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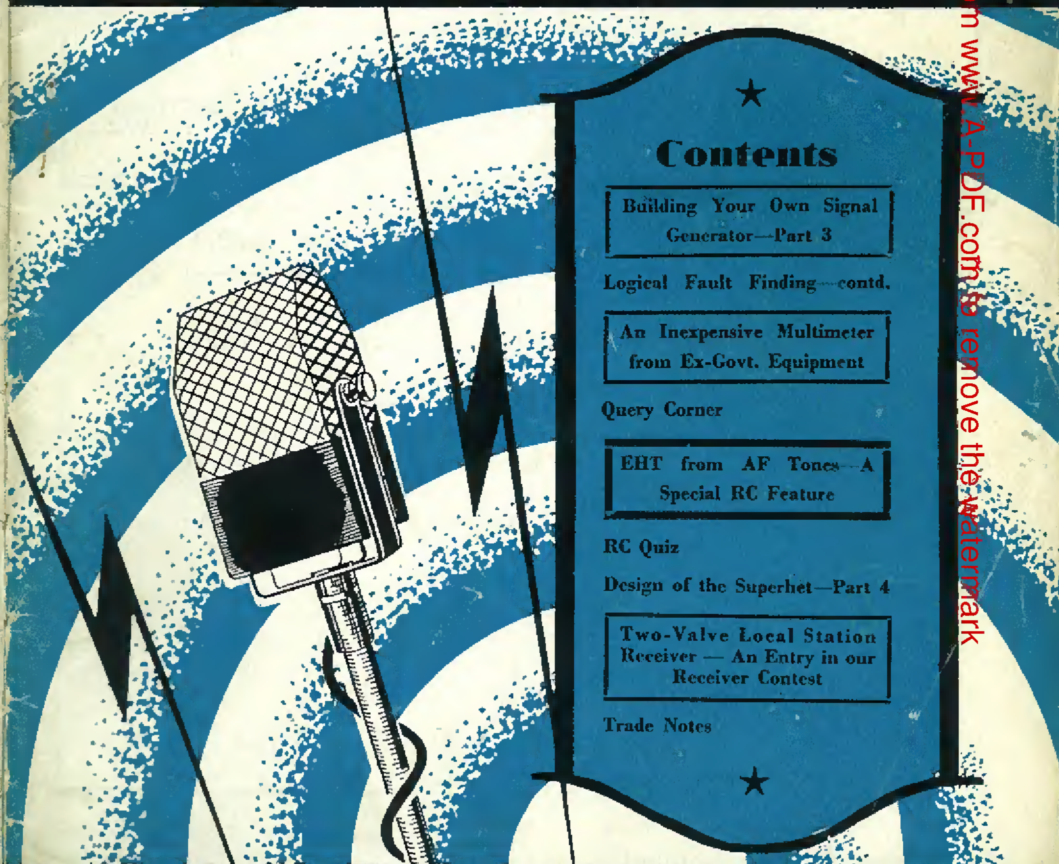
# RADIO CONSTRUCTOR


1/3
Vol. 3 No. 7
FEBRUARY 1950


*For Every Radio Enthusiast*



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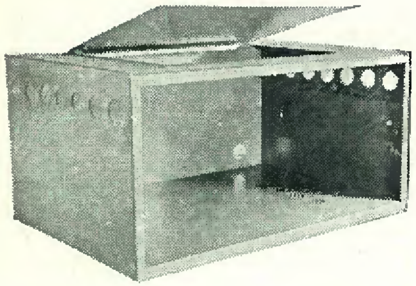

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is a monthly journal which deals with all aspects of short wave radio. The constructional side describes short wave receivers, transmitting equipment, aerials, test apparatus, etc. The amateur and broadcast bands are covered in separate articles, each contributed by an enthusiast in each sphere, and there is usually an illustrated description of an amateur or commercial station. International Short Wave League activities are exclusively recorded in this magazine, and a number of competitions are run for the benefit of readers. Now in its fourth volume, Short Wave News is obtainable from local booksellers at **1/3**, or may be subscribed for at **16/-** annually.

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# *BUILDING YOUR OWN*
# SIGNAL GENERATOR

*By* **W. G. MORLEY**

PART THREE

**The Oscillator Valve**

THE oscillator valve itself is fairly important. Since changing the valve would be liable to slightly affect calibration, it is advisable to start off with a valve in really good condition and which is unlikely to wear out for a good few years. Valves type 6J5, 6C5, etc., are ideal for the purpose. It may prove to be false economy to use a double triode such as a 6SN7 for oscillator and cathode follower or AF oscillator, as unwanted capacitance couplings may be present inside the valve envelope.

The value of grid leak and capacitor may be the usual 20K Ω and 0.0001$\mu$F respectively.

To develop an RF voltage of, say, 1 volt, across an attenuation network of 100 ohms, only 10 milliwatts of RF power are needed, well within the limits of a 6J5 or similar valve.

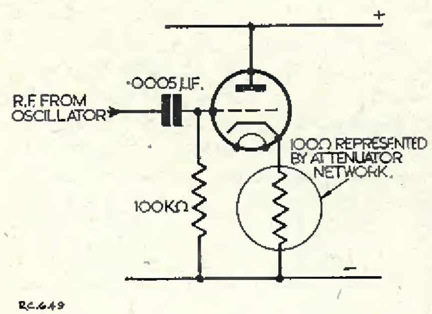



Fig. 6.

**The Cathode Follower**

Before we actually consider the attenuation network, the method of coupling it to the RF oscillator needs a little discussion. We have already touched upon the use of a coil coupled to the main tuned circuit. Another and somewhat simpler circuit is offered by taking advantage of the cathode follower. Fig. 6 shows the circuit. Again a 6J5 or similar valve could be used. However, the 100 ohm resistance in the cathode (offered by the attenuator) is liable to cause a fairly heavy anode current which will not help the regulation of our small power unit. So a circuit as shown in Fig. 7 might be more helpful. In this circuit the cathode follower is getting a more correct value of bias and the RF load is still of the order of 100 ohms.

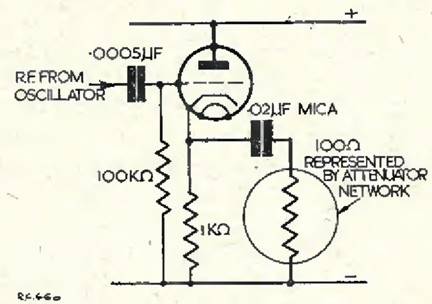



Fig. 7.

The coupling for the cathode follower grid should not be taken from the actual tuned circuit of the oscillator. If a tuned grid oscillator is used, the coupling should be taken from the oscillator anode; if a tuned anode oscillator, from the grid; and if an ECO, from the cathode. This will obviate any additional thermal capacitance changes across the tuned circuit.

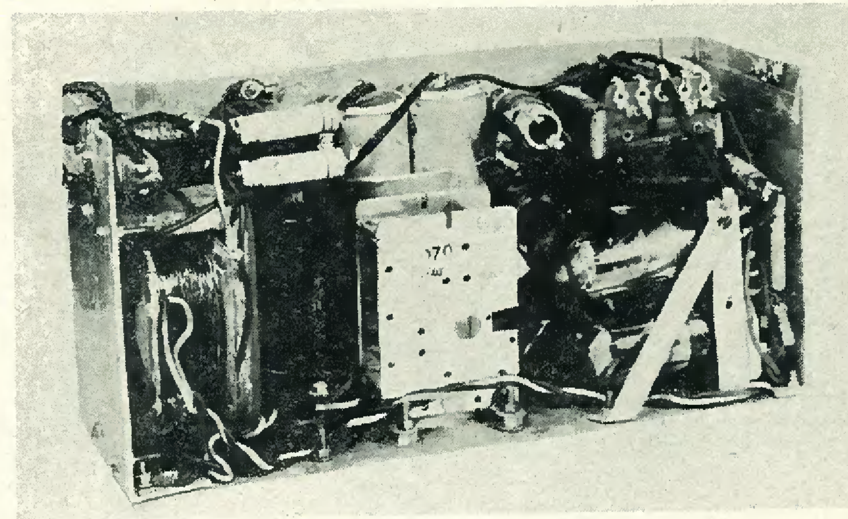
**The Attenuator Circuit**

Many sorts of attenuator are used commercially, varying from complicated constant impedance circuits to simple potentiometer networks. The simplest attenuator we can use is a potentiometer type as shown in Fig. 8. This splits the output into tenths of the available output and is quite useful in practise.

