, you should get lively performance all along the band. If the coils have dust cores we choose a frequency near the bottom end—say, 7 Mc/s—and start padding. (Fig. 4 (*c*).) First of all we adjust the oscillator dust core for correct dial calibration, making certain once more that the signal generator output is below and not above the oscillator. Again, we get a spacing between right and wrong signals of nearly 1 Mc/s. Having got the oscillator on the correct frequency we next align the signal frequency core for maximum signal in exactly the same manner as we trimmed. We then go back to the high frequency end and finally re-trim, exactly as before."

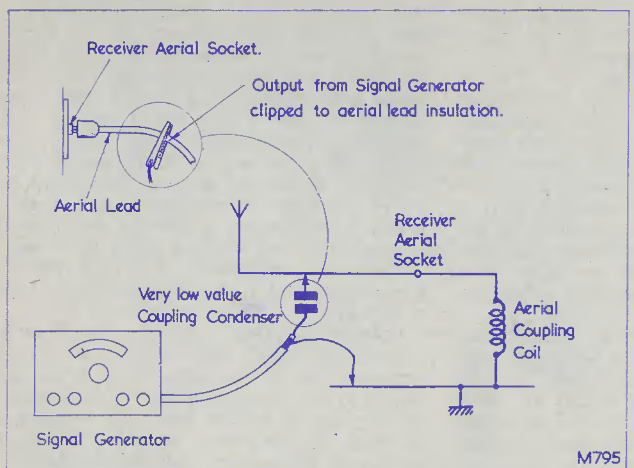


Fig. 5. For final trimming of the Short wave band, the damping effect of the signal generator on receivers having tightly coupled aerial coils may be obviated by the arrangement shown here. A short aerial is connected to the receiver and the signal generator coupled to it via a very low capacity, such as would be given by fitting its output clip over the aerial lead insulation

Smithy carried out the operations he had just described.

"I sometimes get the impression", commented Dick, who had been watching intently, "that the signal generator seems to damp the aerial coils."

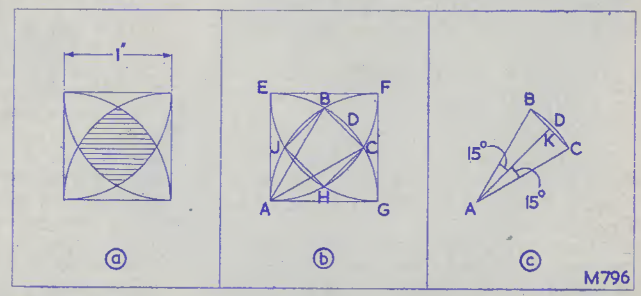


Fig. 6 (a) Smithy's problem. A square has a side of 1in and inside it are drawn four arcs, with centres on the corners of the square, and radius 1in. The arcs enclose the shaded four-sided figure, whose area has to be found. (b) In solving the problem Smithy added reference letters and several further lines. (c) Part of the figure in (b)

"Short wave aerial coil coupling is very tight on some of these domestic sets", said Smithy in reply, "and a certain amount of damping by the signal generator can definitely occur. So, if you really feel keen, it's not a bad idea to finish off the job by connecting a fairly short aerial to the receiver and coupling the signal generator to this by a very low capacity, such as would be given by clipping its output lead on to the insulation of the aerial wire. (Fig. 5.) The signal generator output will still come through if you reduce its attenuation, whereupon you finally trim the r.f. tuned circuit for maximum signal generator output whilst carrying out the same rock 'n' roll business on the tuning condenser as before."

"If you're going to finally align with an aerial plugged in, why not simply trim up on received signals?"

"Because, my lad", said Smithy, "you may pick a second channel signal. Or you may accidentally turn the trimmer too far and lose the correct alignment point, whereupon you mistakenly align on a second channel also. On some sets, you know, there's only about half a turn of the signal frequency trimmer screw between correct and second channel signals."

Find the Area

Smithy carried out the final alignment of Dick's receiver with an aerial connected, whilst his assistant watched.

"By the way, Smithy," said Dick, breaking in for a moment, "I hope you haven't forgotten that little problem about the area."

"What problem?" replied Smithy, giving the last touches to the r.f. trimmer.

"*You* know," said Dick. "The one you talked about when we last got together. You have a square with a side of 1in. You draw four arcs inside the square with centres on its corners, each having a radius of 1in. The problem is to find the area of the four-sided figure in the centre of the square." (Fig. 6 (*a*).)

"Oh, yes, I remember," said Smithy. "How did you get on with it?"

"Not too bad," replied Dick airily. "Mind you, I had to use a bit of calculus and stuff like that on it, you know, but I got the final answer O.K. I make it 1.2 square ins!"

"Bigger than the square, in fact," laughed Smithy.

Dick grinned.

"Actually," he confessed, "I had to give it up."

"Well, it's pretty easy," said Smithy. "Although there are quite a few steps involved. And, as I said previously, all you need is the ability to read and understand trig tables plus a little elementary geometry." Smithy pulled a notepad towards him and started sketching on its uppermost sheet. "To start off, let's add a few more lines, and some reference letters, to the diagram. (Fig. 6 (*b*).) Now, let's get on with the first stage. If I were to add to the lettered diagram a straight line between B and G I would have an equilateral triangle, ABG, it being equilateral because all its sides are 1in long. O.K.?"

"Yup."

"Right. So that makes angle BAG equal to 60°. Since angle EAG is a right angle, then angle BAE must be 30°. By a similar process I can show that angle CAG is 30°. So I can finally say that angle BAC, consisting of 90° minus two lots of 30°, is 30° also. Any snags so far?"

"Not yet."

"O.K.! Now let's pull the section ABDC

out of the diagram like this, (Fig. 6 (*c*)), and add a perpendicular, AK, to BC. The two angles BAK and CAK will now be half angle BAC because AK bisects that angle. So they're each 15°. Now, the area of triangle ABK is $\frac{1}{2}$ (BK x AK)$=\frac{1}{2}$ sin 15° x cos 15° sq. ins."

"Hey, hang on a minute," interrupted Dick, "how can you say that BK is sin 15°, and that AK is cos 15°?"

"Because", replied Smithy, "BK is sin 15° x AB and AB is 1in long! The same applies to AK, relative to AB."

"I'm with it now," said Dick. "Carry on."

"Right. Now the area of triangle ABC is twice that of triangle ABK, so its area is sin 15° x cos 15° sq. ins. You might look those up for me."

"They are", announced Dick, after a moment in which he had searched for a set of tables, "0.2588 x 0.9703, no, wait a minute, 0.2588 x 0.9659."

"Get it right," said the Serviceman, a little testily.

"Sorry, Smithy," said Dick, contritely, "your expression for the area of ABC is definitely 0.2588 x 0.9659 sq. ins."

"Good," said Smithy, mollified. "That's one of the important expressions in this problem. Next, let's have a look at the figure ABDC. Because angle BAC is 30°, the figure ABDC is really one-twelfth part of a circle. So its area is $\frac{1}{12}\pi r^2$."

"Of course it is," remarked Dick, in a surprised tone of voice. "I hadn't noticed that! And since the radius is 1in, then $\frac{1}{12}\pi r^2$ becomes $\frac{1}{12}\pi$ sq. ins!"

"And that," said Smithy, "is another important expression. We next examine the small bit, BDCK, whereupon we see that it has an area equal to that of ABDC minus the area of the triangle ABC. Which, remembering our two previous findings is $\frac{1}{12}\pi$—(0.2588 x 0.9659) sq. ins. That's a little sum you can work out yourself."

There was a few minutes' feverish activity on Dick's part.

"I make it", he said triumphantly, "0.0118 sq. ins."

"That seems to be right," remarked Smithy gravely.

"Of course it's right!" said Dick hotly. "I've checked it and I've double-checked it!"

"I'll take your word for it," chuckled Smithy. "If we next return to the full diagram (Fig. 6 (*b*)) again you will see that it contains a square BCHJ. Now, we already know that BK (Fig. 6 (*c*)) is equal to sin 15°, so we may say that BC, one side of the square, is equal to 2 times sin 15°. Which, to my mind, is 0.5176 ins."

Dick made a quick check.

"I agree with that figure," he said solemnly.

"Thank you," replied Smithy, suppressing a grin. "So we now come to the final bit. We have four equal segments, of which BDCK is one. And *that*, you may recall, had an area of 0.0118 sq. ins. So the area of the shaded four-sided figure is 4 times 0.0118 sq. ins. plus the area of the square BCHJ."

"That's easy," said Dick, excitedly. "The side of the square is 0.5176 ins, so the total area of the shaded bit is 0.5176^2+4 x 0.0118 sq. ins." There was a great flurry of pen and paper and much head-scratching. "Which", concluded Dick victoriously, "is 0.3151 sq. ins."

"A figure we can correct", concluded Smithy, "to three significant figures, making the area of the shaded figure in the square equal to 0.315 sq. ins."

Research into Outer Space Temperatures

News of further research into the conditions obtaining in outer space comes from Bonn University Observatory which is shortly to begin an intensive investigation into the temperatures prevailing in interstellar gas.

To this end, special amplifying equipment employing travelling wave tubes has been manufactured for the University by Marconi's Wireless Telegraph Co. Ltd. of Chelmsford, England. This consists of a dual channel amplifying system incorporating two travelling wave tubes in cascade in each channel.

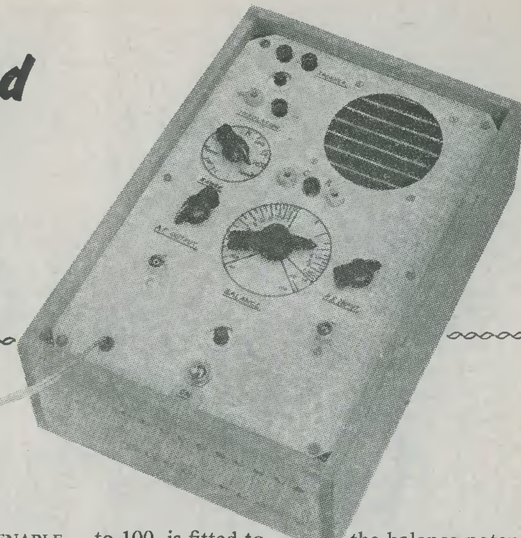
The radio telescope, a parabolic mirror of 83ft diameter, mounted on a pyramidal tower about sixty feet high, scans the sky picking up the cosmic continuum radiation emanating from galactic and extra-galactic radio sources under observation. The signals in the neighbourhood of the hydrogen line frequency (1420 Mc/s) are amplified by one pair of travelling wave tubes, the other pair being used to amplify reference noise signals from a resistor at a known temperature.

The outputs from the two amplifying channels are detected, integrated and compared, the effective cosmic temperature then being determined; from these data contour maps are prepared. So accurate has the system proved in initial tests that a discrimination of 0.1°K has been achieved.

The research programme at Bonn University Observatory is being carried out under the direction of Professor Becker, who is assisted by Herr Heinz G. Müller.

The travelling wave tubes used were manufactured by the English Electric Valve Co. Ltd.

Mains-operated
C-R Bridge



By B. H. SHAW, B.Sc., Grad.I.Mech.E.

THIS BRIDGE WAS DESIGNED TO ENABLE resistors and condensers to be checked in value to a degree of accuracy sufficient for general amateur use, and to provide the facility of condenser leakage checks at a voltage of 250.

In addition to the above principal use of the equipment it may be used to check a.f. amplifiers, as a variable voltage a.f. signal is available at fairly low impedance. Also, the amplifier section may be used as an a.f. signal tracer.

The circuit accompanies this article, and it will be seen that it consists of three sections: (1) the energising oscillator, (2) the bridge, and (3) the balance indicating amplifier.

The oscillator, employing a 6SN7 double triode valve, was that described in these pages by W. E. Thompson, A.M.I.P.R.E., in June 1957. This delivers a signal at about 1,500 c/s to the bridge via the 1:1 intervalve transformer T_1.

The switch S_1 selects the required range from the following:

Resistors: 1Ω–10kΩ, 10Ω–100kΩ, 100Ω–1MΩ, 1kΩ–10MΩ.

Condensers: 1pF–0.01μF, 10pF–0.1μF, 100pF–1μF, 0.001μF–10μF.

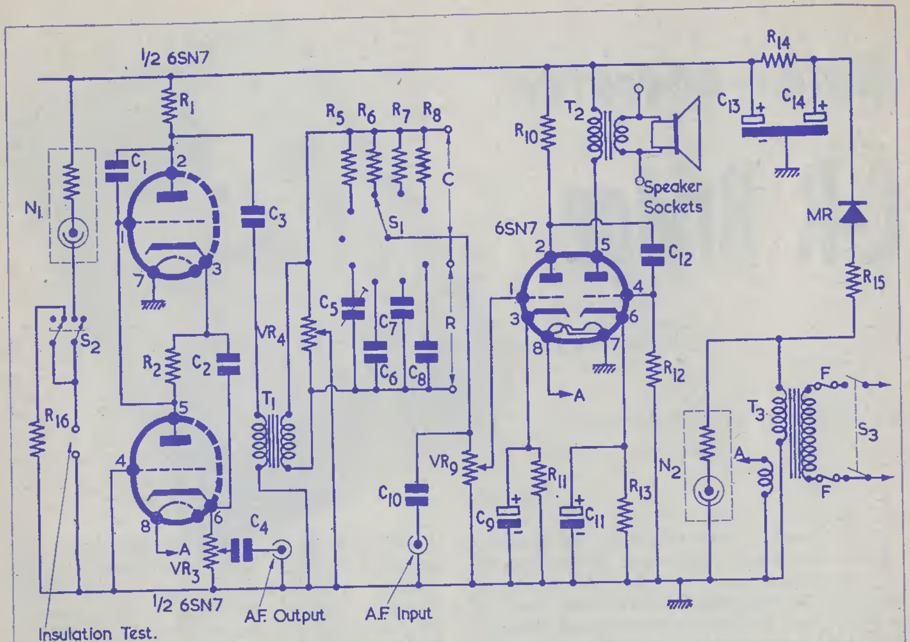
The balance potentiometer VR_4 provides a very wide coverage inside the range selected by S_1, and its scale tends to cramp at the extreme ends. Because of this, very accurate readings are not possible below 10pF and above 1μF, or below 10Ω and above 1MΩ. Readings which would appear at the extreme ends of VR_4 scale on intermediate ranges may be more accurately determined by switching to a higher or lower range, as applicable. A common scale, calibrated 0.01 to 100, is fitted to the balance potentiometer, and is employed on all ranges. VR_4 is a linear wirewound potentiometer having as large a diameter as possible, and a value lying between 10 and 50kΩ.

The standards R_{5-8} and C_{5-8} are components of 5% tolerance or better with the exception of C_5 and C_8. C_5 is a 250pF trimmer and this is adjusted to give a balance at 100pF when a 100pF condenser is connected to the test sockets. C_8 will probably not be obtainable with the required tolerance stated and must either be selected using another bridge or using the 0.01μF range on this equipment.

The unbalance signal from the bridge is fed via the volume control VR_9 to the amplifier which consists of another 6SN7 double triode, and gives adequate output for this purpose. The gain is sufficient to trace an a.f. signal directly from a crystal pick-up. The output is delivered to a 3½in diameter p.m. speaker through a small speaker transformer, T_2.

The power supply is quite conventional, a mains transformer being used to isolate the chassis from the mains, this being useful if connection is to be made to equipment having a non-isolated chassis. If such connection is made, however, care must be taken to ensure that the equipment having the non-isolated chassis is connected to the mains the correct way round, otherwise the co-axial sockets, bolts, etc., of the C-R bridge will be live and the operator may receive an accidental shock.

The neon condenser leakage test is made by connecting the condenser to the appropriate sockets, thus placing it in series with the neon across the h.t. supply. In the



Circuit of the Mains Operated C-R Bridge.

Components List

Resistors

- R_1 10kΩ
- R_2 3.3kΩ
- R_5 100Ω±5%
- R_6 1kΩ±5%
- R_7 10kΩ±5%
- R_8 100kΩ±5%
- R_{10} 100kΩ
- R_{11} 3.3kΩ
- R_{12} 330kΩ
- R_{13} 2.2kΩ
- R_{14} 2kΩ 5 watt wirewound
- VR_3 2kΩ wirewound
- VR_4 See text
- VR_9 500kΩ log.
- R_{15} 150Ω

Valves

- V_1 6SN7
- V_2 6SN7
- Metal rectifier, 250V, 50mA
- Fuses 150mA
- N_1 Mains Indicating
- N_2 Mains Indicating (Both complete with series resistance)

Condensers

- C_1 0.001μF
- C_2 0.01μF
- C_3 0.01μF
- C_4 0.1μF
- C_5 250pF trimmer (see text)
- C_6 0.001μF±5%
- C_7 0.01μF±5%
- C_8 0.1μF±5% (see text)
- C_9 25μF, 25V wkg, electrolytic
- C_{10} 0.01μF
- C_{11} 25μF, 25V wkg, electrolytic
- C_{12} 0.01μF
- C_{13}, C_{14} } 16+16μF, 350V wkg, electrolytic

Transformers

- T_1 Intervalve 1:1
- T_2 Speaker 60:1
- T_3 Mains 250V at 40mA, 6.3V at 1.5A

Switches

- S_1 1 pole, 12-way, Yaxley type
- S_2 2 pole change-over
- S_3 2 pole on/off

Miscellaneous

2 co-axial sockets, 2 wander plugs, 2 crocodile clips, 7 wander plugs, nuts, bolts, etc.

original circuit and in the photograph, no switch was provided for isolating these sockets from the h.t. so care had to be taken to avoid shocks when connecting a condenser. Because of this, many readers will probably prefer to include the switch S_2 which isolates the sockets until connection has been made, and which, when switched off after a test, discharges the condenser through R_{16}.