However, it is better to have a fine attenuator if possible. This is done in the commercial generator by means of a slide-wire device as shown in Fig. 9. The round resistor element consists of a length of resistance wire of very low resistance, and, of course, it possesses little inductance. However, this form of control is fairly difficult to construct, and it is much simpler to fall back on a switch. Fig. 10 shows the circuit of a really useful attenuator which is very simple and cheap to construct.







*Rear view of Signal Generator.*

It will be seen in this circuit that the fine attenuator is out of circuit on the "full" position of the coarse attenuator. This has to be done because it would be impracticable to feed the RF output of the oscillator into an impedance as low as the 15 ohms represented by the fine attenuator.

The attenuator of Fig. 10 presents a constant impedance of 100 ohms to the oscillator output, but the impedance of the attenuator output terminals varies between a fraction of an ohm and 100 ohms. It is assumed—safely enough—that for normal servicing work these output impedances are so low that any change in their value has negligible effect and may be ignored.

**The AF Oscillator**

The next point in the construction of our signal generator is the design of the AF oscillator. This should have a frequency of approximately 400 cps, the most customarily used frequency in commercial signal generators.

To generate a frequency as low as 400 cps an AF transformer with a fairly large inductance is required. An old inter-valve transformer is the best component to use, and these components are fairly prolific in the average constructor's junk-box. To take advantage of the relatively large inductance offered by a component of this type, it is best to use a Hartley oscillator circuit, as shown in Fig. 11(a). This oscillator has the tuning capacitor connected across all the inductance. The primary and secondary windings of the inter-valve transformer may be utilised as shown in Fig. 11(b) by connecting them in series and using the junction as the earthy tap. The

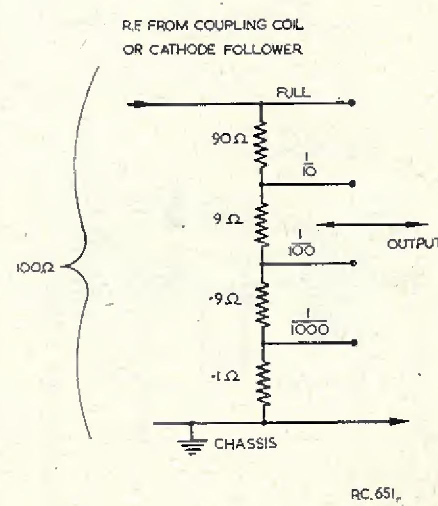



Fig. 8.

primary (assuming that the transformer is a step-up component), should be used for the grid section of the coil.

As the frequency of the oscillator might vary somewhat with an inductive load (such as would be given by connecting a pair of phones between anode and earth), its frequency during construction may be checked by using the dodge shown in Fig. 12. If one side of a pair of high impedance (4,000 ohms) phones is touched against the anode of the AF oscillator, the AF tone will be heard faintly in the phones, at the same time offering neglegible load to the oscillator.

To get the oscillator to work at 400 cps it will be necessary to experiment with the value of C (Fig. 11), until a value of capacitance is found which gives the required frequency.* It is not possible to give definite values of grid leak and capacitor, as different models of transformer will give rise to varying conditions. However, the grid capacitor should lie between 0.001 and 0.0005$\mu$F, and the leak between 10K $\Omega$ and 100K $\Omega$.

The AF oscillator can conveniently be a 6J5 or similar valve.

*If the piano-tuner has done his job properly at his last visit, the frequency of 400 cps should lie between G and G sharp above middle C !

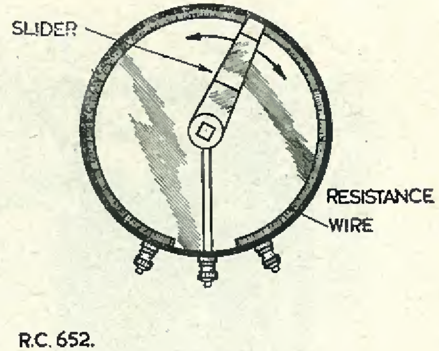



Fig. 9.

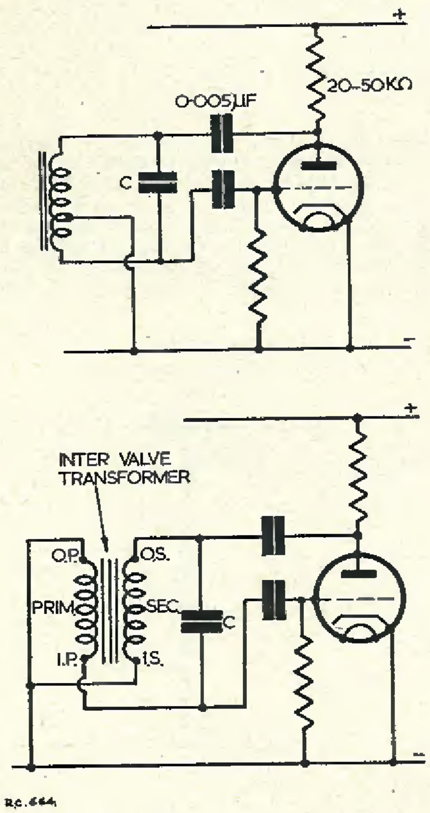



Fig. 11a (above)
„ 11b (below)

## "RADIO CONSTRUCTOR" QUIZ

*Conducted by W. Groome*

(1) When Mr. Brain's extension speaker was operated simultaneously with the main one, he was aware of distortion which he rightly attributed to mis-matching of load, and the effect of long extension leads. Was he right in applying negative voltage feedback to the output stage to reduce the distortion?

(2) What is "trapezium distortion ?"

(3) Why is the high resistance "bleeder" across the EHT supply made up of a number of relatively low value resistors in series, instead of a single high resistance component ?

(4) If, for economy or convenience, a television dipole was constructed of copper wire instead of the usual tubing, what would be the effect on the picture ?

(5) "Woofer and Tweeter" are not a music hall double act. Who or what are they ?

(6) What is a cross-over network ?

(Answers on page 189)





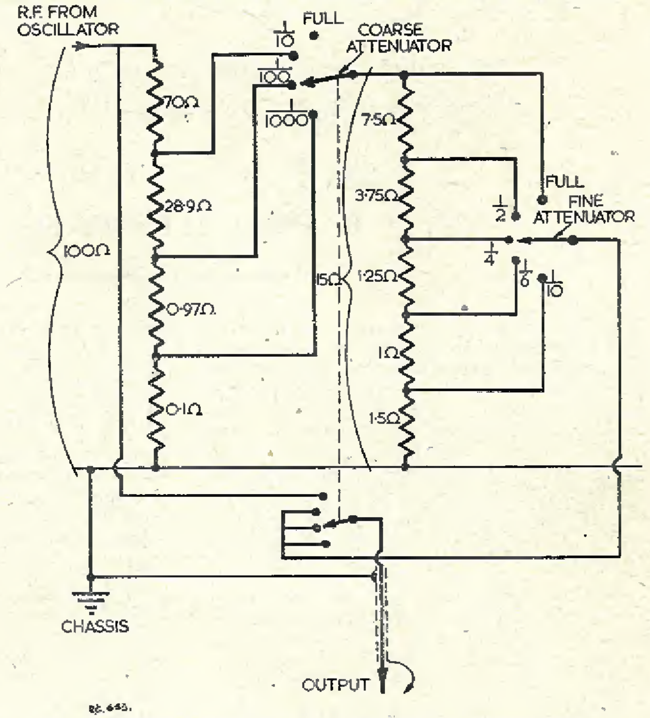



Fig. 10.

*Output Attenuator Network*

# LOGICAL FAULT FINDING

*The eighth in a series of articles to assist the home constructor in tracing and curing faults*

By J. R. DAVIES

## 8: POOR SELECTIVITY

POOR selectivity is not a fault with which the commercial serviceman is very often troubled. Apart from the fact that the tuned circuits of a reciever may go out of alignment (in common with a few other faults enumerated below), poor selectivity is usually caused by the coils and general design chosen by the manufacturer. Quite rightly, the commercial serviceman is not going to waste a lot of time altering and rebuilding an inherently inefficient receiver, as his job is to bring the set up to the condition it was in when it left the factory.

For the home-constructor, however, whose time is not so limited, some quite considerable improvement can be made to a poorly selective receiver, particularly if this is of the home-constructed variety.

In this article, the writer will endeavour to combine both approaches to the fault.

**Poor Selectivity in a Straight Receiver**

First of all, let us review the possible causes of poor selectivity in a straight receiver, assuming that the set was at one time working efficiently, and has since given rise to the trouble.

Fig. 46 shows the RF and detector circuits of a conventional straight receiver. Wave change switching is omitted for simplicity. The selectivity of the set in which these stages are used has become worse than it was originally.

The most probable cause of the lack of selectivity lies in the mis-alignment of the trimmers. Either these have been tampered with, or they have fallen out of adjustment with the passage of time. This point may be easily checked by tuning in a station at the high-frequency end of the band (capacitor vanes nearly completely unmeshed) and adjusting the trimmers for maximum volume. It is very important to see that the "peak" position of the trimmers is obtained. It is not sufficient to find that the signal increases in volume as a certain trimmer is adjusted, maximum volume being obtained when the trimmer is tightly screwed up. The position of maximum volume should be reached *and passed* as the trimmer is tightened. If it is impossible to obtain a "peak" in this manner within the capacitive range of the trimmer, then the tuning capacitor itself must be slightly adjusted, so as to give a little more or less capacitance in the tuned circuit as required. All the trimmers on the selected band will then have to be adjusted again.

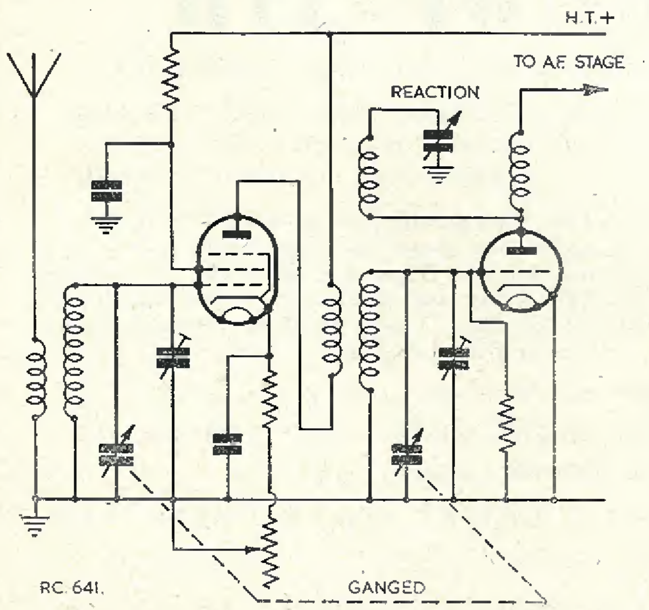



Fig. 46.

*RF and Detector Stages of a conventional straight receiver.*





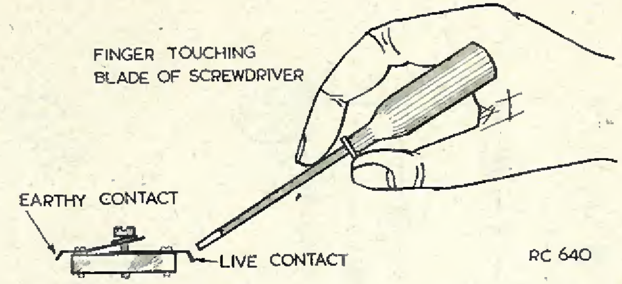


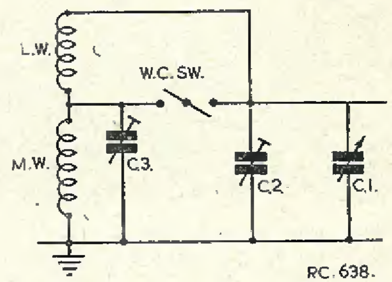

Fig. 47.

*Showing a dodge for quickly ascertaining whether or not a particular trimmer is in circuit.*

When trimming is completed on the station selected, the adjustment can be checked at various points of the dial, whereupon the setting of the trimmers should be found to remain reasonably constant. If this is not the case, we must look for a fault in one of the tuned circuits. We shall deal with this later.

Before trimming the receiver, it is very advisable to ascertain which trimmer is used for each band. This may be done by tracing out the wiring. Alternatively, the following little dodge may be of use, particularly with multiband receivers. If a metal screwdriver blade, whose shaft is touched by the hand, is rubbed against the "live" side of a trimmer that is selected by the wavechange switch, then a loud crackle will be heard in the speaker. This crackle will be much louder than that resulting if any other trimmer not in circuit is so touched. When one is confronted by a receiver bearing several rows of trimmers, this method helps very considerably in selecting the trimmers appropriate to each band. Fig. 47 shows the general method of carrying out this checking process. The hand not holding the screwdriver should be kept away from any adjacent metal objects, in case there is an HT voltage on the trimmers. Incidentally, it is usually quite simple to ascertain which is the "live" side of the trimmer as this will nearly always be the vane that does not come into contact with the trimming tool. As it is advisable to learn the disposition of all the trimmers before adjustments are carried out, the trimmers can be numbered by pencil marks on the chassis, or a sketch could be made on paper and followed during alignment.

Trimming circuits (particularly with medium and long wave sets), are not always straightforward, and a little perplexity may be caused when some commercial sets are checked. An occasionally met variation is shown in Fig. 48(a). C1 represents one gang of the tuning capacitor and C2 and C3 the trimmers. C2 is quite often



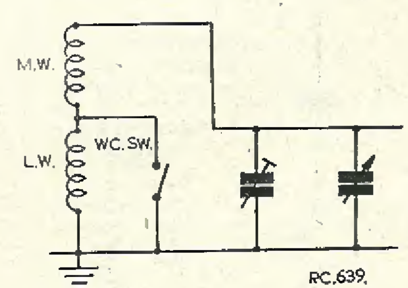
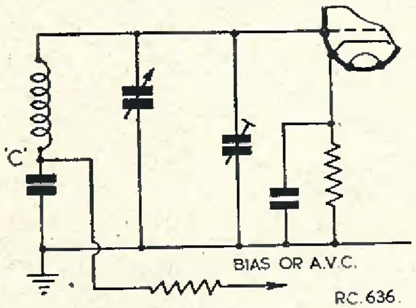




Fig. 48.

*Fig. 48a (above). One method of connecting trimmers to a two-band receiver.*

*Fig. 48b (below). Another circuit in which one trimmer is used for both wavebands.*



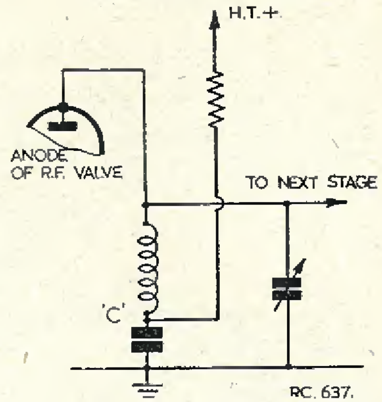




Fig. 49.