As the layout is not critical, it is not proposed to give a detailed description of the original which was built on a Perspex panel using tag strips to hold the components. Stray capacities round the bridge circuit should be kept to a minimum as these will "blur" the balance point when reading high values of resistance. It is also advisable to keep the oscillator away from the bridge network and amplifier in order to limit unwanted pick-up.

This instrument is extremely simple and rapid in use, and the writer advises its use to check all components before they are assembled into a circuit; this may save a great deal of time at a later stage.

Resistors are simply connected across the sockets marked "R" using leads with crocodile clips, the range switch set to an appropriate position and the balance potentiometer adjusted to obtain the minimum tone from the speaker, the volume control then being turned up as the balance is approached.

Condensers are similarly tested across the "C" sockets and their insulation resistance checked by transferring the test leads to the insulation sockets and observing the neon. This will flash as the connection is made and then remain extinguished altogether, or flash very infrequently, if the insulation is good. Electrolytic condensers may not be tested for value on this instrument as no d.c. voltage is available in the bridge to maintain the necessary correct polarity.

Two components may be matched in value by turning S_1 to a vacant position and placing one component across the "R" sockets and the other across the "C" sockets.

When using the amplifier section for a.f. signal tracing, it will be necessary to prevent break-through of the 1,500 c/s tone from the oscillator. The level of this tone may be reduced to a negligible level by setting S_1 to a blank position and adjusting VR_4.

A USE FOR DISCARDED RECTIFIER VALVES

By H. J. LONG, B.E.M., G5LO

The rectifier valve in a radio or television receiver is probably the hardest worked valve in the set. Valve rectification is being largely superseded by the metal rectifier and the latest silicon rectifier. However, quite a few valve rectifiers are still to be found in radio and t.v. receivers, particularly in older models.

A popular radio receiver of a few years ago, and still giving good service today, was the a.c./d.c. type. There were many different models in this range, but most of them used a series heater chain, with half-wave valve rectification, and usually a line-cord or an adjustable mains dropper resistance.

In order to reduce excessive heat that had to be dissipated by the series resistance, quite often the output and rectifier valves would have a higher voltage heater rating. A 25 volt rating was quite common. However, in all cases of the series heater method, one important point had to be observed, namely, that all the valves in the chain *must* have the same current rating. 0.3 amps was a popular current rating, in which case the series mains dropper had to be capable of carrying 0.3 amps continuously without overheating.

Recently, the writer had such a receiver of the type mentioned in for repair. A "cold" test with the ohm-meter across the mains input indicated that the heater chain was intact and also that the on/off switch was functioning normally. Further tests showed that there was a dead short in the h.t. line. Removal of one of the electrolytic smoothing condensers and replacing it with a new one cured this trouble.

On switching on the set for test, the heaters lit up O.K. but no h.t. was indicated on checking. It was assumed that the failure of the electrolytic condenser had "stripped" the rectifier valve, which indeed it had, although the heater had remained intact.

The rectifier valve in question was a type 25Z4G. Reference to the valve data book showed that this valve was a half-wave rectifier, designed for a.c./d.c. receivers. Heater rating was 25 volts at 0.3 amps. Maximum anode volts 250 (r.m.s.). Maximum current 100mA.

Circuit Details

The circuit relating to the rectifier valve in this particular receiver is shown in Fig. 1, together with the key to the base connections.

A search through the "spares" box failed to produce any similar type of valve, and some difficulty was experienced in getting an exact replacement. A further search brought to light some discarded t.v. rectifier valves of the type PZ30. These had been discarded from a t.v. through failing emission, although the heaters were intact.

Why not try out this valve as a half-wave rectifier in the receiver?

Results

Fig. 2 shows the few alterations required in the wiring, together with the key to the valve base connections of the PZ30.

On switching on the receiver, it was found that the set worked normally. A check of the h.t. showed that 230 volts was available on load. Although the rectifier valve had been discarded from the t.v. set due to failing emission, it was perfectly capable of supplying the lighter load required by the receiver. Two other PZ30 valves tried gave similar results.

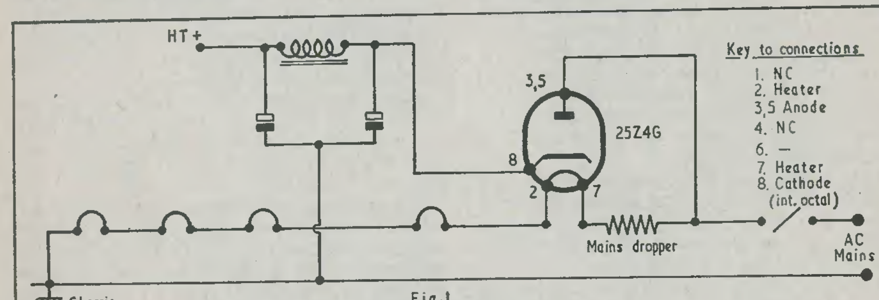


Fig. 1
Circuit of 25Z4G rectifier
Although the anode of the 25Z4G is taken to both pin 3 & pin 5, only pin 3 was wired in the receiver discussed

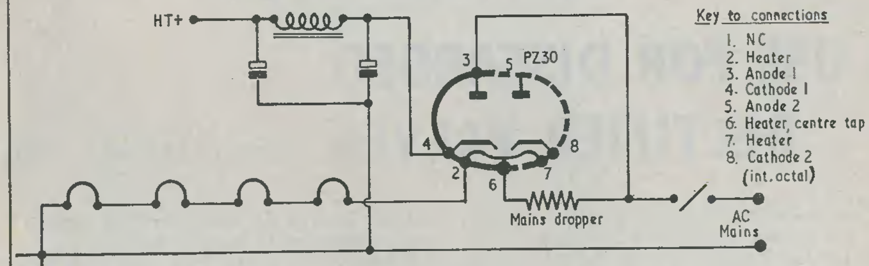


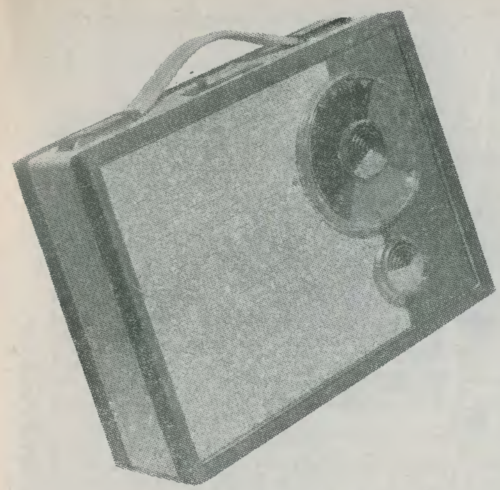
Fig. 2
Showing circuit alterations for PZ30 rectifier
Connections from pin 7 transfered to pin 6
Connections from pin 8 to pin 4
Pins 2 & 3 left as before

E763

Consulting the valve data book again showed that the PZ30 was a dual purpose rectifier; in fact, it has two separate half-wave rectifiers in the one glass envelope. The heater rating is given as 52 volts with a current of 0.3 amps. Also, the 52 volt heater has a centre tap, which is brought out to a separate pin on the octal base. This turned out to be extremely useful, for only half the heater need be used (26 volts) and no adjustment of the series heater resistance would be required.

It might so happen that one half of the rectifier is well "down" in emission, in which case the other half of the rectifier can be quickly wired into circuit.

This is put forward as a practical use for otherwise discarded rectifier valves, and as one way of effecting a repair as economically as possible for an old age pensioner friend.



The continental SIX

Described by P. VERNON

(This article describes a six transistor fully tunable Medium and Long wave superhet with push-pull output. It is a combined car radio and portable receiver. —Editor.)

From time to time the writer receives requests from readers to describe a portable receiver that may be used either in the normal manner or as a car radio for use on those occasions when a little music will help to shorten the journey—or at least appear to do so! The main requirements appear to be a receiver that will produce excellent results with the minimum amount of effort, radio know-how and expense.

The "Continental 6" is relatively simple to construct, having a printed circuit board on which the position to be occupied by every component is clearly marked. In this manner, even the veriest beginner will find that wiring errors are obviated and that the assembly is simplicity itself.

Another virtue of this design is its adaptability for use as a car radio simply by connecting the external car aerial to the socket provided at the side of the attractive two-tone vynide covered case. Such a connection removes all directional properties from the ferrite aerial whilst, at the same time, maintaining the inherent selectivity. Attachment to the car battery is not required, the internal battery of the receiver having a working life, under normal usage, of some four to six months.

The technical specification of the design is shown in the accompanying Table.

Circuit

This is shown in Fig. 1. It will be seen that the circuit is that of a perfectly straightforward standard design, all the additional information required being contained in the technical specification. Wiring errors are obviated by the use of a printed circuit board, the positions of components being clearly marked. Frequent references to the drawings and illustration given with this article will greatly assist construction.

Assembling and Wiring the Circuit

Transistors and crystal diodes can easily be damaged by wrong connection or overheating when soldering the connecting wires to the printed circuit board. In order to prevent heat damage, the transistor connecting wires should be held with a pair of thin nosed pliers in such a manner that the heat is conducted away from the transistors whilst being soldered. The printed circuit board itself is quite robust but care should be taken that heat is not applied for longer than necessary to the thin copper conductors. In order to obtain a sound soldered joint, only good quality resin-cored solder should be used. All components should be treated with some care when being fitted to the board and soldered—they can also be easily damaged through bad handling or overheating. It is important that the correct polarity of the electrolytic condensers is observed. Carefully mount the condensers in such a manner that the negative connections are as shown in Fig. 2. Note also that the two germanium diodes must be mounted into position with correct polarity as shown in Fig. 2.

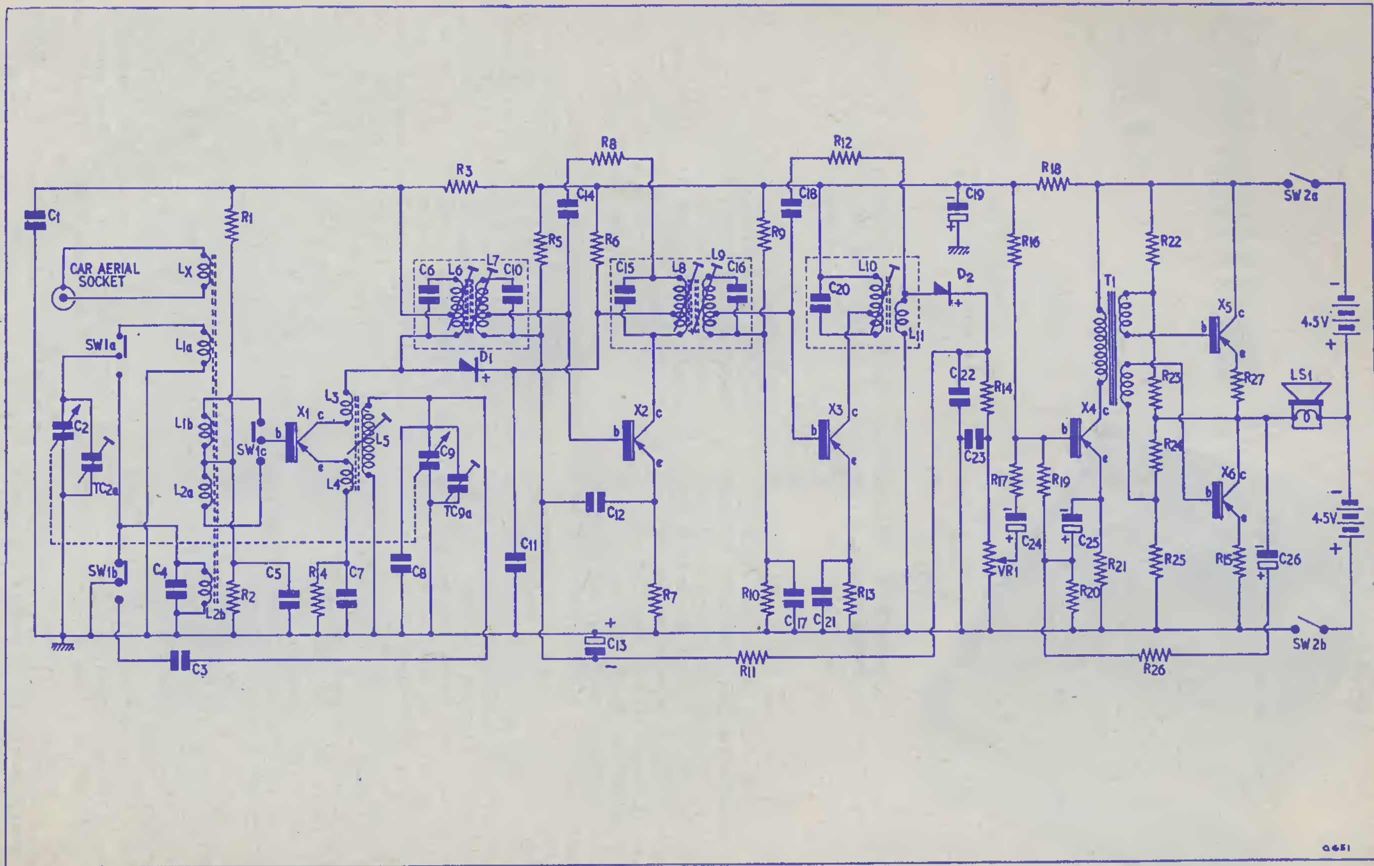


Fig. 1. Circuit of the "Continental 6" combined car radio and portable receiver

The illustrations shown herewith give a clear indication of all the component positions, those in the diagram of Fig. 2 being visible in the photograph. The ferrite aerial rod should be handled carefully, this material is rather brittle and will easily break under pressure or impact. All connections, together with the wiring colour code, are shown in both Figs. 2 and 3.

The printed circuit board should first be wired with the necessary components, Fig. 2 showing these in detail. Solder into position the resistors and condensers and complete the board by mounting into position, and connecting into circuit, the various transformers and coils. The circuit board itself is clearly marked, therefore no difficulty should be encountered here. Fig. 4 shows the reverse side of the printed circuit board, it will be noted that two fixing brackets are required. Ensure that these brackets are securely fastened, one under the volume control fixing nut and the other under one of the tuning condenser screws. These brackets each have a small spigot which locates into a hole in the printed circuit

Components List

(Set out for easy reference to Fig. 1)

Resistors

R_1	33kΩ±10%
R_2	8.2kΩ±10%
R_3	390Ω±10%
R_4	3.3kΩ±10%
R_5	56kΩ±10%
R_6	1kΩ±10%
R_7	680Ω±10%
R_8	3.3kΩ±10%
R_9	15kΩ±10%
R_{10}	3.3kΩ±10%
R_{11}	8.2kΩ±10%
R_{12}	2.2kΩ±10%
R_{13}	1kΩ±10%
R_{14}	470Ω±10%
R_{15}	5.6Ω±10%
R_{16}	27kΩ±10%
R_{17}	330Ω±10%
R_{18}	150Ω±10%
R_{19}	8.2kΩ±10%
R_{20}	10Ω±10%
R_{21}	330Ω±10%
R_{22}	2.2kΩ±5%
R_{23}	100Ω±5%
R_{24}	2.2kΩ±5%
R_{25}	100Ω±5%
R_{26}	470Ω±10%
R_{27}	5.6Ω±10%

Condensers

C_1	0.04μF, 150V±20%
C_2	Variable (ganged with C_9). Henry's Radio Ltd.
C_3	350pF, 125V, Polystyrene, ±1%
C_4	100pF±2%
C_5	0.04μF, 150V±20%
C_6	400pF (part of L6)
C_7	0.02μF, 150V±20%
C_8	8.2pF±10%
C_9	Variable (ganged with C_2). Henry's Radio Ltd.
C_{10}	400pF (part of L_7)
C_{11}	0.04μF, 150V±20%
C_{12}	0.04μF, 150V±20%
C_{13}	8μF, 6V, electrolytic
C_{14}	13pF±5%
C_{15}	400pF (part of L_8)
C_{16}	400pF (part of L_9)
C_{17}	0.04μF, 150V±20%
C_{18}	25pF±5%
C_{19}	250μF, 12V, electrolytic
C_{20}	250pF (part of L_{10})
C_{21}	0.04μF, 150V±20%
C_{22}	0.02μF, 150V±20%
C_{23}	0.02μF, 150V±20%
C_{24}	8μF, 6V, electrolytic
C_{25}	100μF, 18V, electrolytic
C_{26}	100μF, 18V, electrolytic

Transistors

X_1	Mazda XA102
X_2	Mazda XA101
X_3	Mazda XA101
X_4	Mazda XB103
X_5	Mazda XC101 } Matched pair
X_6	Mazda XC101 } Matched pair

Semi-Conductors

D_1	Mazda CG6E
D_2	Mazda CG12E

Coils

L_1, L_2	Ferrite aerial assembly
L_x	Car Aerial Coupling Coil
L_3, L_4, L_5	Oscillator coil
L_6, L_7	Double tuned i.f.
L_8, L_9	Double tuned i.f.
L_{10}, L_{11}	Single tuned i.f.