*Fig. 49a (left) and Fig. 49b (right). Two circuits illustrating how a large value capacitor may be used both to block a DC voltage as well as to complete a tuned circuit.*

the trimming capacitor permanently mounted on the tuning capacitor itself. As may be seen, this trimmer will alter both the medium and long wave tuned circuits. In this case it should be adjusted for best results on the long waveband. The set should then be switched to medium waves and C3 adjusted. Another circuit is shown in Fig. 48(b). In this diagram only one trimmer is used for both medium and long waves. This trimmer should be adjusted for best results on the medium waves only, it being assumed that the long wave tuning is sufficiently flat not to be affected by small changes in trimming capacitance.

Always, when trimming a receiver, use a weak signal. When an attenuated signal generator is unavailable, either align using weak stations or attenuate stronger signals by using only a short length of aerial wire. (This latter course may introduce slight discrepancies in the aerial tuned circuit, but these are usually too small to cause much trouble).

Now, if it is found that the trimming adjustment made at the high-frequency end of the band does not hold over the whole of the band, the serviceman should decide if this fault is sufficiently bad to merit an inspection on the tuned circuits. A slight discrepancy in tracking occurs with most receivers; and the serviceman has to make his own decision.

Referring back to Fig. 46 one finds that there are very few components that may cause bad tracking. The two-gang capacitor should be cleaned and checked, but it is unlikely that it will cause bad tracking.* The trouble lies more probably in the coils. These should be inspected for loose or short-circuited turns. If they are iron-cored the cores should be checked to see that they are not out of position. If screening is fitted the position of each coil with respect to its screening should be examined, repositioning the coil if necessary. Small scraps of metal may have fallen into the coil formers and altered their inductance.

Sometimes, the tuned circuit given by a coil and capacitor is broken by a large-capacitance

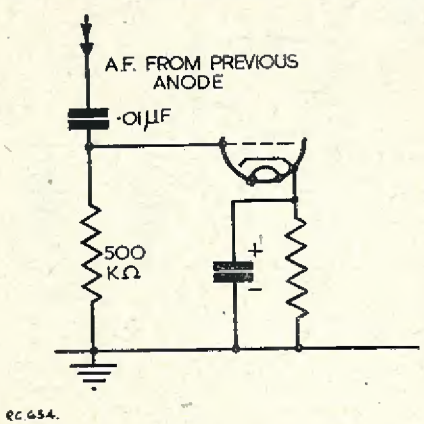



Fig. 50.

*Typical grid circuit of an AF valve.*

*It may be noticed that the writer has made no reference here to the split end-vanes fitted to most two or three-gang tuning capacitors. These vanes are usually adjusted by the manufacturer to ensure that the capacitor gangs all have the same *capacitance*, whatever the position of the moving vanes.





DC blocking capacitor. Fig. 49(a) and (b) show two typical examples, the capacitors "C" in both instances carrying out the tasks of blocking the DC voltages present and of completing the tuned circuit. If these capacitors develop a leak or change in capacitance, then tracking is almost certainly bound to suffer. They should be replaced if suspected. Mica capacitors are best for use in a circuit of this type, although paper capacitors are nearly always used in commercial receivers.

The writer has met one or two cases of mass-produced straight receivers in the "midget" class in which it is impossible to accurately track the two tuned circuits. Particularly is this true of portables using frame aerials as the grid coil of the RF valve. He has cured the trouble by fitting an additional fixed "padding" capacitor in series with the coil possessing the excessive inductance. The values of padding capacitor were found by experiment, capacitors of approximately 0.01μF usually giving the very small alteration required.

Reaction is sometimes used to improve the selectivity of a straight receiver, as well as being used to increase its sensitivity. Unfortunately, however, this reaction is very often used as a volume control alone, so that its ability to improve selectivity is often lost. It is very often beneficial to fit a separate volume control to a straight receiver in addition to the reaction control. Then, if it is desired to receive a signal suffering strong adjacent channel, the reaction control may be adjusted to just below oscillation point, providing the necessary selectivity, whilst the separate volume control can be used to give the volume level required. Unless the receiver is well-designed, the writer does not advise fitting

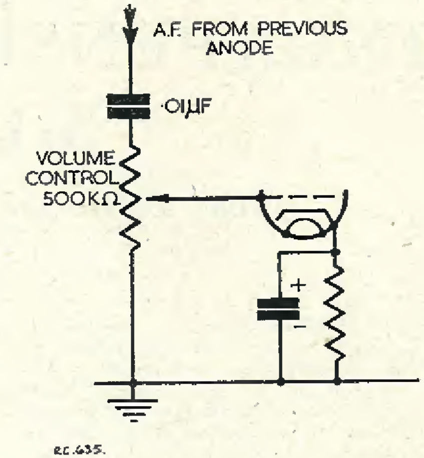



Fig. 51

*How a volume control may be fitted to the circuit of Fig. 50a. The volume control should have the same value as the grid resistor previously in circuit.*

this extra volume control to the RF circuit, as the adjustment of the control often causes changes in the reaction setting, thereby making tuning a difficult and fiddling business. It is usually better to fit the volume control in the AF section of the receiver, even if this necessitates it being connected in the grid circuit of the output valve. Figs. 50 and 51 illustrate how the grid leak of an AF valve may be replaced by a volume control, this component having the same value as the leak.

(To be continued)

## ANSWERS TO QUIZ

(1) Mr. Brain was right. Negative feedback does not, of course, adjust the load, and the mismatch is still present, but the amount of distortion will be lessened.

(2) Distortion of the raster when using an electrostatic CRT, the effect being that opposite edges are not parallel. Usually only one pair of sides are so affected, and these are those controlled by the pair of deflector plates nearest the screen. The remedy, apart from tube design, is to apply deflecting voltages to both the plates concerned from a symmetric or push-pull source.

(3) By using a long chain, the voltage drop across each resistor is kept small. Thus with four equal value resistors across a supply of 2kV, the drop across each would be 500V. If the full 2kV were across a single resistor, there would be a danger of "flash-over" or arcing from one end of the resistor to the other.

(4) The diameter of the aerial conductor has an important bearing on the bandwidth accepted by it, and this in turn affects the quality of the picture received. A copper wire dipole would not be as satisfactory as one made of tubing, for this reason. A "cage" consisting of eight or ten strands would give good results, but would be more trouble to construct and erect than the tubular type.

(5) In a dual loudspeaker arrangement, the 12" or so bass unit is commonly called the "woofer," and the smaller high frequency unit the "tweeter."

(6) In a "woofer-tweeter" system, a choke-capacitor network is used to divide the audio frequencies between the two speakers. At a selected frequency (often 1,000 cps) an attenuation of about 12 dB per octave is arranged—above the cross-over frequency in the case of the "woofer," and below it in the case of the "tweeter."

AN

# INEXPENSIVE MULTIMETER

## From Ex-Government Equipment

By D. NAPPIN

A MULTIMETER is an almost indispensible accessory for the radio experimenter, and the one about to be described has a sensitivity of 2,000 ohms per volt, making it suitable for all but the most exacting tests. This meter covers eleven current and eleven voltage ranges, and measures resistance. This can be altered to suit personal taste, should any ranges not be required. The voltage ranges cover both AC and DC. The basis of the meter is a movement with a full scale deflection of 500$\mu$A, having a DC resistance of 500 Ω, which was purchased for the modest sum of 7/6. This movement has a diameter of 2", is supplied with a fixing clip, and is a very neat looking job.