Coils (Henry's Radio Ltd.)

Cabinet, dial, etc. (Henry's Radio Ltd.)

Miscellaneous

T_1	Transformer, printed circuit mounting (Henry's Radio Ltd.)
LS	5in speaker, 25Ω (Henry's Radio Ltd.)
VR_1	5kΩ semi-log
SW_1	3-pole, 2-way, wavechange
SW_2	On/off (part of VR_1)
Printed Circuit Board (Henry's Radio Ltd.)	
TC_{2a}	Trimmer (part of variable condenser)
TC_{9a}	Trimmer (part of variable condenser)

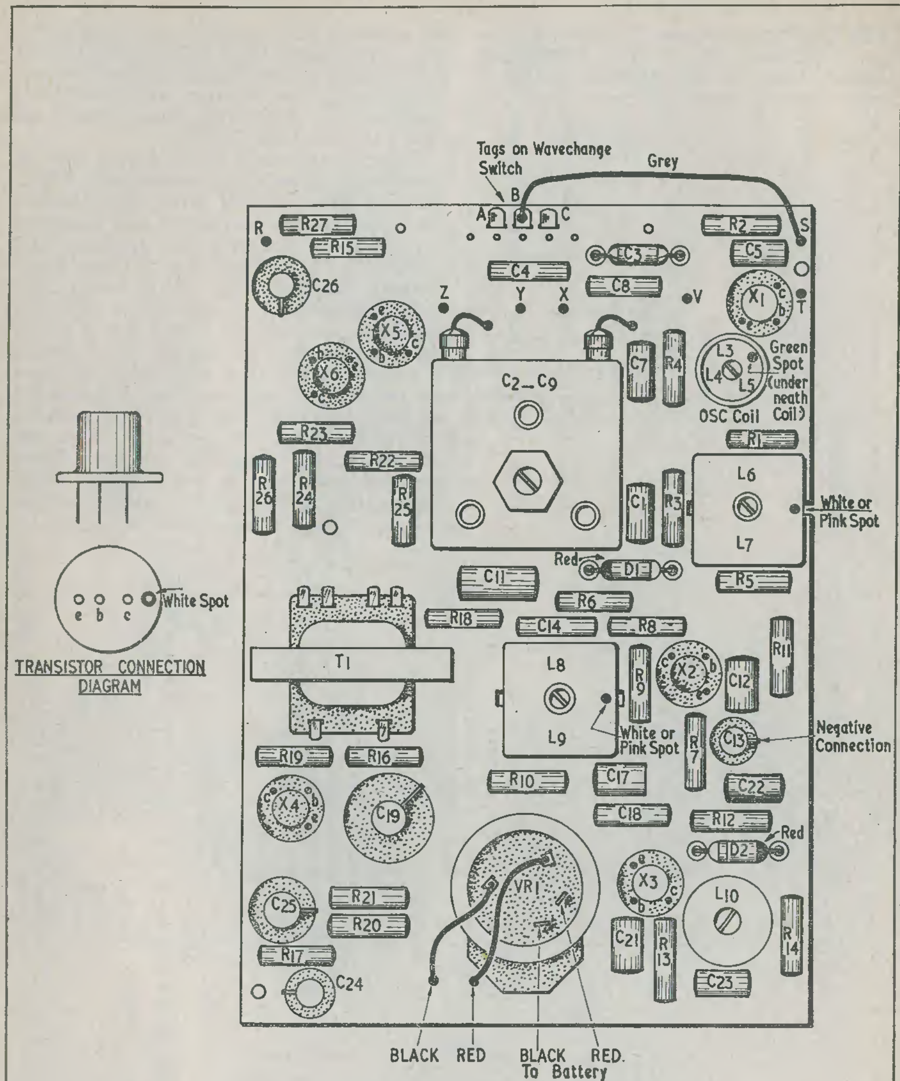


Fig. 2. Layout of components on the printed circuit board. Connections and wire colours to points R.T. and Y.Z.V, together with the remaining tags A and C on the wavechange switch, are shown in Fig. 3. The oscillator coil L_3, L_4, L_5, must be mounted with the green spot (marked below the coil), relative to the edge of the printed circuit board as shown in the diagram. The i.f. coil L_8, L_9, should be mounted so that the blank pin locates with the hole NOT connected to the copper pattern

board. The brackets secure the board to the case by means of two 4BA countersunk screws, these being inserted from the front of the case. It will be found that these screws project somewhat through the brackets and care should therefore be taken with the soldering of the board at the rear of the brackets. Bulky soldering here may possibly cause a short circuit. Once secured into position, VR_1, together with C_2, C_9, should be soldered into circuit.

Once the printed circuit board wiring itself has been completed, the speaker should next be mounted in the case as shown in Fig. 3. The board is not mounted yet.

The wavechange switch control may now be fitted to the board and coupled with the wire connecting link shown in Fig. 5. The body of the switch is on the printed side of the board. The short end of the wire coupler must be attached to the wavechange switch before the printed board is mounted into the case, crimping the wire ends of the coupler with a pair of pliers. The switch should be set to the MW position (to the left when viewed from the back of the case), before fitting the coupling wire. The wavechange switch escutcheon is secured to the case ensuring that the letter "L" is fully visible when the control is at the left of two gimp pins. The two station indicators are already fitted and located at the front of the case on either side of the centre of the dial.

Fit the ferrite frame aerial to the board assembly by means of the bracket provided, this latter securing to the rear of the variable condenser by means of two 4BA screws. Complete the wiring to the ferrite frame aerial and wavechange switch which is illustrated in Fig. 3, fitting also at this stage the white lead to point R.

It will be noted that the apertures on the front of the case for the spindles of the tuning and volume controls are covered with vynide cloth. These should be cleared with the aid of a sharp razor blade.

Mount the printed circuit board into the case. At the rear of the case will be found a small wood block covered with plastic foam. When the circuit board is finally fitted, the end of the ferrite rod aerial may be secured to this block by means of an elastic band, this being slipped into the groove provided on the block. Complete the speaker, on-off switch and battery connections shown in Fig. 3.

Also, couple the wire connecting link from the wavechange switch to the cabinet control section, in the manner illustrated in Fig. 5.

The tuning dial and volume control knobs

TECHNICAL SPECIFICATION—"CONTINENTAL 6"

A fully transistorised MW/LW circuit incorporating a self-oscillating mixer, two i.f. stages, audio amplifier, and a single-ended push-pull output stage. Both i.f. stages include double-tuned transformers. Two germanium diodes are employed, D_2 as detector, and D_1 assisting the a.g.c. operation as a variable damping element.

1.	*Frequency Range* ..	MW 540 kc/s to 1,640 kc/s. LW 160 kc/s to 270 kc/s.
2.	*Sensitivity*	MW at 1,000 kc/s—140μV/Metre } for 5mW output. LW at 210 kc/s—150μV/Metre } for 5mW output.
3.	*Adjacent Channel Selectivity* ..	MW at 1,000 kc/s—32dB. LW at 210 kc/s—39db.
4.	*I.F. Frequency* ..	470 kc/s.
5.	*A.G.C.*	For signal input change of 60dB, output varies less than 6dB.
6.	*Power Output* ..	400mW at 10% distortion into 25Ω speaker.
7.	*Image Rejection* ..	50dB on LW, 38–47dB on MW.
8.	*I.F. Rejection* ..	36dB to 45dB.
9.	*Controls*	Tuning: Direct drive via integral slow motion to ganged condenser. Volume: Variable potentiometer first audio stage.
10.	*Speaker*	5in round, 12,000 line, 25Ω.
11.	*Transistors*	Mazda: XA102 Self-oscillating mixer. XA101 } I.F. amplifiers. XA101 } I.F. amplifiers. XB103 Audio amplifier. XC101 } Single-ended push-pull amplifier. XC101 } Single-ended push-pull amplifier.
12.	*Power Supplies* ..	4.5V+4.5V dry battery PP11 or equivalent. 150–200 hours life.
13.	*Power Consumption*	15mA under quiescent conditions—average listening leve 25–30mA.
14.	*Sockets*	Aerial, suitable for insertion of car radio aerial.
15.	*Case*	Two-tone, vynide covered, white plastic spring-loaded handle.

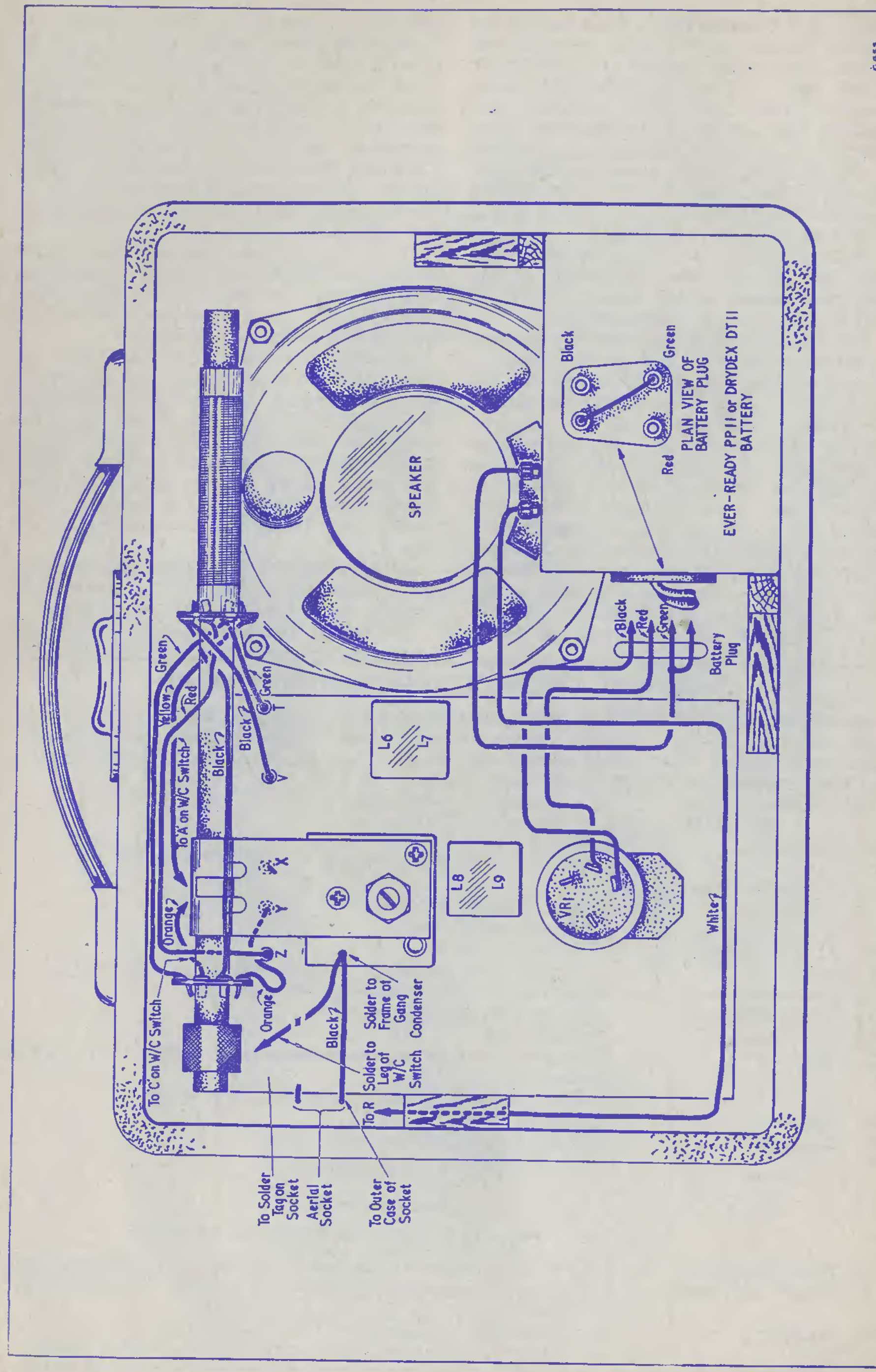


Fig. 3. Showing the positions of the speaker, printed circuit board, battery, ferrite aerial, etc., within the case

should next be fitted. It is essential that the variable condenser spindles, which are "D" shaped, are turned until the "flats" are in line with each other. The station scale is fitted first, this being pushed on in order to clear the first section of spindle. The outer thumb wheel of the dial is then fitted by simply pushing on to the spindle. The volume control on/off switch spindle is also "D" shaped and the control knob therefore also a "push-on" type.

Check the battery lead connections carefully before switching on—wrong polarity or reversed leads may completely damage the transistors.

The circuit will operate efficiently from a car radio aerial, a special socket being provided and affixed to the side of the case by means of two split pins being pushed into the holes already drilled for this purpose.

Aligning the Receiver

The circuit should be aligned by using a signal generator and an output meter. If, however, such equipment is not available, good results can still be obtained by aural methods using broadcast stations as the source of signals. The respective procedures for these two methods are as follows:

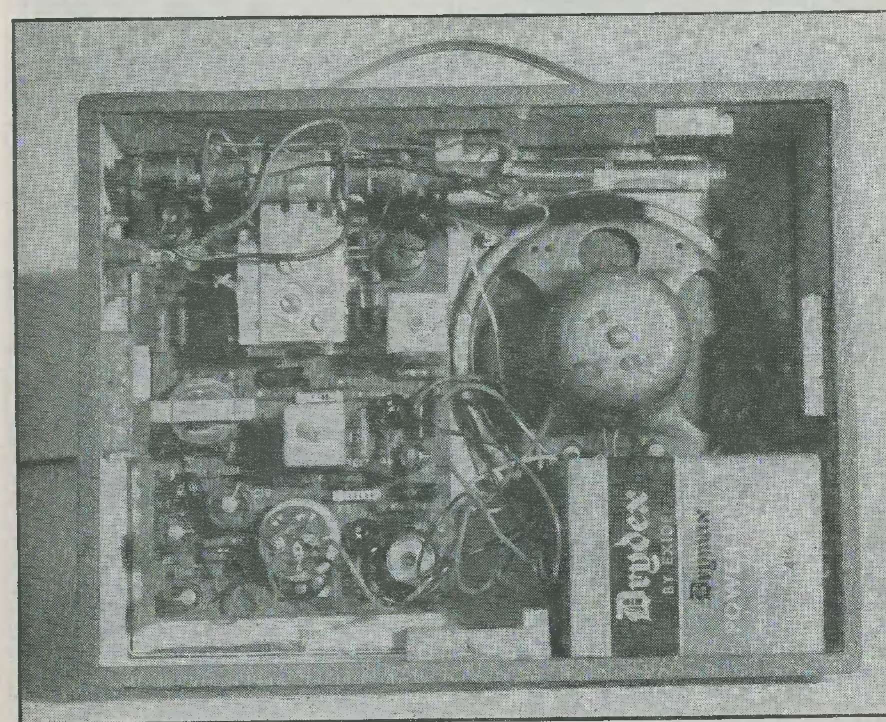
Procedure Using Signal Generator

Equipment Required

Output power meter. (Avometer or similar instrument.)

Modulated signal generator covering the i.f., M.W. and L.W. bands.

Suitable radiator or loop. (The loop used for the accompanying measurements consisted of three turns of copper wire, 0.25 metres (approximately 9½in) diameter, plus a series resistor of 430Ω. The loop should be situated 0.6 metres (approximately 24in) from the receiver ferrite rod.



The completed receiver. Compare with Fig. 3 on opposite page.

I.F. Stages. (For these measurements a 0.5μF capacitor and 820Ω resistor must be used in series with the generator output lead.

1. Connect output power meter across speaker terminals.
2. Connect signal generator to base of X_3. Set generator to 470 kc/s. Adjust L_{10} for maximum output.
3. Transfer signal generator to base of X_2. Adjust L_8 and L_9 for maximum output.

4. Connect the signal generator to the base of mixer X_1 and with C_2 bypassed with a 1μF capacitor, adjust L_6 and L_7 for maximum output.

adjust L_{2b} for maximum output.

NOTE: In all cases, signal generator output should be set to the minimum level for an adequate deflection of the output meter.