The case came originally from an R1134 amplifier, and is 4" deep, 6⅝" wide and 4¼" high. It is finished in black crackle. A new panel had to be made, and the dimensions for this are given in Fig. 1. This panel was made from aluminium sheet. The controls shown in this drawing are, to the left of the meter, the main selector switch, and to the right, the ohms range zero-set potentiometer. The bottom row of controls are, from left to right, the "Volts-mA-Ohms" selector switch, the "AC-DC" switch, and the "Ohms On-Off" switch.

The voltage multipliers—series resistors for the volt ranges—should be as accurate as can be obtained, with a tolerance of ±1% if possible. They are mounted on a tag-board which measures 2½" by 4½", which is suspended by stiff connecting wires. The shunt resistors for the current ranges can be mounted in like manner if desired, but in the case of the original it was found much more convenient to run them to an 18swg busbar running part way around the switch. Home-wound shunts of values above 10 Ω are inclined to be bulky, so standard value resistors were used and the current ranges adjusted accordingly—in the model built these ranges are 1.5mA, 3mA, 8mA and 25mA. The maximum error, apart from resistor deviations, is 2%.

A note is necessary about the selector switch. This is of the two-bank Yaxley type, but the selector mechanism has had one of the stops removed in order to secure 360 degree rotation. The wafers are identical, each having eleven contacts. In the twelfth position, with S2 set to volts, the meter is disconnected from the circuit.

The rating of the rectifier is of little importance so long as it is able to pass the current drawn by the meter. It should not, however, be too highly rated, as otherwise there will be non-linearity in the calibration of the AC volt ranges. In my model the rectifier was composed of four Westinghouse G4 units connected in a bridge circuit. The instrument type is, however, preferable.

The ohms range arrangements are quite standard. The series resistors R11 and VR1 should be carefully chosen to suit the voltage which is to be applied. For instance, with a movement of 1mA FSD, 1,000 ohms will be needed for every volt applied. Of this, the internal resistance of the meter will account for, say, 100 ohms. Of the remaining 900 ohms, the greater part—say, 650 ohms—should be taken up in the safety resistor R11, and the remainder in the zero-set control VR1. A graph should be drawn up showing resistance values against meter scale readings. The resistance values can be calculated by Ohm's Law, the applied voltage and current flowing being known. It should not be forgotten that the calculated value includes all resistance in circuit, and the figures for the internal meter resistance and R11, and that portion of VR1 which is in circuit, should be deducted. The total of these last three resistances can easily be found by assuming the test prods to be shorted. A most useful article on the calibration of home-built multi-range meters appeared in the last issue of this magazine.

A multiplication of the ohms range can be accomplished by using an external battery to boost the applied voltage. With an internal voltage of 1.5, the addition—remember polarity!—of 13.5V will increase the range by ten times. R11 will also have to be increased proportionately, of course.

The internal battery or cell can easily be accommodated in the meter case, although I myself have brought out a pair of leads which are taken to a 4V accumulator.





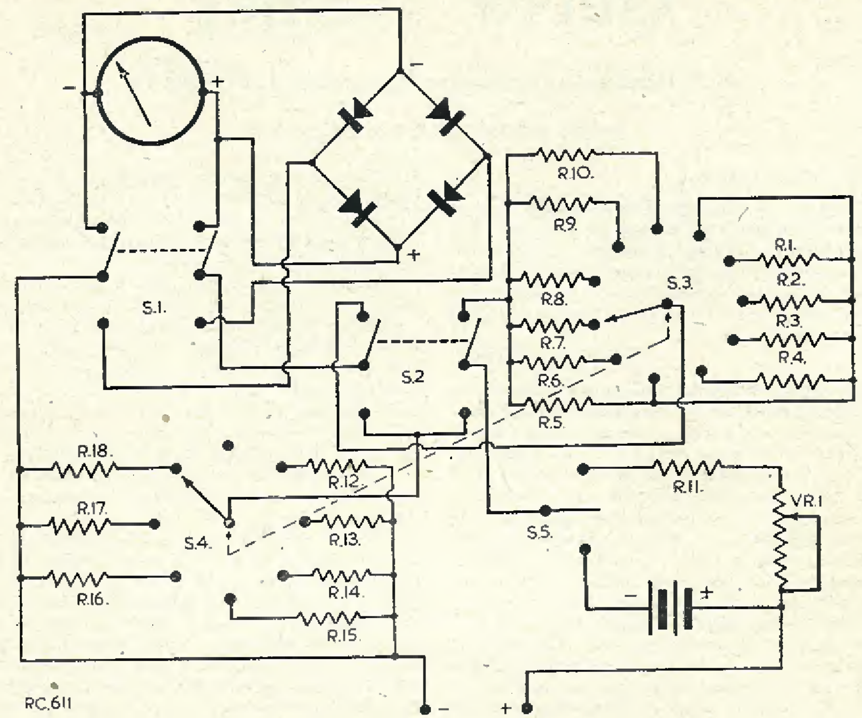



Fig. 1—CIRCUIT OF THE MULTIMETER

*Component List*

| Resistor | Range | Resistor | Range |
|---|---|---|---|
| R1—500 Ω | 0.5V | R13—100 Ω | 3mA |
| R2—1.5k Ω | 1V | R14—33 Ω | 8mA |
| R3—9.5k Ω | 5V | R15—10 Ω | 25mA |
| R4—19.5k Ω | 10V | R16—5 Ω | 50mA |
| R5—50k Ω | 25V | R17—2.5 Ω | 100mA |
| R6—100k Ω | 50V | R18—1.0 Ω | 250mA |
| R7—200k Ω | 100V | Meter—0-500$\mu$A 500 Ω | |
| R8—500k Ω | 250V | VR1—1000 Ω potentiometer | |
| R9—1M Ω | 500V | S3, 4—2 Bank SP 11 Way | |
| R10—5M Ω | 2.5kV | S1, 2—DPDT toggle | |
| R11—7k Ω | Ohms | S5—SPDT toggle | |
| R12—250 Ω | 1.5mA | Tag Board | |
| | | Rectifier—see text. | |

NEXT MONTH APPEARS THE FIRST OF TWO ARTICLES ON **"REBUILDING THE R1155 RECEIVER"**

# Query Corner

## A " Radio Constructor " service for readers

**Battery-Mains Receivers**

"*I am in possession of a battery portable receiver which was designed to operate from an HT battery and a 1.5 volt LT battery. I believe that it is possible to modify receivers of this type so that they might operate from AC or DC mains and I would appreciate your comments on such a conversion.*"

*D. Williams, Salisbury.*

This enquiry is typical of many which have been received on this particular subject. The majority of battery receivers which operate from a 1.5 volt LT supply may be converted to mains operation, but it is likely that the unwary constructor will fuse a number of his valve filaments before the correct operating conditions are obtained. It will be appreciated that modern battery valves having a filament current of 50mA., must of necessity possess very thin filaments which may fuse on quite small overloads. Because of this the valve manufacturers recommend that when these battery valves are operated from a mains supply unit the filament voltage should be 1.3 volts when the mains voltage is at its nominal value. This figure is lower than that at which the filament is normally operated and allows for small fluctuations in the mains supply voltage.

Now in order to convert a battery receiver to operate from the mains the following modifications and additions must be made.

(1) An AC/DC type of power pack must be provided to supply both the HT and LT power.

(2) The valve filaments must be connected in series, and for this reason it is essential that all the valves have the same filament current, normally 50mA.

(3) Because the valve filaments are series connected the mean potential of some of the filaments will be positive with respect to the chassis. This upsets the biassing of these valves and therefore a modified bias circuit will be required.

Taking these points in turn, the circuit diagram of the power supply is shown in Fig. 1. As previously stated this follows the standard AC/DC technique and a selenium rectifier is used in preference to a valve rectifier to eliminate the necessity of providing a separate rectifier heater circuit. The selenium rectifier also has the advantage of smaller size, a point worthy of mention when the receiver to be converted has a small cabinet. Separate smoothing is used for the HT and LT circuits, as such an arrangement provides the best possible LT voltage stability.