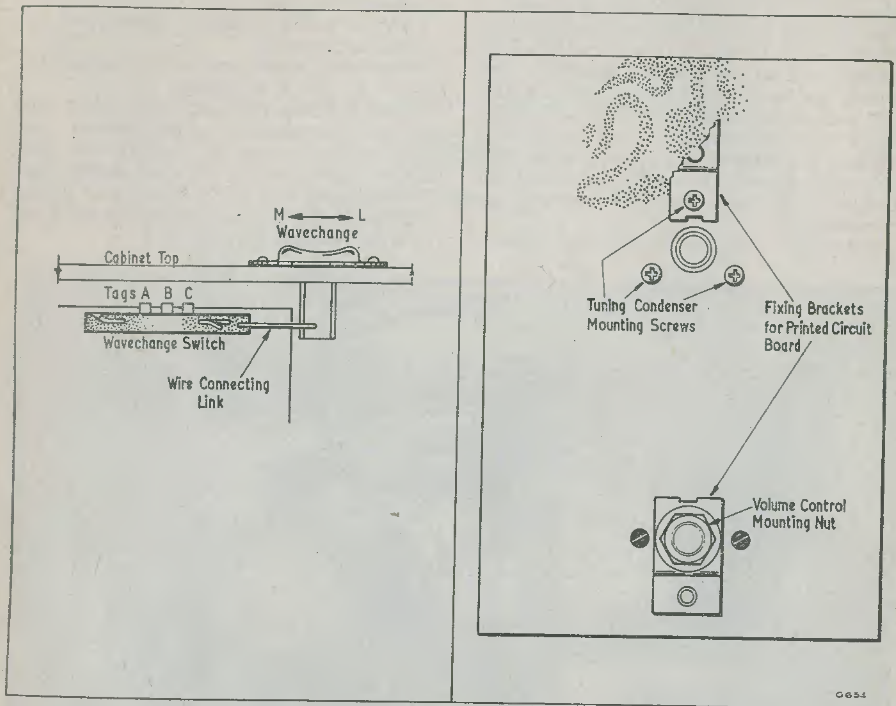


Fig. 4 (right). The reverse side of the printed circuit board
Fig. 5 (left). Assembly of the wavechange switch mechanism looking at the rear of the cabinet

5. With the generator connected as in 4, the circuit switched to M.W. and the variable condenser at maximum capacity, set the generator to 540 kc/s and adjust L_5 for maximum output.

6. Set the variable condenser at minimum capacity and the generator to 1,640 kc/s. Adjust TC_{9a} for maximum output. Repeat operations 5 and 6 to ensure correct coverage.

Signal Circuit. (Remove 1μF from across C_2.)

1. Connect loop to signal generator, set generator to 600 kc/s. Tune the variable condenser to 600 kc/s and adjust $L_{1}a$ for maximum output.

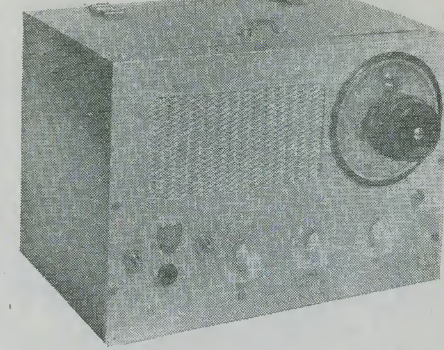
2. Set generator to 1,400 kc/s, tune the condenser to 1,400 kc/s and adjust TC_{2a} for maximum output. Repeat operations 1 and 2 to ensure optimum tracking.

3. Switch circuit to L.W., set generator to 220 kc/s, tune gang capacitor to 220 kc/s,

Procedure Using Broadcast Stations

1. Connect output meter across loudspeaker terminals.
2. Tune to a strong local station by means of the variable condenser. Turn the volume control to maximum.
3. Orientate the printed board and aerial for minimum audible output.
4. Adjust L_{10} for maximum output.
5. Adjust L_8, L_9 for maximum output.
6. Adjust L_6, L_7 for maximum output.
7. Tune by means of the condenser to a station whose frequency is in the region 540–650 kc/s. Orientate as above for minimum audible output. (This is to prevent the a.g.c. action masking the effects of adjustment.) Adjust L_5 for maximum output at correct dial reading.
8. Tune to a station in the region of 1,300–1,640 kc/s. Re-orientate if necessary. Adjust TC_{9a} for maximum output at correct dial reading. *Continued on page 935*

The "Globe-King" 300/A A.C. Mains SHORT WAVE RECEIVER



Described by James S. Kent

PROBABLY ONE OF THE MOST FREQUENT requests received by this magazine is that from readers, often young in the hobby, who require a good and reliable Short wave receiver, relatively inexpensive and easy to construct. Such a design should serve, more often than not, as an introduction to the hobby, both in the constructional and the operational sense. The romantic atmosphere of Short wave listening and operating is one that most of us know, and remember, with nostalgia, long after we have given up the active listening side of the pastime. The memories of evening and early morning listening sessions, not to mention the long night watches, crowd in upon us as we mentally scan the past.

In his "Introduction to the Short Waves" (*Short Wave Receivers for the Beginner*—published by Data Publications Ltd.), Frank A. Baldwin, A.M.I.P.R.E., aptly describes Short wave listening, from the beginner's point of view, in the following manner:

"To the beginner, the Short wave spectrum represents a whole vast unexplored world—a world in which no frontiers exist, no passports are needed and no visas are required. With the aid of a very simple receiver, the beginner is able to explore this new world and to reach into the uttermost corners of the globe. To the new Short wave listener, enthusiastically tuning his receiver for the first time, such faraway places as Pernambuco, Nairobi, Karachi, Rangoon, Goa, Peking and Wellington are likely, given favourable conditions, to burst upon his ears, with their short wave radio transmissions reaching him over many thousands of miles of land and sea."

To those beginners for whom this article is intended, and who have read the above paragraph for the first time, the writer would say two things, (*a*) there is nothing he can add to the above, and (*b*) he would recommend this book to them.

300/A General Description

This receiver has been designed to operate from an a.c. mains supply of 200/250V. It is perfectly safe to handle due to the inclusion of a double wound mains transformer, and therefore the chassis is completely isolated from the mains. The phone jack is also safe in that it is isolated from the output anode circuit. Three new type fully enclosed coils are utilised, these being of the plug-in variety. Being fully enclosed, they are perfectly safe when handled in the process of coil changing and, in addition, impart a further advantage in that they are incapable of variation with respect to frequency coverage. The range of these coils are as follows: Coil No. 1, 30 to 17.5 Mc/s; Coil No. 2, 15 to 7.5 Mc/s; Coil No. 3, 7.3 to 3 Mc/s. Coil changing is effected by means of the lift-up lid of the attractive grey hammered case shown in the article heading. The use of plug-in coils is preferred in beginner constructed receivers by virtue of the fact that the wiring is very much

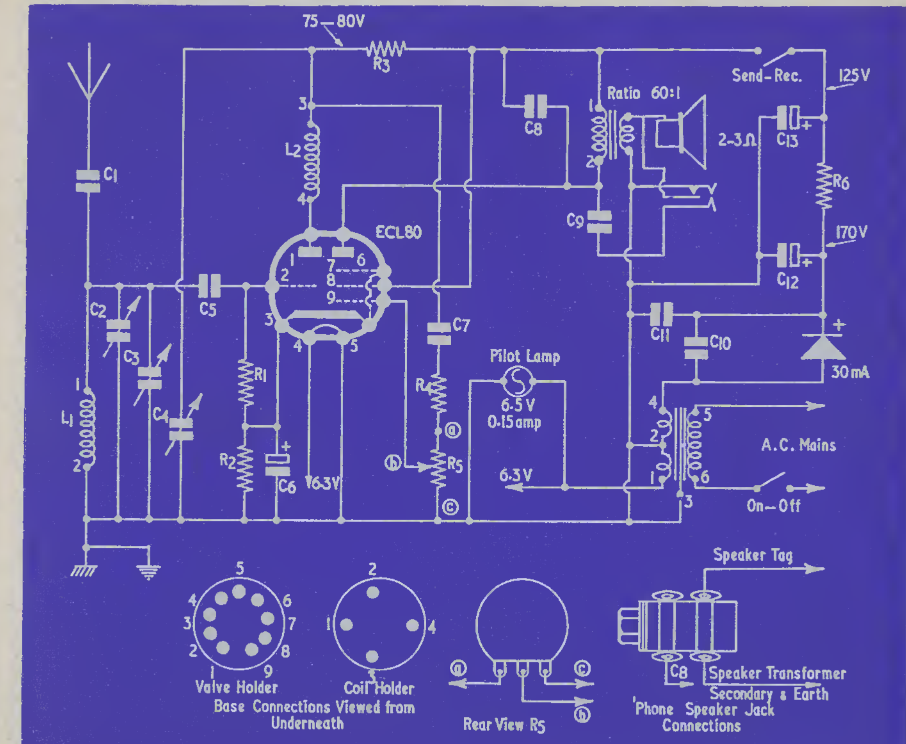


FIG. 1

CIRCUIT OF THE "GLOBE-KING" S.W. RECEIVER

Components List

Resistors

- R_1 3.3MΩ ¼ watt
- R_2 470Ω ½ watt
- R_3 180kΩ ½ watt
- R_4 10kΩ ½ watt
- R_5 500kΩ pot.
- R_6 5kΩ 3–5 watt

Cabinet and Chassis

12in x 8in x 8in, ready drilled (Johnson's Radio)

Speaker

Elac 7in x 4in elliptical

Transformers

Output (Wharfedale OP3)
Mains (Johnson's Radio)

Dials, Knobs, etc.

Johnson's Radio

Rectifier

200/250V at 30mA

Switches, Hardware, etc.

Johnson's Radio

Condensers

- C_1 5pF, mica
- C_2 140pF, variable } Johnson's Radio
- C_3 10pF, variable } Johnson's Radio
- C_4 140pF, variable } Johnson's Radio
- C_5 0.0002μF, mica
- C_6 25μF, 25V, electrolytic
- C_7 0.05μF, tubular
- C_8 0.005μF, tubular
- C_9 0.1μF, tubular
- C_{10} 0.01μF, tubular } 250V a.c. wkg.
- C_{11} 0.01μF, tubular } 250V a.c. wkg.
- $C_{12, 13}$ 32μF, 350V, electrolytic

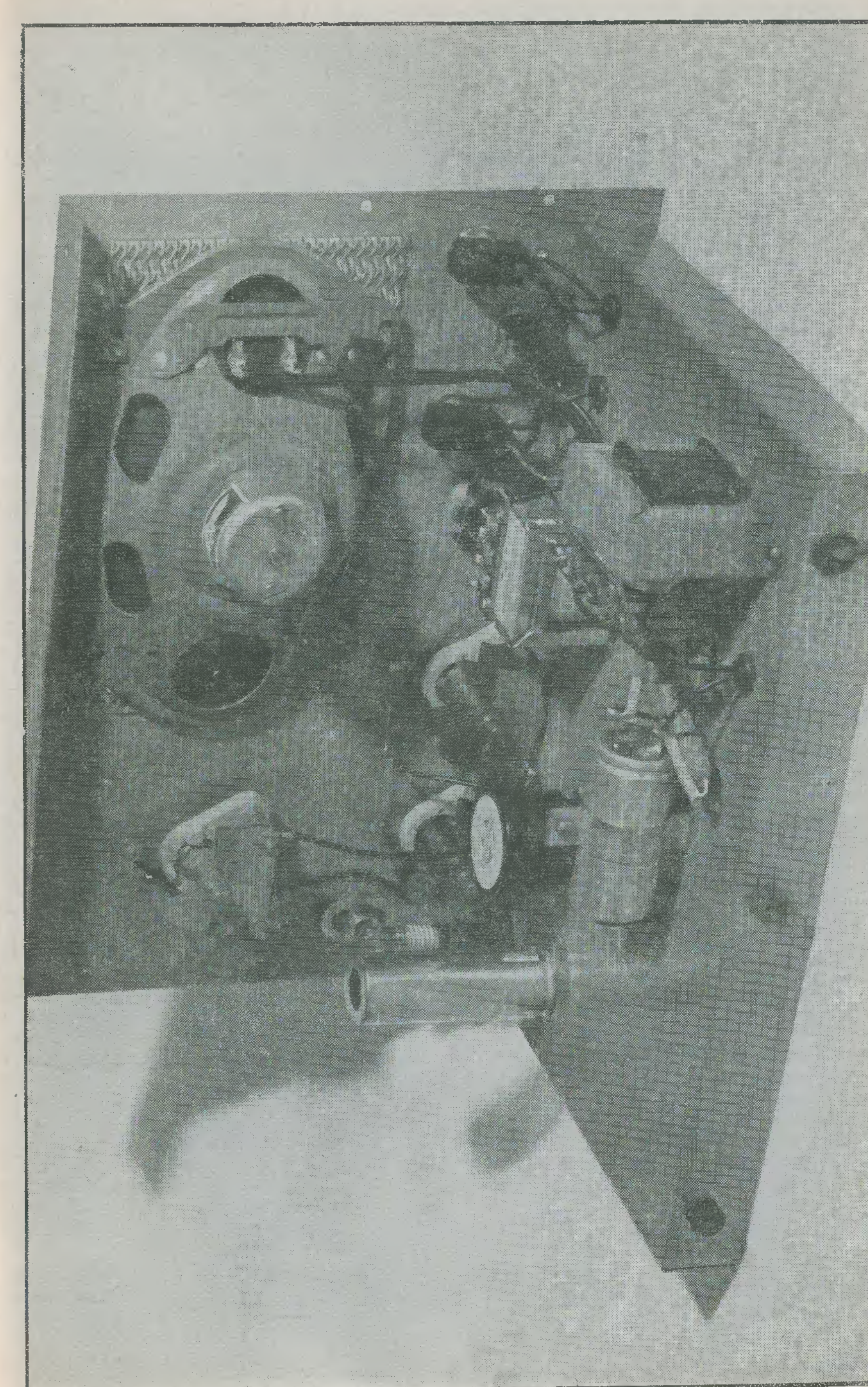
Coils and Holder

Johnson's Radio

Valve

ECL80 Mullard

Fig. 1.—Note that centre contact of headphone jack should be connected to opposite side of speaker and not as shown.
Headphone jack inset—for C_8 read C_9.



Above-chassis view of the completed receiver showing layout of main components simplified over that of the wavechange switch method of band changing.

Looking at the heading illustration, the panel controls are as follows: top right, bandspread (direct and 55/1 drive); bottom, left to right, standby switch; phone jack; on/off switch; volume control; reaction; bandset; on/off indicator panel light. These, with the speaker mesh grill, form an attractive and efficient panel layout.

A 7in x 4in elliptical speaker is mounted on the front panel, this being automatically muted when the headphone plug is inserted into the jack.

Circuit

This is shown in Fig. 1. The aerial is fed, via C_1, to the primary winding L_1, this being tuned by the variable condensers C_2 (bandset) and C_3 (bandspread). The grid bias resistor R_1, together with the condenser C_5, have values chosen to provide a time constant which will produce positive feedback, or reaction, free from overlap or backlash. In a receiver of this nature, this is extremely important if maximum sensitivity and overall performance are to be obtained. The combination of R_2 and C_6 provides the required bias for the cathode of the ECL80 miniature triode pentode. The secondary winding L_2 acts as the reaction component which, in conjunction with the variable condenser C_4, controls the amount of positive feedback; in addition to which it also performs as the r.f. choke. The resultant rectified output is then fed, via C_7, and R_4, to the volume control R_5, from which latter point a controllable amount of audio is applied to the grid of the output pentode section. The, by now greatly amplified audio signal is then taken from the anode to the output transformer primary winding, and fed, via the secondary winding, to the speaker. The condenser C_8 is included for tone correction purposes. The headphone output is taken direct from the anode via the isolating condenser C_9. The send/receive switch is incorporated into the main h.t.+ line.

The power supply circuit consists of the double wound mains transformer, the on/off switch being incorporated in one of the a.c. mains leads. The primary winding is rated at 200/250 volts a.c., and the secondary winding at 175V at 25mA. The heater winding is rated at 6.3V at 0.6A. The metal rectifier is rated at 200/250V at 30mA. The condensers C_{10} and C_{11} are included to help remove a.c. mains ripple and obviate modulation hum. The resistor R_6, together with the electrolytic condensers C_{12} and C_{13}, are the required smoothing components, this resistor having a rating of 3 to 5 watts.

Three voltages are included as a guide for testing purposes, these being 170V and 125V on the positive tags of C_{12} and C_{13} respectively, and 75 to 80V at pin 3 of the coil holder. All readings obtained under no signal conditions with the volume control R_5 set at maximum.