The valve filaments are of the 50mA type and are series connected. When the receiver is operated from the mains the filament current is limited by the resistor R1. The value of this resistor must be adjusted until the voltage across each valve filament is 1.3 volts, this adjustment being made when the supply voltage is at its nominal value. If this procedure is followed the maximum life will be obtained from the valves. A little consideration of the circuit diagram will reveal that the anode current of some of the valves will flow through the filaments of the others. This is an important point, which must not be overlooked, as the combined anode and screen grid current of the output valve may be as high as 8.5mA. This current in making its return to HT— will flow through the filaments of the remaining three valves, the filaments of which will consequently be over-run. To prevent this effect at least one shunting resistor is normally included in the filament circuit, and shunts the electrode current of the output pentode. The electrode currents of the other valves are generally so low that it has no effect upon their filament voltages. In the normal four valve superhet portable the sum of the filament voltages of the valves is 7.5 volts and for truly portable operation this voltage is supplied by a special 7.5 volt dry battery. If so desired this battery may be left in circuit when the receiver is mains driven. Such an arrangement simplifies the filament switching and allows the receiver to continue to operate when the mains plug is pulled from its socket. It has the disadvantage, however, that after a long period of use the batteries may tend to charge from the mains supply unit and this in turn may lead to excessive corrosion.

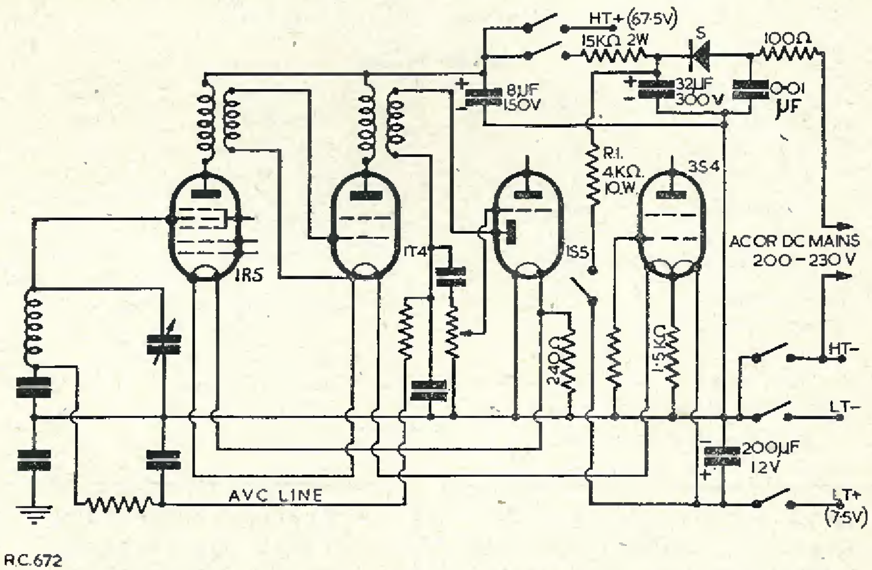



Fig 1

*Skeleton circuit of a 4-valve battery superhet, showing method of connecting AC/DC power supply, and amended biasing arrangements. " S " is a 60mA selenium rectifier.*





## " Query Corner " Rules

(1) A nominal fee of 1/- will be made for each query.

(2) Queries on any subject relating to technical radio or electrical matters will be accepted, though it will not be possible to provide complete circuit diagrams for the more complex receivers, transmitters and the like.

(3) Complete circuits of equipment may be submitted to us before construction is commenced. This will ensure that component values are correct and that the circuit is theoretically sound.

(4) All queries will receive critical scrutiny and replies will be as comprehensive as possible.

(5) Correspondence to be addressed to " Query Corner," Radio Constructor, 57, Maida Vale, Paddington, London, W.9.

(6) A selection of those queries with the more general interest will be reproduced in these pages each month.

The grid bias of each valve is the DC voltage which appears between its control grid and filament. Because the filaments of three of the valves are positive with respect to the chassis a modified biassing arrangement is required. Such an arrangement has been included in the circuit shown in Fig. 1 and will prove to be very satisfactory when employed in most four valve superhets.

One last word of warning before leaving the subject; when determining the exact voltage of the filament current limiting resistor R1, err on the high side as it is easy to reduce the resistance in circuit, but to have to increase the resistance may also mean that a valve must be replaced because of a broken filament.

**Television Aerials**

"*I live in the Birmingham television area and wish to erect an H type aerial. Would you please provide me with the salient dimensions of this type of aerial?*"

*E. Smith, Leicester.*

Television aerials at present in general use may be classified into three groups. For use in areas of high field strength, the simple dipole or loft type aerial is satisfactory. For normal use the addition of a reflector to the dipole results in the familiar " H " type of aerial. This system has the advantage that it increases the forward gain of the array and reduces the pick up of noise which is generated behind the aerial. For fringe area reception the use of a multi-element reflector system is normally employed. Such an aerial however, although it has a high gain, suffers from the disadvantage that it is difficult to maintain

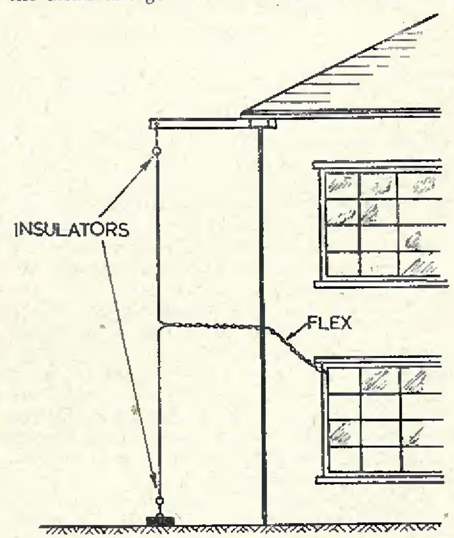



Fig. 3

*Showing method of hooking up a temporary TV aerial.*

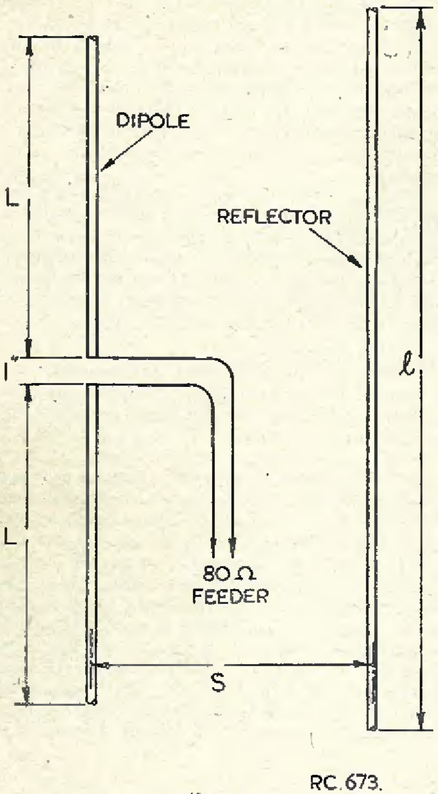



Fig. 2

*Dimensions of dipole and reflector (for figures see text).*

the required bandwidth. The diagram Fig. 2 and the table reproduced below provide the dimensions of the standard dipole and reflector, two sets of measurements being given to cover the London and Birmingham transmissions. A great deal of experimental work has been conducted by investigators in the aerial field to determine the optimum spacing between the aerial and the reflector; and also the optimum length of the reflector. It has been found that 1/8th wave-length spacing may be employed between the dipole and the reflector in place of the 1/4 wave spacing used until quite recently on many commercial systems. The smaller spacing enables a much more rigid and lighter assembly to be used and it is also claimed to provide a more even gain over the required bandwidth.