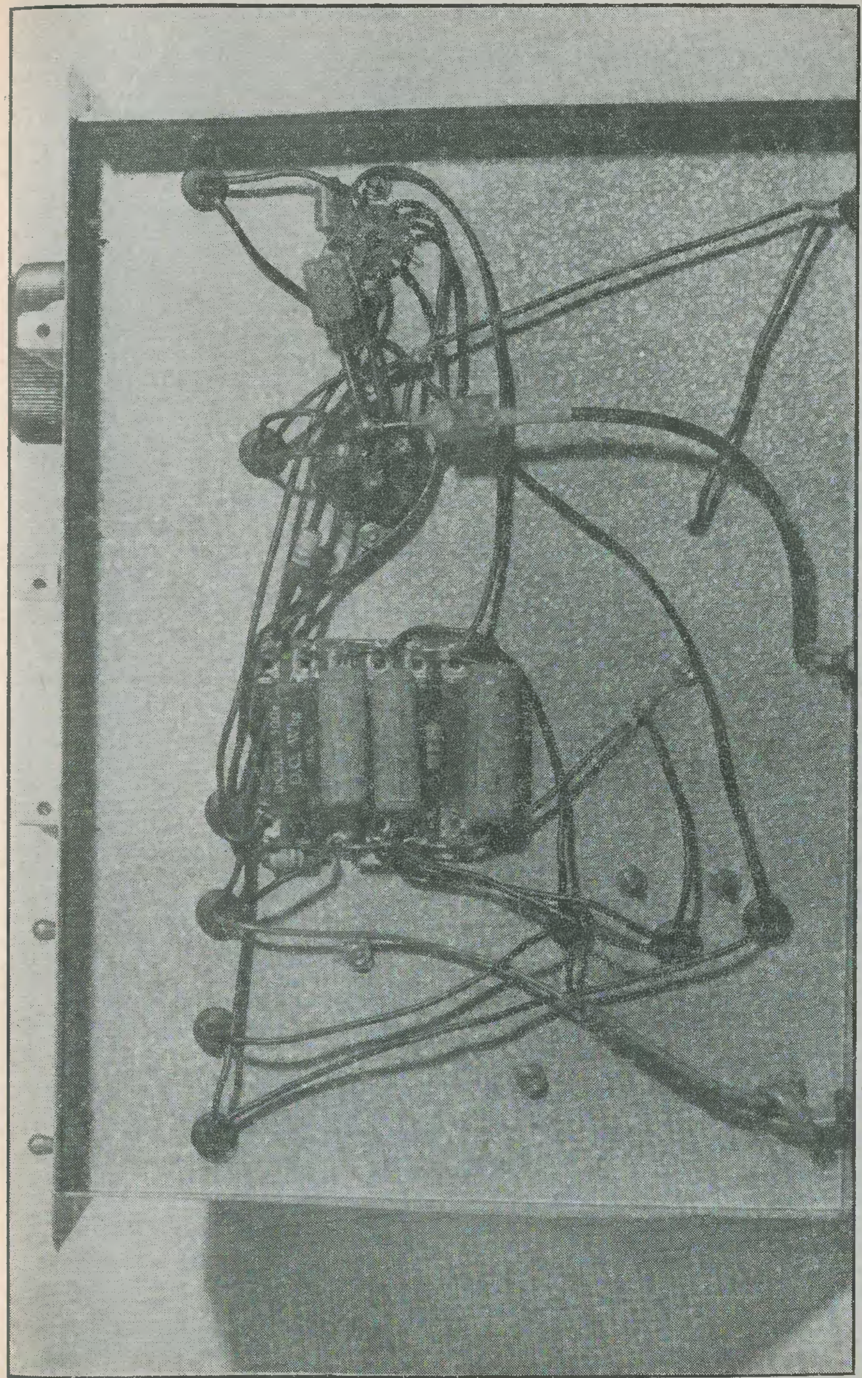
Also shown in Fig. 1 are the coil connections, looking at the underside of the holder; the headphone connections and the valveholder and volume control connections.

Assembly

As received, the panel is already drilled. In addition, the valve and coil holder holes are also drilled. Firstly mount into position the valveholder so that pins 4 and 5 are nearest to the side chassis wall. Secure into position by means of two 6BA screws and nuts, not forgetting to mount a brass washer under each nut. Secure to the chassis, in a similar manner with 4BA screws, the coil holder, noting from the photograph herewith the correct orientation of this component, and also that the flanges should be situated on the underside of the chassis. To that screw nearest the valveholder, fit a solder tag, having firstly scraped away the grey hammer finish so that the solder tag makes a good contact with the bright metal underneath. Secure into position the mains transformer and the output transformer by means of 4BA screws and nuts, firstly having scraped away the grey hammer finish under the chassis so that the nuts are firmly in contact with the bright metalising of the chassis via the brass washers. See photograph of above chassis view for the correct positioning of these two transformers. With the output transformer, do not tighten that screw nearest the centre of the chassis as yet—this is also used to secure into position the tagboard at a later stage. Secure into position the aerial and earth sockets.

Mount into position, by means of the metal clip provided, the smoothing condensers C_{12} and C_{13}, these being both contained within a single metal can. Secure the clip to the chassis by means of a 4BA screw, washer and nut, also mounting under the washer another earth tag. Here again, the chassis must be scraped in order to obtain a good electrical earth connection. By means of the two flat-headed 6BA screws and nuts, fasten the metal rectifier to the chassis with the positive (+) connection nearest the front of the chassis (or nearest the small output transformer), and the minus (−) tag nearest the rear edge of the chassis.

Dealing now with the front panel, secure into position the send/receive switch (extreme left—viewing panel from the front), headphone jack (all washers being behind the panel—none at the front), and the on/off switch.



Under chassis and tagboard wiring of the "Globe-King"

Before mounting the volume control, the bandset and the reaction condensers into position, the spindles of these must be shortened to approximately $\frac{3}{8}$ of an inch in length from the end of the threaded portion. Use a fine hacksaw for this purpose (available in any branch of Woolworths at 1s. 6d.) and follow this by "cleaning off" the rough edges with a fine file. As these controls are fitted to the panel, slip on, under the nut, one of the small scales provided in such a manner that the figure 5 is at the top dead centre, then tighten the nut securely. Looking at the three white control knobs from left to right (heading illustration), these are the volume control, reaction control and bandset control respectively. Next, fit the three knobs to the respective spindles. When dealing with the reaction and bandset controls, secure the knobs so that the pointers indicate zero with all the moving vanes out of mesh. The volume control knob should be so fitted that with the spindle rotated fully clockwise, the pointer indicates 10 degrees.

Fit the speaker to the front panel by means of four 6BA screws passing through the panel and mesh and the speaker fixing slots. Secure with small brass washers and nuts. The speaker should be so positioned that the two connecting tags are nearest the left hand edge of the panel looking at the front of the panel. Secure to the panel the on/off indicator light assembly, both the fibre washers being contained immediately behind the panel.

The assembly of the main components is now completed.

Wiring the Receiver Circuit

The first job of work here is to solder the components to the tagboard as shown in Fig. 2. Commence by cutting to a suitable length all the wire ends of the following components: C_6, C_7, C_{10}, C_{11}, R_2 and R_4. Leave sufficient wire so that a couple of turns may be made around each tag, ensuring that the wire ends to be soldered are bright and clean so that a good soldered joint will result in each case. Solder to tags 1 and 7 the condenser C_6, taking care that the positive end is secured to tag 7. Connect R_2 between tags 2 and 8; C_{10} between tags 3 and 9; C_{11} between tags 4 and 10 and C_7 between tags 5 and 11. Next, solder R_4 between tags 5 and 6. With a short length of p.v.c. covered wire, bare both ends and connect together tags 2 and 4. Similarly deal with tags 7 and 8, using a short length of bare wire, and tags 9 and 10. Having completed this operation, the next task is to mount the plain paxolin panel, together with the tagboard, to the chassis underside as shown in the photograph. Note that the correct position of C_6 is towards the rear of the chassis. Remove that nut nearest the centre of the chassis which holds the output transformer into position. Place the plain paxolin panel into position and follow this with the wired tagboard. Secure into position with the nut.

Proceed now to wire into circuit the remainder of the tagboard connections as follows: with a length of p.v.c. covered wire, bare both ends and connect one to the earth tag mounted under the holding clip of C_{12}, C_{13}. Solder the other end to both tags 1 and 2. (See Fig. 2.) From tag 7, solder a length of p.v.c. covered wire to pin 3 of the valveholder. To tag 9, solder a length of covered wire, the other end of which is then soldered to the positive tag (+) of the metal rectifier (that tag nearest the front panel). Note that this wire will have to be fed through the rubber grommet at the rear of, and nearest to, the tagboard. To tag 11, solder a length of covered wire the other end of which is then connected to pin 3 of the coil holder. (See Fig. 1.) To tag 12, connect one end of R_3, both ends of this resistor being first covered with systoflex, and connect the other end to pin 3 of the coil holder. Also connect to the same tag, a length of p.v.c. covered wire, the other end of which is then soldered to pin 8 of the valveholder. A further two lengths of wire must now be soldered to tag 12. The first is then taken, via the rubber grommet nearest the edge of the chassis, to the standby switch. Solder this wire to that tag of the switch nearest the edge of the panel. The other wire must be taken through a convenient grommet and secured to tag 1 of the output transformer. (See Fig. 3.)

From tag 6, connect a length of covered wire to tag A of the volume control R_5. (See Fig. 1 for connections to R_5.) Similarly connect tag 4 to tag C of the volume control, feeding both these wires through a convenient rubber grommet. To tag 3 of the tagboard, next solder two lengths of p.v.c. covered wire, and via the rubber grommets, feed and connect one to tag 4 of the mains transformer, and the other to the metal rectifier negative (−) tag. (See Fig. 4 for mains transformer connections.) Connect C_8 to tags 1 & 2 of the output transformer. This completes the tagboard wiring.

From the other side, or tag, of the standby switch, solder a wire, p.v.c. covered, of sufficient length to be fed through the adjacent rubber grommet, under the chassis and through the grommet nearest the rear of the chassis, and then solder this end to the white, or plain tag of the condenser C_{12}, C_{13}, i.e. *NOT* the red coloured tag.

Deal next with the remaining connections to the output transformer. (See Fig. 3.) To tag 2, solder a length of wire, feed through a grommet, and connect the other end to pin 6 of the valveholder. Also to tag 2, solder one end of C_9, having firstly covered both suitably shortened wire ends of this condenser with systoflex. Solder the other end of C_9 to the phone jack tag. (See Fig. 1 for connections to phone jack.) Tag 3 of the output transformer is left blank. With the two enamelled wires coming from the bottom of the output transformer, cover them with systoflex, having cut them to length, scrape away a little of the enamel at the ends to be soldered, and connect one to the top speaker tag and the other to the phone jack. (See Fig. 1.) It does not matter which of these wires is connected to the speaker or phone jack. Connect the other tag of the speaker to the phone jack. To that tag joined to the metal edge of the volume control, solder a length of p.v.c. covered wire, and connect this at the other end to the phone jack. (*NOTE:* Bend this wire so that it is well clear of the tags of the on/off switch which will be discussed later. This last mentioned connection to the phone jack is marked "earth" on Fig. 1.) Next, join tag B of the volume control to pin 9 of the valveholder, using covered wire and feeding this through a grommet.

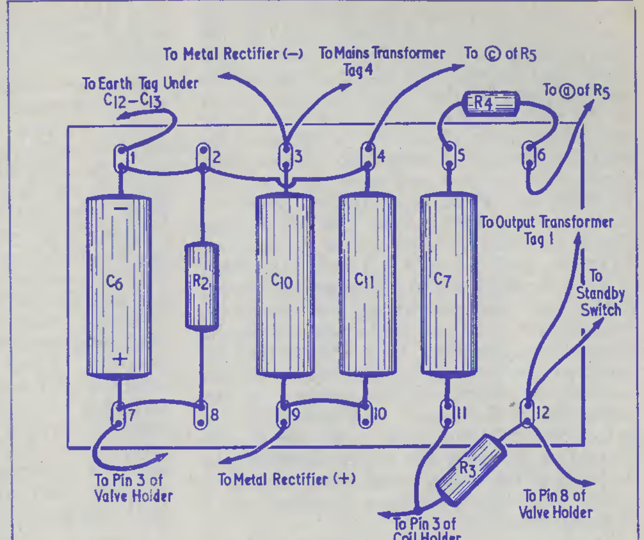


FIG. 2

TAG BOARD WIRING DIAGRAM

We next deal with the connections to the mains transformer. With a suitable length of p.v.c. covered wire, bare both ends and solder one to tag 1 of the transformer (see Fig. 4), pass under the chassis via a grommet, and up to the indicator light via the grommet nearest to this latter component. Solder this wire end to that tag of the indicator light nearest the outside edge of the chassis. With a further length of suitably covered wire, solder one end to the same tag, feed through the grommet, and connect the other end to pin 4 of the valveholder.

Still dealing with the mains transformer,

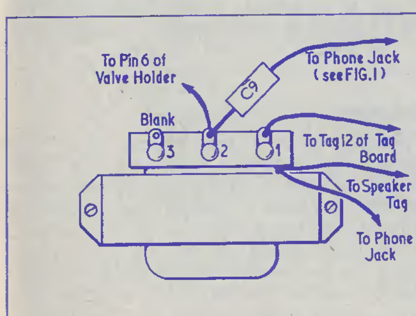


FIG. 3

OUTPUT TRANSFORMER CONNECTIONS

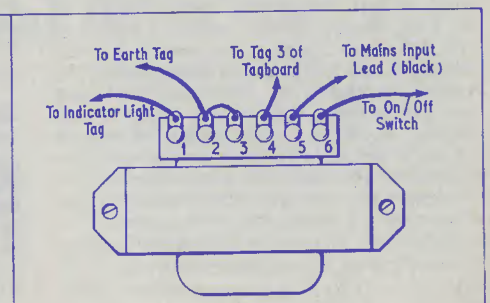


FIG. 4

MAINS TRANSFORMER CONNECTIONS

tags 2 and 3 connect to the chassis solder tag under C_{12} and C_{13}. Connect tag 5 to the mains input lead. Firstly, pass the mains input lead through the rubber grommet on the backdrop of the chassis and tie a knot in the lead, see photograph, this then taking any undue strain which may be put upon the lead externally at a later date. Allow sufficient wire for the red lead to reach up through one of the front rubber grommets and on to the on/off switch. The surrounding plastic covering must, of course, be removed to expose both the inner red and black wires. Taking the black wire up through a grommet, solder the bared end to tag 5 of the mains transformer. The red lead—which must be longer than the black lead, should then be soldered to that tag of the on/off switch nearest the centre of the chassis. To the other tag of this switch, solder a length of p.v.c. covered wire, pass under the chassis through a grommet and solder the other end to tag 6 of the mains transformer, having of course taken the wire above the chassis via a suitable grommet.

Dealing now with the remainder of the power supply, suitably shorten the wire ends of the resistor R_6, cover with systoflex, and solder one end to the white, or plain, tag of the smoothing condensers C_{12}, C_{13}, and the other wire end to the red tag of the same component. Ensure that this resistor does not come into contact with the chassis or any other metal or component.

Continue now with wiring into circuit the coil holder. (See Fig. 1 for base connections.) Dealing with pin 1 first, solder one end of C_5, suitably covered with systoflex, to this pin, and the other wire end to pin 2 of the valve. Again to pin 1, solder one end of C_1, the other wire end of which is next connected to the aerial input tag contained on the rear chassis wall. (*NOTE:* This wire end will have to be extended by soldering to it a further length of systoflex covered wire.) Lastly, to pin 1 of the coil holder, solder a length of wire, take up through a grommet and solder the other end to the small brass tag of the variable condenser C_2 (bandset), this being that component nearest the edge of the chassis. Solder a further length of wire to the same tag and the other end of this wire connect to the small tag of the bandspread condenser C_3, alongside the speaker. These wires must, of course, be p.v.c. covered.

With pin 2 of the coilholder, simply connect this to the adjacent earth tag.

We already have two connections to pin 3 of the coil holder and we must now add a further length of wire; pass up through the rubber grommet and solder the other end to the small brass tag of the variable condenser C_4 (reaction).

To pin 4 of the coil holder, solder one end of a length of wire, p.v.c. covered, the other end of which is then soldered to pin 1 of the valveholder.

Return now to the above chassis deck wiring. With a suitable length of *bare wire*, solder one end to that tag of the volume control which is connected to the outer metal casing of this component. From there, continue the wire and solder to both the large white metal tags of the brass variable condensers C_2 and C_4. (*NOTE:* These are the electrical earth connections of these components and are those tags uppermost and nearest the front panel of the receiver. Continue the same wire, and solder, to the remaining unconnected tag of the pilot light assembly. From this point, cover the wire with systoflex and solder the far end to the earth tag of the bandspread condenser C_3. Midway between the two brass condensers, to this bare wire, solder a further length of wire, p.v.c. covered, take through the rubber grommet, and solder the other end to the earth tag alongside the coil holder.

Lastly in the wiring-up process, we deal with the remaining few connections still to be made to the valveholder and earth socket. Obtain R_1, shorten the wire ends and solder one to pin 2 and the other to pin 3 of the valveholder. To pin 5, solder a short length of covered wire, connecting the other end of this to the earth tag alongside the coil holder. To the earth socket tag mounted on the rear wall of the chassis, solder a length of wire, the other end of which is then connected to that earth tag nearest the coil holder. A further length of wire should now be soldered to the earth tag on the chassis wall, passed through the chassis, and connected at the other end to the outer metal casing tag of the smoothing condensers C_{12}, C_{13}.

This completes the wiring details of the receiver. Beginners, for whom of course, this article is intended, should now carefully check over the wiring—both against these textual instructions and the circuit diagram.

Operating

Having checked the wiring, place into position the indicator bulb, the valve, and the coil number 2—this being the best choice for our purpose. Connect the aerial and earth to their respective sockets. Connect the mains input leads to the a.c. mains and switch on the receiver on/off switch and the standby switch. Set all dial controls to read zero. Allow a few seconds for the valve to warm up and proceed as follows: Volume control, rotate to read 10 degrees (first dial from left); Bandspread, rotate to read 90 degrees (micro-slow motion dial); Bandset, rotate to read 4 degrees (third dial from left); Reaction, rotate slowly until a click, or rushing noise is heard on the speaker. Back-off this control slightly, in this position the detector is at its most sensitive condition. It is in this position that the reaction condenser should be maintained when searching for signals, especially long distance—or Dx—transmissions. Now rotate the fast drive of the bandspread either side of the 90 degree mark until a signal is heard. Fine tune with the slow motion drive, this being the outer control knob.

A little practise and some experience with this excellent receiver will soon enable the operator to compile a list of known frequencies and to spend many happy hours searching the various bands for those interesting and intriguing transmissions that emanate from every part of the globe. For c.w. (morse) operation, the reaction control should be slowly advanced until the detector goes into gentle oscillation—heard in the headphones or speaker as a breathing sound. Headphone operation is recommended when searching for those distant, and sometimes elusive Dx signals.

For the guidance of beginners, Table I shows some actual frequencies, against dial readings, obtained with the prototype described herewith.

Table I

Frequency Mc/s	Bandset	Band	Metres
Coil No. 1			
30–28	0 to 0.5	Amateur	10
25.5–26	2	Broadcast	11
21.75	5.5	Broadcast	13
21.5	6	Amateur	15
17.5	10	Broadcast	16
Coil No. 2			
15	0 to 1	Broadcast	19
14	1 to 1.5	Amateur	20
12	3	Broadcast	25
9.5	5.5	Broadcast	31
7.5	10	Broadcast	40
Coil No. 3			
7.3–7	0 to 1	Broadcast/Amateur	40
6.2–5.95	2	Broadcast	49
5.05–4.75	4	Broadcast	60
4–3.5	8	Amateur	80
3	10	Broadcast/Commercial	100

The "Continental 6"

(*Continued from page 926*)

9. Repeat operations 7 and 8 to ensure correct coverage.
10. Set tuning dial to station selected for operation 7. Adjust L_{1a} for maximum output.
11. Set tuning dial to station selected for operation 8. Adjust TC_{2a} for maximum output.
12. Repeat operations 11 and 12 to ensure maximum tracking.
13. Switch to Long Wave band and tune to a local station. Adjust L_{2b} for maximum output.

Car Aerial Coil

Car aerial pick-up coil L_x is placed on the rod between the Long wave winding (L_2b) and the mounting bush, the two wires from this coil connecting to aerial socket.

The short length of orange wire fitted to the ferrite aerial connects to C of the wave-change switch.

Next Month

A Portable Oscilloscope,
Low-Power Transmitter Modulator,
High Sensitivity Shorted Turns Tester, etc., etc.

RTTY In Theory and Practice

by J. B. Tuke, G3BST

PART 3

THE FIRST TWO ARTICLES IN THIS SERIES have dealt with the type of waveform produced by a teleprinter, and the manner in which the wave may become distorted during its travel from sending to receiving machine, together with the amount of distortion which is permissible before faulty printing results. With this knowledge, we will now consider various radio-link systems which might provide a practical method of conveying the teleprinter signals. It must be borne in mind that the radio system must be suitable for use in the amateur bands—that is, it must have a restricted bandwidth and the ability to work through a certain amount of interference.

To impress any form of intelligence on a radio signal is to modulate it, and therefore the first consideration is whether to use amplitude or frequency modulation. Let us first deal with amplitude systems. Clearly the most efficient method will be to modulate the amplitude of a radio carrier by 100% —and that will mean an "on-off" keying system. Since we require the preservation of the d.c. component (the Mark-Hold signal) it could be arranged that the absence of a transmitter carrier could correspond to the Space teleprinter signal, and full carrier to the Mark. Since the maximum frequency which we need transmit is the third harmonic of the fundamental 25 c/s—i.e. 125 c/s—the sidebands will be the carrier frequency plus and minus 125 c/s; so that the overall bandwidth of the signal will be 300 c/s. To restrict upper harmonics a simple keyclick filter of conventional type will be required, otherwise the high harmonic components of the square wave will cause local interference. About the only advantage that this system has to offer is that of extreme simplicity, a printer being connected in place of the usual morse key. Providing no unsuitable keying relays are used, the transmitter requires no modification. Unfortunately, from a practical communication point of view, this system is practically unworkable over any distance due to interference. Any interfering signal (even if it is only atmospherics), appearing during the Space character when the transmitter is not radiating, will appear as a Mark at the receiving end with the result that printing will be completely upset. A reversal of the keying so that "Transmitter off" corresponds to Mark will be even worse, any QRM arising during the comparatively long breaks between letters, when hand operating the keyboard, will start the receive printer, thereby resulting in complete loss of intelligibility. However, though this system is unsuitable, it should not be completely forgotten, it may be used to provide a local link over a very short distance and is clearly applicable to limited v.h.f. circuits.

If modulating the amplitude of the wave is unsuitable then the frequency must be modulated instead. This means that the carrier is going to be frequency modulated by the 25 c/s (max) square wave output of the teleprinter. In normal frequency modulation, the amount of carrier shift depends upon the amplitude of the modulating signal, while the rate of frequency shift depends upon the frequency of the modulation. In this case the amplitude of the modulation is unchanging and can be any figure we like to choose. The frequency of the modulation will be the reversal voltages obtained from the transmitting printer contacts, this causing the carrier to "jump" suddenly from one frequency to another—the amount of "jump" being known as the "Frequency Shift". Because this is a telegraphy system, it is often called "Frequency Shift Keying", but although it bears this name, and mechanical means may be used to bring it about, it must be remembered that the result is just ordinary frequency modulation of the carrier—the same rules applying in calculating the bandwidth occupied by the signal just as though we were considering the transmission of, for example, speech or music by this method.

In order to calculate a typical bandwidth occupied by an f.s.k. teleprinter radio signal, we must first decide the amount of shift to be employed. This is generally in the order of 800 c/s on the h.f. bands, and this figure will be used as a basis for the calculations. Since we are dealing with frequency modulation which is varying by 800 c/s from one extreme to the other, we can imagine that there is a central carrier frequency which is being shifted plus/minus 400 c/s. Admittedly, this carrier is never transmitted in reality, but looking at it from this point of view makes it rather easier to understand. If we imagine a central carrier on 3,700 kc/s, being frequency modulated by a teleprinter signal, then the frequency corresponding to Mark might be 3,700.4 kc/s, while that corresponding to Space would be 3,699.6 kc/s, and the signal as a whole must occupy a bandwidth equal to the total shift—i.e. 800 c/s. It may be stated at this point that there is no standard laid down as to whether Mark or Space raises or lowers the transmitted frequency—but this is of little importance as will be seen when receiving systems are discussed.

It can quickly be seen that the bandwidth must at least be the total shift produced by the modulation, but this is not quite all. During transition from Mark to Space the carrier is rapidly changing from one frequency to another and additional sidebands must therefore be generated. It has been shown in earlier articles that the rapidity with which this change takes place is governed by the number of harmonics of the fundamental 25 c/s signal which we are prepared to pass from the transmit to the receive position—and it was also concluded that transmission of the third harmonic was sufficient—i.e. a frequency of 125 c/s. For our "modulation frequency" we have, therefore, 25 c/s, 75 c/s and 125 c/s—all frequencies being maximum figures, and we must now consider the overall bandwidth required to transmit this composite signal by f.m.

As all f.m. enthusiasts will know, the detailed calculation of the bandwidth of these signals is very involved—but for our purpose a very simple treatment will suffice. Assuming that modulation is 100% (as it must be with telegraphy), the criterion of an f.m. signal is the ratio between frequency deviation and modulating frequency. This figure is known as the modulation index. Using a standard shift of 800 c/s (which will be 400 c/s relative to the imaginary central carrier), our signal will have three modulation indices: 400/25=16, 400/75=5.3 and 400/125 =3.2.

Reference to any frequency modulation textbook will reveal a diagram or table which indicates the bandwidth, or number of sidebands, appropriate to various modulation indices. We may summarise by saying that when the modulation index is 16, sidebands up to the 25th will be significant, when the index is 5.3 then nine sidebands will be significant, and when the index is 3.2, five sidebands will be present. At first glance this looks a pretty grim picture until calculation is carried further. Twenty-five sidebands of 25 c/s only equals 625 c/s, nine sidebands of 75 c/s equals 675 c/s and five sidebands of 125 c/s equals 625 c/s. Further, the 75 c/s and 125 c/s components of the signal are only 1/3 and 1/5 the amplitude of the main transmission, being somewhat attenuated at the start. It appears therefore from the above that sidebands will not extend more than 675 c/s either side of the imaginary central carrier, making a total bandwidth of 1,350 c/s—but, in fact, this is being rather generous and in practice satisfactory operation can be obtained by limiting the sidebands to plus/minus 500 c/s, making a 1 kc bandwidth overall. Although it might appear from the foregoing that all the harmonics could be transmitted, since the lower modulation indices that result with the higher frequencies mean lower numbers of sidebands, this is not so. Consider the 100th harmonic—2,500 c/s. Although the modulation index will be low, even the smallest amount of sideband energy radiated will be in multiples of 2,500 c/s either side of the central carrier—and the bandwidth will be excessive.

Since these sidebands only exist at the moment of transition from Mark to Space or vice versa, they will sound like key clicks, being very objectionable, particularly to local stations. Some sort of low pass filter, therefore, attenuating all frequencies above 125 c/s, should be employed between teleprinter and modulator. It may, in practice, be found that clicks do not result even if this filter is not used—this may be due to several different reasons, one of the most likely being that since frequency modulation is normally produced at the oscillator, the subsequent passage through the doubler and/or amplifier tuned circuits will attenuate the upper harmonics before they can do any harm. It is, however, far better to use a filter in the first case, these types of key clicks being most objectionable when they occur.

In the above example we quoted the shift as being plus/minus 400 c/s—i.e. 800 c/s in all. This figure has largely become standard on the h.f. bands, although there is no essential reason why the amateur should use it, except it is most desirable that a definite standard is laid down. Reduction of shift will reduce the bandwidth occupied and this would, of course, be beneficial on the amateur bands, particularly as it would enable teleprinter signals to be copied through the simple type of crystal filter found on some older receivers. There is a figure for minimum shift which can be employed, but this is in the order of 60 c/s, being bound up with the operating speed in bauds, and will obviously not concern the amateur. If amateurs were to use, say, 400 c/s shift, better working through interference would be possible—although increased stability on the part of transmitters and receivers is, of course, necessary. It seems unlikely that advanced amateur stations use unstable equipment these days, therefore the use of reduced frequency shift should be seriously considered.

Having calculated the bandwidth involved in the use of this system, let us now examine it as a practical working system for use in the crowded h.f. bands. It can be said straight away that other amateur users cannot grumble at the frequency occupied—the figure arrived at being much lower than that required even for "well-tailored" telephony. It is rather greater than that required for c.w., although it must be borne in mind that since communication speed is 66 w.p.m., the transmitter will not be on for as long as would be required to transmit the same amount of intelligence by c.w. From the equipment point of view, no large modulator is required, and the methods by which frequency modulation of this sort can be brought about are remarkably simple as will be seen later. Overmodulation is impossible, and t.v.i. should not be troublesome—in fact it may clear in some instances, since the on/off shock wave is absent.

The system will obviously discriminate against many types of interference. Since it is essentially f.m., discriminator circuits preceded by amplitude limiters will be used at the receiving end, fading becoming of no importance (unless the signal fades completely when any communication system must fail). Since both Mark and Space signals are transmitted, interference cannot occur during an "off" period as with amplitude modulation. The amount of interference that can be tolerated is really a receiver problem and will be dealt with under that section, it being clear at this point that the system is likely to show up well from this angle.

Selective fading can be troublesome at times—when perhaps either the Mark or Space signals will disappear. Suitable receiving circuits can cope with this to a limited extent but absence of one signal leaves an open path for interference to cause trouble.

The system caters adequately for the preservation of the d.c. component and a Mark signal can go on indefinitely. During this time, the receiver is protected against random bursts of interference and will only release when a Space signal is received.

Distortion of the signal may appear in any radio system, though this is not likely to trouble the amateur. It may arise when reflected signals are received a fraction of a second later than those arriving by a shorter path, or, under certain circumstances, when signals are received both via the long and short paths round the world. With amplitude modulation, the effect would be the prolongation of the original signal by the later reflected one. With the f.s.k. system this is not so troublesome since any reflected signal is likely to be weaker than the direct one. The receiving circuit is usually arranged to follow the strongest signal so that if the direct signal changes from, say, Mark to Space, and there is still present a much reduced Mark signal due to reflection, the receiving circuit should move directly to the Space condition, responding to the full strength Space signal rather than to the weaker Mark. Of course, under very adverse conditions, strong multiple reflections may occur and then printing is likely to be faulty. We all know conditions where c.w. signals flutter rapidly, or sound like a T7 note—well, RTTY is unlikely to work then! Sometimes the Mark and Space signals, being on slightly different frequencies, will follow different paths, thereby causing their relative position to be misplaced on arrival at the receiving end—in other words, distortion occurs. Nothing much can be done about this—though by means of special repeaters the signal may be cleaned up before being passed to the printer. However, this is delving more into the commercial rather than the amateur field, in view of expense involved, and the necessity for commercial communications to receive 100% copy at all times.

There remains one other mode of transmission to consider—and this is really a compromise of a.m. and f.m. If a v.h.f. link is required then the simple a.m. system will be prone to interference, unless is is only radiated over a mile or two, while stability requirements make the f.m. system difficult to work. The answer is to modulate the carrier in the normal a.m. manner with two audio tones—one corresponding to Mark and the other to Space. This has all the simplicity of the normal a.m. system, while imparting a number of the f.m. advantages. To achieve this, the teleprinter is arranged to shift the frequency of a small audio oscillator, the output from this oscillator being amplitude modulated to the v.h.f. carrier in the normal manner. It might be thought that this system would find application on the h.f. band as well—and it can indeed do so. Its main drawback is its inefficiency. A complete audio modulator would be needed resulting in a low overall efficiency at the transmitting end. At the receiving end it is well known that the output of the modulation contained in a carrier cannot be as great as that of the carrier itself, therefore a much larger signal will be needed at the receiving end in order to produce the same power output compared with straightforward f.s.k.

The combined a.m./f.m. system (known as "amplitude modulated f.s.k.", or "a.f.s.k.") can, however, achieve one result that the f.s.k. system cannot—and that is to handle several different teleprinter signals simultaneously. Two or more printers can be used at the transmitting end, each working into different audio oscillators and producing different pairs of tones. These tones can all be amplitude modulated to the carrier, being separated by audio filters and passed to different printers at the receiving end. This enables multi-channel information to be conveyed on one carrier. A much modified form of this system can be applied to the h.f. bands, and will be mentioned again later, although multi-channel systems have little application in the amateur field.

It is hoped that the foregoing will have shown that for normal h.f. teleprinter operation the only satisfactory method is f.s.k. It is also hoped that it has been made clear to any doubters that the system is *efficient*, and *economical in bandwidth*.

In the next article we shall discuss the relative merits of the various methods of producing f.s.k., and of receiving it, including techniques which use this system to its fullest advantage.

Loft Aerials for Fringe Area Reception

By F. E. ASH

ANYONE WHO LIVES IN A FRINGE AREA will be familiar with the Christmas tree appearance of the houses, bristling with aerials for Bands I, II and III. Local authorities are also disturbed by it, and in many council flats shared aerial systems are being installed.

From the point of view of appearance, there is a good case for employing internal aerials, if these can be used in fringe areas. From the constructor's point of view, such aerials can be made easily and installed without much trouble. The cost is relatively low, being only a few shillings, whereas the cost of an H aerial plus erection cost is about £10, and that of an f.m. aerial about £5.

It must be remembered that the signal strength inside a building is very much lower than outside, and an internal aerial must therefore have a higher gain than an external one to feed a signal of comparable strength to the receiver. On the other hand, an internal aerial does not have to face the weather, and can therefore be made much lighter and less robust than the outdoor type. Light copper rods and even lighting flex can be used for the elements. It is possible, in view of the greatly reduced cost, to add sufficient elements to an indoor aerial so that it will give a better signal than an outdoor aerial.

Before venturing into the loft—a few words of warning. *Stand only on the joists, not the regions between, otherwise you may descend to the bedroom below, and your "cheap" aerial may cost you a lot in ceiling repairs!* It is a good idea to put a few planks across the joists to make a working platform. Some form of lighting will be necessary. A candle is better than a flashlight, but if possible run an inspection lamp up from the house lighting. This should be suspended somewhere in the loft to shed as much light as possible. The loft forms an ideal "heat-trap" and it is not advisable to work there for long periods. Come down for a "breather" occasionally. Also, particularly in old houses, the loft may be very dirty, so go suitably clothed. Having considered most of the general points, we can now consider the various aerials in detail.

Band I Aerial

The main problem here is the question of height. A dipole for use on Channel I measures about 10ft 6in from tip to tip, and as the maximum height of most lofts is only about 8ft, some special design must be employed. One solution is to use a "slot" aerial as illustrated in Fig. 1. For vertically polarised transmissions an ordinary dipole will have its maximum dimension in the vertical plane, whereas a slot aerial will have its maximum dimension in the horizontal plane across the wavefront.

A more adaptable aerial is the ground plane type illustrated in Fig. 2. Basically, the normal array can be cut in half along the centre line and the bottom half replaced by a ground plane. The ground plane can be regarded as a kind of mirror which reflects the upper half of the array. It is as well to spend some time and trouble in obtaining a really efficient ground plane. An area of the loft may be covered by chicken wire. This should extend a distance of at least $\frac{\lambda}{4}$ on each side of the aerial. The elements themselves can be constructed from copper

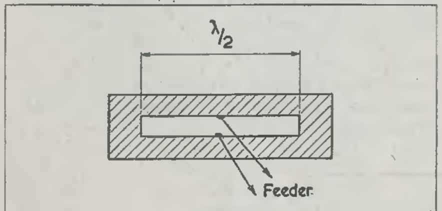


FIG 1.