Having determined the length of the elements, a few words regarding the method of constructing a TV aerial may be useful. Firstly the two vertical members may conveniently consist of ½″ Duralumin tubing having a wall thickness of not less than 1/16″. The use of tubing of this gauge will ensure adequate mechanical strength.

| Transmission | London | Birmingham |
|---|---|---|
| Length of each limb of dipole (L) .. | 64″ | 47″ |
| Total length of reflector (l) .. .. | 139″ | 100″ |
| Spacing between dipole and reflector (s) | 33″ | 24″ |

If possible the tubing should be obtained in the lengths required and joints thereby avoided. The cross member and supporting pole may consist of 1″ wooden rod or ½″ gas piping. If it is decided to use the latter material the help of the local garage may be enlisted for the purpose of cutting the threads for the T junction adaptors. This type of aerial must be connected to the receiver by means of an 80 ohm feeder, and if co-axial cable is employed the earthed braiding is joined to the lower element of the dipole.

Duralumin is particularly susceptible to corrosion and the vertical members must therefore be thoroughly cleaned and treated with a paint or varnish. The ends of the tubing may be sealed with pitch or similar material.

Finally for those who wish to erect a TV aerial at a moment's notice the dodge illustrated in Fig. 3 may prove useful. It consists merely of using rubber covered flex for both the dipole and lead in. The flex is unwound to form the dipole, the lower limb of which is connected to the earthy side of the receiver input. In areas of high field strength this type of "hook-up" aerial is capable of providing very good resutls.

DESIGN OF THE SUPERHET—

*continued from page 203*

Both oscillator and aerial coils may, however, be conveniently placed beneath the chassis. It is usually adviceable to screen them one from the other, although this screening need not be at all extensive. Fig. 5 shows an excellent layout for an all-wave receiver in which all coils are placed below the chassis and all wiring is short. The wiring to the short wave coils is the shortest of all as these are placed nearest the wave-change switch. The lead to the signal-grid of the frequency-changer (assuming a top cap) is taken from the top connection of the signal frequency section of the two-gang capacitor.

Many more combinations and layouts are of course possible, and the constructor will find some good examples in the better class modern commercial receivers which come his way.

**Next Month**

We have, by now, gone pretty thoroughly into the theory and practice of the frequency-changer, and it is therefore proposed to turn to another part of the superhet. Next month, then, we shall deal with the stage which follows the frequency-changer, the IF amplifier.



# EHT *from* AF TONES

★ ★ ★ ★ ★ ★ ★ ★

## AN ENTIRELY NEW METHOD OF OBTAINING EHT—*By J. R. Davies*

★ ★ ★ ★ ★ ★ ★ ★

THE problem of supplying a cheap yet efficient EHT supply for home-constructed television receivers has, for a long time, been a somewhat vexatious necessity. The ordinary 50 cycle EHT transformers are plentiful but are also fairly expensive. "Ringing choke" and flyback methods need a certain amount of juggling before they become really reliable. RF oscillators provide a good solution to the EHT question, but again, if home-made, require a certain amount of experiment, in addition to the job of manufacturing the coil.

In this article the author wishes to introduce an entirely new method of obtaining EHT. Instead of using an RF oscillator, this utilises an AF tone; and, in conjunction with Government surplus transformers, should prove capable of providing a reliable and very cheap source of EHT.

**The Transformer Used**

The transformer used by the author is a typical example of the high frequency type mentioned above. It rejoices in the reference of 10KB/1016 and is found in a power unit which probably originally supplied the Indicator Type 6.* It had three primary taps, labelled respectively "0," "80" and "115." One side of the secondary was taken to the mounting frame and subsequently, of course, to the power unit chassis; and the other end appeared at two terminals marked "EHT4V." The four-volt tap was obviously intended for a rectifier heater and as the rectifier cathode would then be connected to the "hot" end of the winding the EHT used in this particular equipment would be negative with respect to chassis. Several careful checks of the turns ratio were made by connecting the secondary to

**FIRST DETAILS IN ANY MAGAZINE OF A NEW SYSTEM OF EHT GENERATION, WHICH WILL BE OF INTEREST TO ALL TV CONSTRUCTORS**

**The Principle**

As most constructors are aware, nearly all surplus RAF radar equipment was originally designed to work from an AC supply of 80 or 115 volts at a frequency of approximately 1,000 cps. This relatively high frequency enabled extremely small and light transformers to be used in the power units. These transformers, however, when purchased as part of surplus radar equipment, are usually discarded because they are far too small for mains frequencies at 50 cps.

In the method of obtaining EHT described in this article we show how one of these transformers may be used to supply EHT for television purposes, it being driven from a source of power *fed from an AF oscillator working at approximately 1,000 cps.*

To see whether the project were feasible, a typical 1,000 cps surplus EHT transformer was subjected to a series of tests. It was found that not only is the scheme practicable but is also sufficiently reliable to be put into use by most television constructors with a minimum amount of experimental work.

different sources of 50 cycle AC. It was found that the transformer must have been intended to deliver a voltage of approximately 2,500 across its secondary. Having completed these checks the author was then quite certain of the suitability of the transformer. Fig. 1 shows the connections of this component.

**Preliminary Experimental Work**

At first it was decided to try using the transformer primary as the inductance in a single valve oscillator. Using the 80-volt tapping as an earthy connection, the anode of a power valve was taken to the bottom ("0") terminal of the primary and the grid, via a suitable leak and capacitor circuit, to the 115-volt terminal. The arrangement oscillated at AF, a capacitor being connected across the primary to give a frequency around 1,000 cps. As had been expected, the oscillator was unsatisfactory and proved incapable of

*The author is not quite certain of this point, but working from the data found in the experiments, the transformer was designed to give an EHT of approximately 2,500 volts for radar equipment.

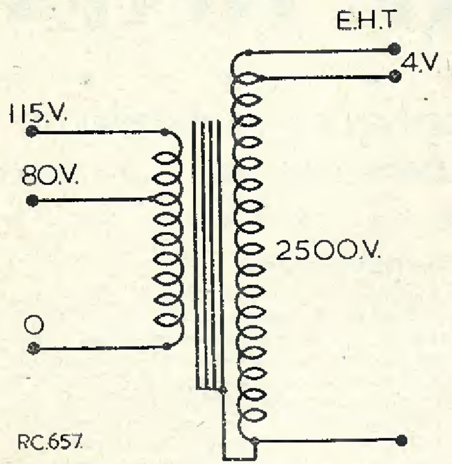



Fig. 1.

supplying any useful voltage in the secondary. This was mainly due to the small amount of inductance present in the transformer primary, coupled with the extremely large voltage swings required. However, the scheme was thoroughly checked by experimenting with a large range of different component values, valves and so on, before it was finally discarded as useless.

The transformer was then connected up in the circuit shown in Fig. 2. The output of a BFO (which would be replaced in practice by an ordinary AF oscillator) was connected between grid and cathode of a high gain power tetrode. In actual fact, a 6V6 was used. It was necessary to use the BFO instead of a simple home-made AF oscillator as it could more conveniently provide the necessary voltages and frequencies needed for the experimental data. A variable source of negative supply was utilised to bias the grid of the valve, this being provided by a 27-volt battery (three 9-volt batteries in series) tapped at every 1.5 volts. The HT supply for screen-grid and anode of the 6V6 were variable, both supplies being decoupled by 16$\mu$F capacitors.

The whole primary winding of the EHT transformer (0-115V) was connected in the anode circuit of the 6V6. In the secondary circuit was connected an EHT rectifier feeding directly into a 0.1$\mu$F reservoir capacitor, across which the various test loads were connected.