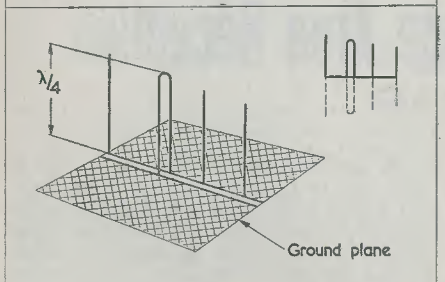


FIG.2.

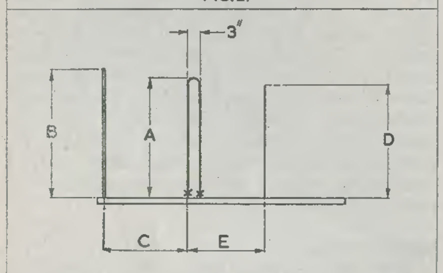


FIG.3. M767

aerial rods which can be purchased on the surplus marked for about 2s. 6d. a dozen. Before joining the sections, the ends should be thoroughly cleaned with fine sandpaper to ensure good electrical contact. The inner surfaces may be cleaned by wrapping sandpaper round a ¼-in shaft. The sections should then be rammed firmly together. They can be mounted on a strip of wood about 1in x 1in and of suitable length, by drilling ¼in holes. The full dimensions are shown in Fig. 3 and Table 1.

To avoid serious mismatch, a folded dipole aerial is used. Most t.v. receivers have an 80Ω input, this being the impedance of a dipole aerial at the centre points. The addition of a reflector reduces the impedance to about half this value, and the addition of a director reduces the impedance by a further factor of two, giving an impedance of about 20Ω for a normal 3-element array. When a dipole is folded, the impedance is increased as the square of the number of "elements" in the fold. Thus a single folded dipole has a centre impedance of $80 \times 2^2 = 320\Omega$, and the addition of a reflector and director brings the impedance back to 80Ω. Further directors may be added without seriously affecting the impedance.

A further advantage of using a folded dipole is that it has a wider bandwidth than a normal dipole, which is a useful asset as the addition of reflector and directors tends to reduce the bandwidth of an aerial.

Dimensions are given in Table 1 for all Channels in Band I. The key dimension in making your own aerials is $\frac{\lambda}{4}$. This will be the length of one arm of the dipole. Elements behind the aerial must be slightly longer (about 5%), whilst elements in front of the aerial should be slightly shorter, again about 5%. Various systems of spacing can be used. All the aerials considered in the present article are designed so that the reflectors are spaced slightly more than $\frac{\lambda}{4}$ from the dipole, whilst the directors are spaced slightly less than $\frac{\lambda}{4}$. Some references give a reflector spacing of 0.15 and a director spacing of 0.1 as giving optimum gain, but in general close spacing of the elements results in a lower aerial impedance than that quoted above. Some designs employ equal spacing (of about 0.2) for all elements.

The following formulae may be useful to constructors designing their own aerial arrays.

$$\text{Dipole length} = \frac{462}{f}$$

$$\text{Reflector length} = \frac{476}{f}$$

$$\text{Reflector spacing} = \frac{246}{f}$$

$$\text{Director length} = \frac{434}{f}$$

$$\text{Director spacing} = \frac{140}{f}$$

The above answers are in feet, where f is in

Mc/s; f is taken as the mid-frequency of the transmitted signal.

Band II Aerials

Fig. 4 shows a suggested aerial for reception of the B.B.C. f.m. transmissions in Band II. It may be found that your f.m. receiver will work with a length of flex of suitable length along the picture rail or even inside the cabinet. But a much higher signal, with consequent improvement in signal/noise ratio, can be obtained by installing a loft aerial.

The aerial illustrated has a centre impedance of about 20Ω, and there is therefore a mismatch when connecting to a receiver with an input of 80Ω. The solution would be to use a folded dipole as in the case of the Band I aerial already considered, but practical tests show there is no noticeable improvement when doing this. If the aerial input to the receiver or tuner is for 300Ω, the mismatch would be more serious and in this case it might be advisable to use a folded dipole.

Alternatively, a slight alteration to the receiver would give a better match. Fig. 5 shows a balanced 300Ω input, and the changes necessary to use this with an 80Ω coaxial cable.

The "backbone" of this aerial is again made of timber, and the elements of copper rods. An alternative arrangement consisting of ordinary lighting flex mounted on a wooden frame is shown in Fig. 6. It is a lot easier to make folded dipoles with flex than it is with copper rods. Great care must be taken in bending copper rods.

It will usually be necessary to assemble both the Band I and Band II aerials in the loft itself. The "backbones" may be drilled and the elements cut to the right length in the workshop. Drill holes in the aerials in the positions shown to attach the aerial down-leads.

Band III Aerial

The dimensions of a suitable aerial for Band III reception are shown in Fig. 7. This should be mounted as high as possible in the roof. A folded dipole is essential in order to obtain a reasonable impedance and adequate bandwidth. Owing to the relatively small size of this aerial it may be possible to construct this entirely in the workshop and then install it in the loft. The construction of this aerial is similar to the two previously described. The folded dipole in this case is made of strip metal, which is easier to bend than copper plated rods. The number of elements used will depend upon the signal strength. An alternative construction is shown in Fig. 8. In this case a wooden framework is employed, and the elements are made of flex or similar wire. This array is very directional, having a pronounced forward lobe in its polar diagram, but also a number of secondary lobes. Two such arrays mounted side by side 0.5λ apart, and connected in parallel, have an improved forward gain, and the secondary lobes are entirely eliminated.

Aerial Down-leads

Most modern t.v. receivers use coaxial

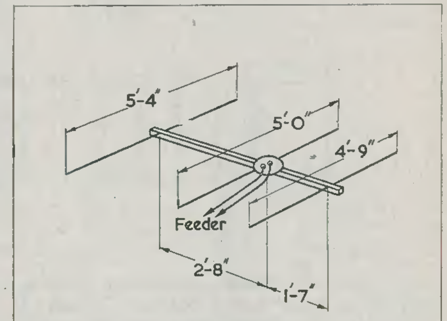


FIG.4.

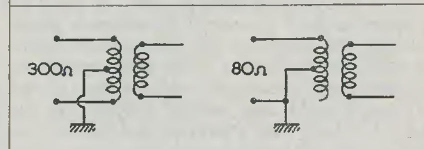


FIG.5.

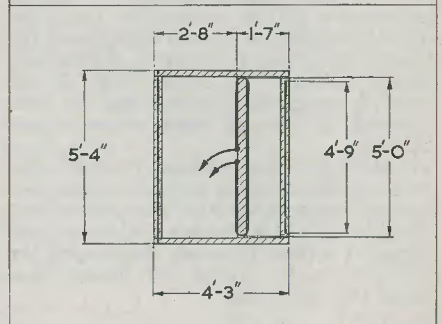


FIG.6. M768

cable in preference to twin feeder. The Band I aerial illustrated is unbalanced and ideal for coaxial cable. The Band III aerial is, strictly speaking, balanced, but can in fact be used with coax, without any ill-effects. The upper part of the folded dipole should be connected to the inner conductor and the lower one to the outer. It is recommended that low loss coaxial cable is used for the Band III aerial.

The Band II aerial should preferably be

used with twin feeder, providing the f.m. receiver or tuner has a balanced input. If the input is unbalanced, coax may be used.

In a house with cavity walls, it may be possible to feed the aerial down-leads down through the cavity to an appropriate point on the skirting board. The mortar can be scraped away at a convenient point in the loft and a small lead weight lowered on the end of a line. By marking the line at the appropriate length, you can determine when the lead has reached the floor. Careful measurement will be necessary to locate the weight. A hole can then be drilled, and the feeder cable attached securely to the line and hauled back up. Fit solder tags to the feeder before taking the end into the loft; soldering in the loft may present some difficulties.

If cavity walls are not used, the cable can, of course, be fed down through ceilings and floors in the corner of the room. In this case, ceilings should be drilled from below to avoid damage. A piece of paper thrust over the drill will prevent pieces of plaster from getting into the chuck.

FIG.7.

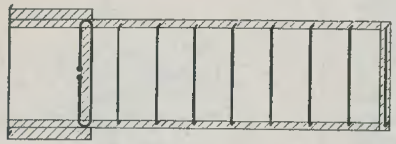


FIG.8. M769

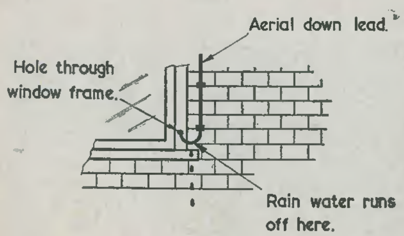


FIG.9. M770

An alternative method is to take the cable out under the eaves, down the outside wall, and back in through the edge of the window frame. When doing this the cable should be clipped back to the wall at frequent intervals, and should be led down and up through the window frame. (See Fig. 9.) This prevents rainwater from running down the feeder and into the room.

Positioning the Aerials

Because of its height, the Band I aerial will probably have to be placed near the centre of the loft, under the peak of the roof.

If the Band II aerial is laid on the joists, it must be clear of the ground plane of the Band I aerial, and on the signal side of it.

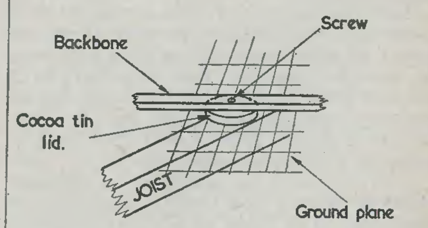


FIG.10. M771

Avoid pointing aerials at water tanks; if possible, place the aerials so that any water tank in the roof space is behind the aerial.

If the Band II aerial must be placed over the ground plane, it should be supported at least 2ft above it. It is not advisable to drive nails into the joists: tin tacks (or staples in the case of the ground plane) can be used. If wooden struts have to be fitted, screws should be used.

The Band III aerial should also be placed well away from the ground plane, otherwise its polar diagram may be severely distorted. Mount it as high as possible in the loft. All three aerials should be installed facing roughly in the direction of their respective transmitters.

Aerial Orientation

Having installed the aerial it must be oriented for the best possible results.

The simplest method of doing this is to run a pair of leads from the loudspeaker in the receiver to an extension loudspeaker or pair of headphones in the loft. The aerial can then be oriented for maximum signal.

If the receiver is of the "live chassis" type, care should be taken to ensure that the extension speaker leads are not alive.

The Band I aerial can be mounted by means of a screw and a cocoa tin lid, as illustrated in Fig. 10, and is then easily rotated. Stand behind the reflector when swinging the aerial. The optimum position may not be very well defined. In this case swing the aerial in both directions until a drop in signal strength is noticed. Mark these points, and set the aerial to the mid-point of the arc.

The Band II aerial can be aligned in a similar manner. The maximum will not be clearly defined. The Band III aerial, on the other hand, has a much narrower angle of acceptance, and the maximum is therefore more sharply defined.

TABLE 1
Dimensions of Band I Ground Plane Aerials

Channel	Mid-frequency (Mc/s)	Dipole length (λ/4) A	Reflector length B	Reflector spacing C	Director length D	Director spacing E
1	43.25	5ft 4in	5ft 6in	5ft 8in	5ft 0in	3ft 5in
2	50	4ft 7in	4ft 9in	4ft 11in	4ft 4in	2ft 9in
3	55	4ft 2in	4ft 4in	4ft 6in	3ft 11in	2ft 6in
4	59	3ft 10in	4ft 0in	4ft 2in	3ft 8in	2ft 4in
5	65	3ft 6in	3ft 8in	3ft 9in	3ft 4in	2ft 2in

TABLE 2
Dimensions of Band III Aerials (all dimensions in inches)

Channel	Mid-frequency (Mc/s)	Dipole length A	Reflector length B	Reflector spacing (0.15λ) C	Director length D	Director spacing (0.1λ) E
8	187.5	30	31	9	28	6
9	192.5	29	30	8.7	27	5.8

OBITUARY

It is with great regret that we have to record the recent death of *Centre Tap*, Mr. R. E. Copp, G2DUV.

We know from the letters *Centre Tap* received that many of our readers will feel a sense of personal loss on learning this sad news. "Radio Miscellany," which *Centre Tap* contributed regularly to this magazine for more than a decade, before ill health intervened, was a very popular feature and revealed much of his personality and the wide range of his interests.

To his widow, on behalf of our readers and ourselves, we extend the deepest sympathy.

RADIO topics

BY RECORDER

IT WON'T BE LONG BEFORE THE NATIONAL Radio Show is upon us again. I find myself looking forward to it this year with a little extra whetting of my appetite because of the absence, in April, of the usual R.E.C.M.F. component exhibition. The latter has gone to ground for the moment and will emerge once every *two* years in future.

I must confess that my approach to the Radio Show these days is rather more blasé than it was when I made my first visit quite some years ago. I now find myself looking around for friends and acquaintances almost as much as for new and interesting design trends, I being the last to deny that the current tendency of many exhibitors *is* to concentrate on showing cabinet styling and the like rather than on demonstrating "the works". One can hardly blame them for this: attach yourself to any group around a stand featuring, say, television receivers and notice how much more frequently you hear, "Coo, isn't the woodwork *luverly?*" than you hear, "Not so bad, old man, I think they've even managed to go two and a half megs wide this year!"

To the general public the appeal of a domestic receiver rests more on its external appearance than on its performance, and this fact is fully appreciated by the manufacturers. Whilst there is the comforting fact that a predisposition is growing amongst budding television set purchasers to check performance more critically than in previous years (this being due to the fact that they are buying replacement sets and know from experience what a reasonably good picture *should* look like) this predisposition still, I think, outweighs judgment entirely by cabinet appeal.

I don't want to give the impression from the last paragraph that I feel that domestic electronic equipment could, provided it gives a good performance, be fitted in a corner of the drawing room on a grey enamelled 19in G.P.O. rack, because that is far from being the case. I don't yearn for the best of both possible worlds, I just want a balanced appreciation: good looks *and* good performance.

Another point which tends to make the technical type more critical after a number of visits to the Radio Show is that, apart from offering a means of presenting the latest products to the public, it is also a sales exhibition designed to collect the orders of retailers during the coming year. The occasional supremely bored young men you see gracing some of the stands may be a little off-hand if you ask them how many dB feedback there is in the a.f. stages of a particular radio, but say also that you represent a large retailer who is interested in buying a sizeable quantity of them and you'll be in that discreet little back room with a large gin in front of you almost before you've drawn breath!

Behind the Scenes

Some years ago I had a glimpse myself of what goes on behind the scenes at Earls Court, and a very fascinating experience it was, too. In company with a colleague, it was my job to spend a day at the Show keeping an eye on the TV sets of a particular manufacturer and seeing that they behaved themselves. We were not, fortunately, expected to be on hand all the time and as part of our responsibility was concerned with the performance of several receivers in Television Avenue (that dates this story!) we had, as it were, quite a comfortable strolling brief. The main stand had, as an attendant, one of the uniformed sergeants who are members of the Earls Court staff. When my friend and I arrived, we found that he had everything completely weighed up. "The sets are going fairly well," he announced, as we arrived an hour and a half before the Exhibition opened. "The first set on the left is a bit poor on interlace. And I shouldn't run the middle set on the I.T.A. signal if I were you, because I think its tuner's a bit dicky. It's O.K. on the B.B.C. signal, though. The others are going quite nicely." We switched on, found he was exactly right, and adjusted the height controls to give a slight amount of overscan (that was in the days when "frame shrinkage"—loss of height due to increasing resistance in the frame coils as they warmed up—was rather more prevalent than it is today). We next checked the sets in Television Avenue and decided that we then had a boring hour or so of waiting before the doors were opened to the public. This was not to be, however. In the next minute Test Card C, fed from the studio in the Exhibition, faded from all the receiver screens around us and we were confronted with the face of the Exhibition compère, who then proceeded to give a screamingly funny programme just for the benefit of the engineers and sales staff in the building. This impromptu show ended with a long and very solemn appeal for someone to look after two children who had been discovered sleeping in one of the stands and who had presumably been locked in all night. Just as the heart of the flintiest-eyed amongst us was melting a picture of the "children" was flashed on to the screens. They turned out to be two coloured ladies of uncertain age and marked deshabillé.

After that, a sober Test Card C returned to the screens and, when the public entered a quarter of an hour later, the Exhibition was pervaded by the correct and proper atmosphere of modern electronic efficiency.

Which? Reviews TV Sets

The May issue of *Which?*[1] contains a report I have been looking forward to seeing for some time. *Which?* is a monthly publication wherein the Consumers' Association gives details of tests carried out on branded products available to the public, giving recommendations in many cases on what the Association feels to be the best value for money amongst the range tested. Brands are quoted by name and details of shortcomings, or failures during the tests, are recorded. The style of writing in *Which?* is almost always beautifully crisp, technical details being presented and explained in a manner which is not only capable of being understood by the lay public but which is also cut to the minimum number of words without the introduction of inaccuracies due to over-simplification.

The report in the May issue of *Which?* covers tests carried out on nineteen different makes of TV receiver and whilst, for various reasons, it would be preferable for me not to give a detailed description of the tests themselves, I think I *can* say that they were of a commonsense nature and were adequately and carefully explained. Only once was I puzzled by the report, this being due to a reference to a whistle other than line output transformer whistle which was evident on some receivers. The source of this whistle was not identified.[2] In the conclusion of the TV set review, the Consumers' Association state what they consider to be the best value for money amongst the range of receivers tested.

An Oscillograph By Any Other Name

During my thirteen years (ta-ra!) in the Services I once made the acquaintance of an Irishman who had developed to a fine art his particular contribution to the social life of the camp at which we were both stationed. Whenever my friend spotted a group of people in animated conversation he would join them. After a few carefully chosen interjections on his part the group would suddenly find itself engaged in bitter argument, under cover of which my friend would unobtrusively depart.

If ever there had been an Order of the Wooden Spoon, Paddy would have been its Patron.

I am convinced that, when his Service career ended, my Irish friend attached himself to groups of electronic engineers in the higher echelons, because that is the only way I can explain the acrimonious wrangles about terminology which continually appear in the correspondence columns of our "more technical" magazines. Without having to refresh my memory by looking up the material I can distinctly remember quarrels in print on the correctness or otherwise of such words as "valve", "datum", "oscillograph" (in place of "oscilloscope"), "potential", and many more.

Whilst such discussions are of considerable interest to those who indulge in them, I don't feel that they achieve a great deal. I must admit in fairness, though, that a partial degree of success has been evident in the case wherein it is considered that "oscillograph" is more correct than "oscilloscope". The recommended change in terminology here, evident in much printed matter, has not extended down to many of the engineers handling these instruments, however, as they still rely entirely on the abbreviation

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[1] Published by Consumers' Association Ltd., 333 High Holborn, London, W.C.1.

[2] Since writing these notes I have been informed by Consumers' Association that "the reference is to a heterodyne whistle with the line time base".

"'scope". An Australian engineer once had me baffled completely by asking for the "crow". It was only after he had gently explained that Australian practice was to use the initials "c.r.o." that I finally realised what he wanted. (He also used to call flexible mains leads "two-forty cords" because, he said, the standard Australian mains supply is at 240 volts; but we put a firm stop to that one at once.)

I don't feel that pedantism concerning new words which are introduced due to electronic developments has any great effect—language is so much a living thing that it refuses to be tied to roots which died many centuries ago. People will almost inevitably choose, or manufacture, words which they find euphonious and easy to pronounce, or which appeal to their imagination. Electronic engineers are particularly liable to indulge in "incorrect" but colourful terms (frequently borrowed) to describe particular things. There is, for instance, "humdinger", this defining a potentiometer connected across a heater supply with its slider connected to chassis. Such a potentiometer is adjusted for minimum hum in the output of the associated equipment. Another term that comes to my mind is "gimmick". Many years before this word achieved its present notoriety in relation to stage and TV entertainers it was used to describe a capacitive trimmer, one "plate" of which consisted of a piece of stiff wire which was bent to the position which gave the desired capacity. The word "superhet", an abbreviation of "supersonic heterodyne", is now completely accepted because, although its constituent parts convey absolutely no relevant information, it is a word which is sufficiently brief and easy of utterance to stand on its own. The same applies, albeit to a lesser degree, to the term "Magic Eye". I feel, incidentally, that the toolmakers are not far behind electronic engineers in finding impressive terms; for instance, the collection of tools needed for stamping out and forming a mass produced product is known as a *suite* of tools. Just how grandiose can you get?

Quite a lot of confusion was caused in the word-mongers' camp a few years after the war ended when it was found that many plugs had appeared in the industry which, whilst having bodies capable of being inserted into sockets, made connection to pins therein and were, therefore, of the nature of sockets themselves. At the same time, the complementary members, whilst accepting the plugs, still had pins, whereupon they took on the nature of plugs! The arguments on nomenclature for these hermaphroditic assemblies waged for quite a long time and it was finally capped, to my mind, by a delightful limerick which appeared in the correspondence columns of *Wireless World* around 1954. I cannot trace the particular issue (and I would be in the debt of any reader who can help me out here) but the limerick, reconstituted from memory, went something like this:

An etymologist said, very smug,
As he looked into "socket" and "plug",
"If you have a male socket,
Why not call it a plocket,
And refer to its plug as a sug?"

An Impromptu Group Board

by S. POLLARD, ZS6AHI

When a quick hook-up is wired to try out a circuit, there is always a danger that floating connections between the wire ends of resistors may short to the chassis if a suitable blank terminal cannot be found for anchoring them.

The neatest way of mounting resistors and small condensers, once the apparatus is wired in its final form is, of course, a group board. It is rarely worth the trouble of designing a group board layout in the hook-up stage, when many changes may have to be made before reaching the final version.

An old valveholder serves admirably as an impromptu group board to anchor floating "hot" connections—such as the junction between a decoupling resistor and an anode load resistor. It can be mounted flat on the underside of the chassis in any convenient position as the wiring proceeds. It is necessary to drill only one ⅛in hole in the chassis to contain a bolt securing one side of the valveholder. If the sockets are liable to short to the chassis when the valveholder is bolted flat to the metal, a nut can be used as a spacer to give the required clearance.

If an octal valveholder is used, the eight anchoring points will be found to be invaluable.

STEREOPHONIC BROADCASTING

A detailed announcement of the present position of stereophonic broadcasting is given in the latest B.B.C. Engineering Monograph, published by the B.B.C. Engineering Division. The monograph, "A Summary of the Present Position of Stereophonic Broadcasting," is written jointly by Mr. D. E. L. Shorter and Dr. G. J. Phillips.

The monograph discusses the various methods by which stereophonic programmes can be produced for sound recording or broadcasting, with particular reference to stereophonic reproduction under domestic conditions.

The problem of transmitting stereophonic programmes on existing radio-frequency channels, while providing for "compatible" reception on ordinary broadcast receivers, is considered; the principles and potentialities of the main systems so far proposed are discussed. Attention is drawn to the difficulties which would arise in distributing stereophonic programmes to transmitters by lines at audio frequency.

A brief reference is made to the possible application of stereophony to television sound.

This monograph is No. 29 in the B.B.C. Engineering Monograph series and can be obtained (price five shillings, post free) from B.B.C. Publications, 35 Marylebone High Street, London, W.1, or through newsagents and booksellers.

MODEL RAILWAY DEMONSTRATES PHOTOCELL APPLICATIONS

An ingenious method of demonstrating the industrial applications of their latest photo-conductive cadmium sulphide cells, which operate relays directly without intermediate amplifiers, was employed by Mullard at the 1960 Instruments, Electronics and Automation Exhibition. Mullard installed, on their stand, a model railway consisting of 30ft of track complete with two trains, a level crossing, points, and a station. The entire operation was controlled automatically by the cells. Typical instances of the control provided were the ringing of an alarm and subsequent opening of the level crossing gates on the approach of a train (analogous to clearing the way in a factory for mechanical handling gear), prevention of collision at points and junctions (analogous to factory safety mechanisms), the switching of trains into pre-selected routes by recognition of coding symbols on the engines (analogous to pre-selected routing of industrial products), and indication of train position on a remote indicator panel (analogous to automatic conveyer progress monitoring).

TEMPORARY MAINS CONNECTIONS WITH SAFETY

Temporary connections without plugs and sockets to the mains are frequently a source of shock hazard, and especial attention to this point has been paid in the design of the Rendar Safebloy "Mains Coupler" recently introduced by Rendar Instruments Ltd., Burgess Hill, Sussex. The Safebloc consists partly of a plastic platform on which are mounted three clips capable of taking the three stripped ends (live, neutral and earth) of the mains lead to any appliance. The Safebloc is also provided with a plastic lid which, when lowered, completely shrouds the clips and lead ends. Interlocking contacts in the lid isolate the clips when it is raised, thereby allowing connections to be made without risk of shock. Provision is made for fusing the live line up to a maximum of 13 amps. The Safebloc may be secured in any convenient position on the bench or on a wall.

HAM HOP CLUB MEETING

The recent welcoming of Mr. John F. Dormois, WØGDH, of Kansas City, the World President of the International Ham Hop Club, by Mr. G. A. Partridge, G3CED, Hon. Gen. Sec. of the club (see last month's *Radio Topics*) at Broadstairs, was given very adequate coverage in the local *Thanet Times* for 24th May. Also present were Mr. and Mrs. Ken Mitchell. Mr. Mitchell, ZS1IR, is national representative for South Africa. The *Thanet Times* report included a full description of the aims of the club and was presented alongside a four column photograph of Mr. Dormois, Mr. and Mrs. Mitchell, and Mr. Partridge in the latter's shack.

AUTUMN AUDIO FAIR IN SOUTHPORT

The Autumn Audio Fair, 1960, will be held at The Palace Hotel, Southport, on Friday, Saturday and Sunday, 7th, 8th and 9th October.

Excellent road and rail communications make Southport a particularly suitable venue for the large populations of Liverpool, Manchester and Lancashire generally.

Full details will be sent to potential exhibitors shortly.

The organisers are Audio Fairs Limited, 22 Orchard Street, London, W.1 (WELbeck 9111).

Smoothing Circuit DESIGN

by R. H. PALMER

ALTHOUGH THE AVERAGE CONSTRUCTOR takes great care in the design of most equipment, the design of the power supply unit smoothing circuit is normally left to tradition. That is to say, a pair of 8µFs and any choke which fits the space available.

As a rule this method gets away with it, but the time comes when the h.t. supply is required to have a minimum ripple voltage in the output. When this occurs, the following procedure may be used to decide the components needed.

Consider the full-wave rectifier with capacitor input filter, the most widely used circuit. Ripple frequency=100c/s. (See Fig. 1.)

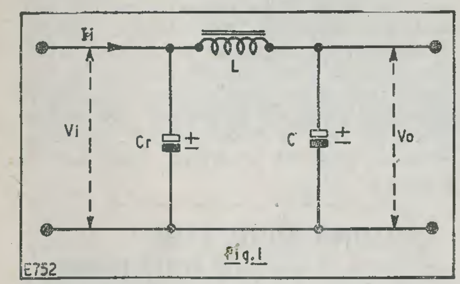

Fig. 1

I_i = input ripple current with r.m.s. value of $\sqrt{2} \times I_{dc}$ (current drawn from unit).

V_i = input ripple voltage = $I_i \times X.C_r$. Thus C_r should be as large as possible within the maximum for the rectifier used. This value should not be exceeded or the peak inverse voltage developed may damage the rectifier.

V_o = output ripple voltage.

Thus $\frac{V_o}{V_i}$ = Ripple Reduction Factor (RRF)

$$= \frac{1}{\omega^2 LC} \; (= \omega = 2\pi f)$$

As $RRF = \omega^2 LC$ then $LC = \frac{RRF}{\omega^2}$

Multiplying by 10^6, $LC = \frac{RRF \times 10^6}{\omega^2}$ (µF.H)

This answer divided by the value of the choke available gives the minimum value of C.

Example

Required output of 250V at 60mA with ripple voltage not more than 0.1V. Full-wave circuit with $C_r = 16\mu F$.

(*a*) $I_i = \sqrt{2} \times I_{dc} = 1.414 \times 60mA$
$= 0.085$ amps

(*b*) $V_i = I_i \times X.C_r = 0.085 \times \frac{1}{2\pi fC}$
$= 8.5$ volts

(*c*) Required ripple=0.1V

$$RRF = \frac{1}{85} = \frac{1}{\omega^2 LC}$$
$$85 = \omega^2 LC$$

(*d*) $LC = \frac{85}{40 \times 10^4}$

(*e*) Multiply by 10^6, $\frac{85 \times 10^6}{40 \times 10^4} = 212\mu F.H$

(*f*) Using 10H choke, the value of $C = \frac{212}{10}$
$= 21.2\mu F$, in practice $16\mu F + 8\mu F$ in parallel.

When the power supply is required to deliver a large current, better regulation is obtained by using a choke-input filter. The design procedure is similar except that there is a minimum value for the choke. This is to prevent the rectifier being destroyed by surges of current, especially important with gas-filled valves.

Minimum value of choke

$$= \frac{\text{Load resistance}}{1{,}000} \text{ henrys}$$

Example

Unit to give 600V at 200mA with ripple voltage not more than 0.5V.

(*a*) Load resistance $= \frac{600V}{200mA} = 3{,}000\Omega$

(*b*) Minimum value of $L = \frac{3{,}000}{1{,}000}$
$= 3$ henrys

(*c*) Input ripple of full-wave rectifier $= 66.7\%$ of $= 66.7\% \times 600$
$= 400$ voltsV_{dc}

(*d*) $RRF = \frac{0.5}{400} = \frac{1}{800}$; $800 = \omega^2 LC$

$$\therefore C = \frac{800}{\omega^2 L}$$

(*e*) Multiply by 10^6, $C = \frac{800 \times 10^6}{40 \times 10^4 \times 3}$ µF

$$\therefore C = 660\mu F$$

This is impracticable, so either L must be increased or a double section filter used.

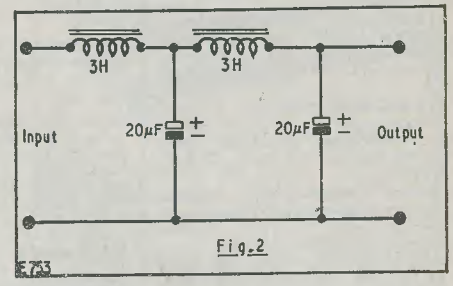

Fig. 2

(See Fig. 2.)

Using double section filter:

(*a*) RRF of first section=23 approx.

thus $C = \frac{23 \times 10^6}{40 \times 10^4 \times 3}$ µF
$= 19.2\mu F$ approx;
in practice, $16\mu F + 4\mu F$ in parallel.

I.A.R.U. Region 1 Conference —Folkestone June 13th-17th

It is surprising that the work of the International Amateur Radio Union, particularly that carried out by Region 1, is not better known to the amateur radio fraternity. One feels this acutely on occasions such as the Region 1 conference, recently held at Folkestone, Kent. Quite apart from the extensiveness of the agenda—which has to be considered by several individual committees in order to cover the whole ground during the five days of the conference—the enthusiasm of the delegates is such that it would convince even the most sceptical that amateur radio is a hobby of unparalleled liveliness. Generally speaking, Region 1 of the I.A.R.U. covers the countries of Europe. Region conferences are held, more or less, once every three years, a different "host country" staging the conference on each occasion. Lausanne, Stresa and Bad Godesberg have been recent venues, this time it being the turn of the United Kingdom. The Radio Society of Great Britain had the responsibility of organising the conference on this occasion—which they very ably arranged at the Grand Hotel, Folkestone. A total of some fifty delegates attended from Italy, Western Germany, Eire, Norway, France, Luxembourg, Great Britain, Finland, Yugoslavia, Sweden, Belgium, Spain, Switzerland, Holland and, for the first time, from Poland. Mr. A. L. Budlong, W1BUD, well-known secretary of the A.R.R.L., was also a distinguished visitor and observer.

The pattern for the future development of amateur radio may well be set by the deliberations of these delegates. Among the items on the present agenda for instance are such matters as draft specifications for amateur transmitters and receivers. The ultimate intention here is to reach an agreement on the technical and mechanical standards to which amateurs, or commercial firms building this type of equipment for sale to the amateur, could work, in the full knowledge that when such designs comply with these specifications they would bear a recognised hall mark of approval.

RTTY is just getting started in this part of the world and another paper presented for consideration deals with the technical standards to be used in this mode of communication. A special committee will consider the question of v.h.f. activity in the Region, much discussion appearing likely to revolve around the future development of amateur radio emergency services. Interest in this aspect of amateur radio has been greatly stimulated by the recent series of floods, earthquakes and other natural catastrophes, in which amateur radio communications have played a prominent role. Amateur television, reception of radio signals from inter-planetary satellites, s.s.b., interference by amateur radio transmitters with essential t.v. and other radio services are but a few of the items which catch the eye as one turns the pages of the documents which the delegates will have to consider. The bright sunny weather which graced the opening sessions and brought added beauty to the picturesque town of Folkestone gave many of the delegates a favourable impression of their first visit to the United Kingdom.

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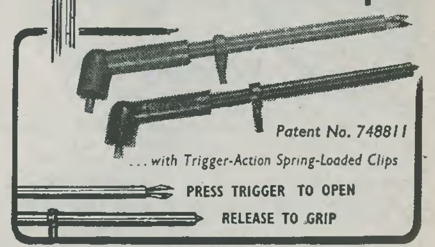

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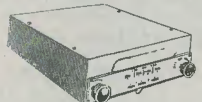

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continued on page 959

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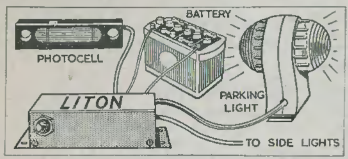

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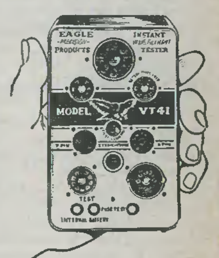

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