Meters were connected in the following parts of the circuit:—Firstly, a valve voltmeter across the output of the BFO; secondly, an electrostatic voltmeter across the EHT reservoir capacitor; and finally, a 0-100 milliameter in series with the negative HT line.

**First Results Obtained**

It was decided to run the valve in class C, relying on the "kicks" at each half cycle of anode current to provide the AC EHT in the transformer secondary.

The valve was accordingly biassed back to about 24 volts. The output of the BFO was fed to the grid and it was found that more than 4.5 kV was obtained with no load connected to the EHT circuit. This was then loaded by 5 M $\Omega$, whereupon the EHT dropped to about 2.7 kV. This was considered sufficiently useful to enable us to try various values of grid bias. It was found, however, that the bias had no appreciable effect on the output so long as it lay within the limits of 0-20 volts. As it was obvious that the leak and capacitor were biassing the valve back, it was decided to check the grid current of the valve. With an input of 40 volts peak the grid current was negligible, and with an input of 80 volts peak it was equal to 0.2 mA. The anode and screen-grid voltages, incidentally, were 310 volts during this test.

The grid leak was then returned to the HT negative line and a resistor (decoupled by a 20$\mu$F capacitor) was inserted in the cathode circuit to give cathode bias. Various values of resistor were tried out, but in all cases the results were inferior to those previously obtained. (About 1.5 kV was the maximum output). It was therefore obvious that it was necessary to use fixed grid bias.

For the remainder of the tests the cathode was connected directly to HT negative again and, in order to protect the valve against cessation of oscillation, 15 volts grid bias was applied to the grid.

The next point to test was whether, as the transformer primary was being excited by half-cycle "kicks," and as the current was being drawn from the secondary also in half-cycles, there would be any difference in output if the primary terminals of the transformer were reversed. The primary terminals were changed over. A very noticeable drop in output from 2.7 kV to 1.9 kV was observed.

Explaining this dramatic change, we would say that in the first case, most probably, the positive half-cycle for the rectifier was being obtained from the voltage generated in the secondary when the 6V6 commenced to pass anode current. In the second case, then, the voltage would be developed by the reduction in primary current, *i.e.*, when the transformer field was breaking down. Empirically, at any rate, the first method of connection was the most successful and was used for the remainder of the tests.

A further test was then made by connecting the anode of the 6V6 to the 80-volt tapping on the primary; and secondly, by using that part of the primary between the 80 and 115-volt terminals as the anode load. As was to be expected, the output readings dropped very considerably with these connections and, for the remainder of the





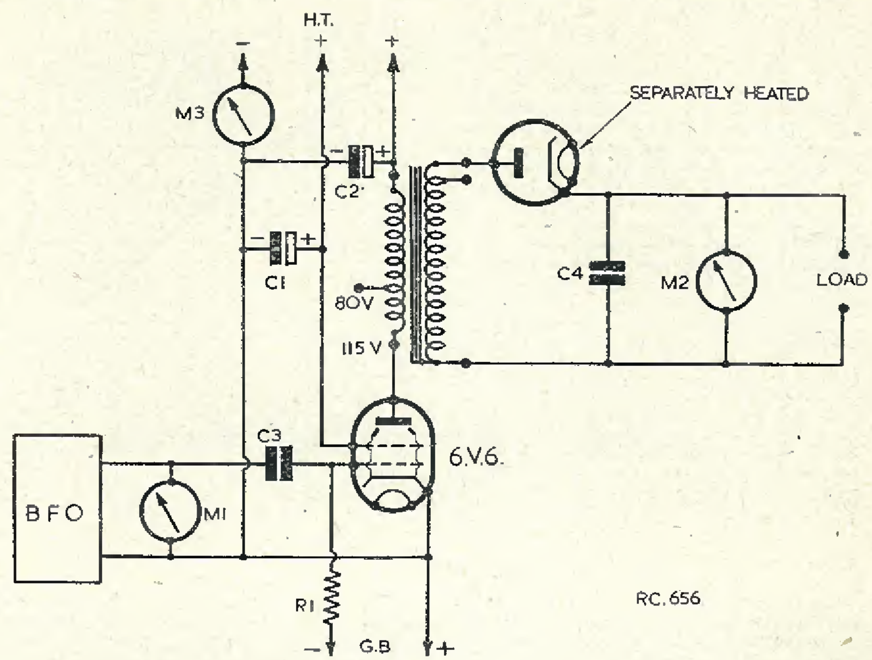



Fig. 2.

tests, the original method of connection (*i.e.*, using the entire primary as anode load) was used.

The next point was to decide the optimum frequency of operation. It was expected that change of frequency would have little effect on output, except perhaps a slight rise in output with increase in frequency. In practice, however, the very interesting curve of Fig. 3 was obtained. It will be seen from this graph that optimum output occurs around 1,250 cps. This is extremely interesting and at first sight would point to a resonance in the transformer. However, we remembered that, in the previous check, when it was decided to use the transformer as a tuned circuit, some 0.01$\mu$F of capacity across the primary was needed to enable it to tune down to 1,000 cps. In addition, in the preliminary oscillator experiment, the secondary was loaded in exactly the same manner as it is in the present test, so that the 0.1$\mu$F reservoir capacitor had just the same effect as it has in Fig. 2. Resonances, therefore, do not appear to account for the rise at 1,200 cps. We may only assume, then, that the losses in the transformer are at their minimum when it is used at the frequency for which it was designed (or very near that frequency).

This point is of some importance since the results given by these tests would be useless if they were obtained only because the particular transformer used happened to be resonating in this individual case! Removing the reservoir capacitor, besides, of course, giving a drop in reading, did not affect the point of optimum frequency, so the assumption that the curve of Fig. 3 is not due to resonance is then strengthened. This point is stressed because we may now safely assume that the results obtained with this particular transformer *are applicable to almost all 1,000 cps EHT transformers.*

For the remainder of the tests, the input wsa left at 1,250 cps.

**Regulation**

Having smoothed out all the initial difficulties it was then decided to obtain a series of regulation curves.

This was done by plotting voltage output against output current, and the family of curves shown in Fig. 4 was then obtained. The various circuit values used to obtain these curves are given in the accompanying table. Three of these curves show the results when a 5 ohm load is connected across the 4-volt tapping at the EHT end of the secondary winding. This was done to check whether it was possible to heat a rectifier from this output (assuming that negative EHT is

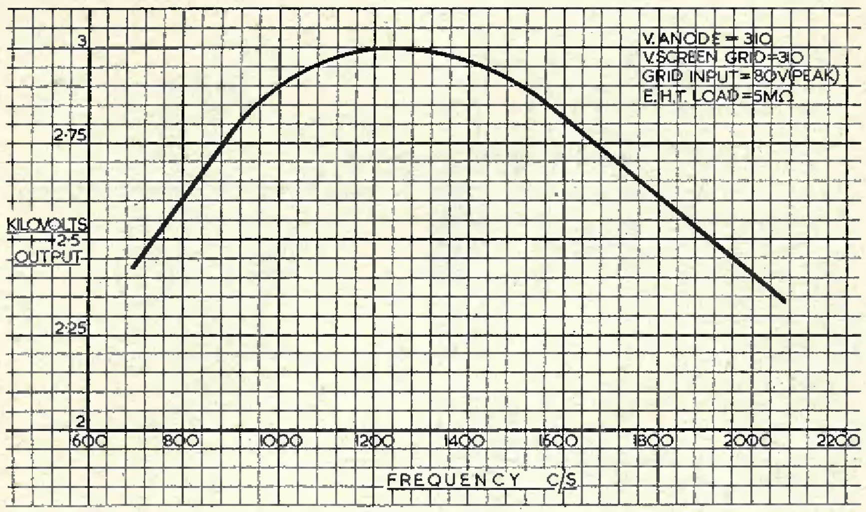



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Fig. 3.

required). A typical EHT rectifier needing a low current at four volts is the Mullard HVR2, needing 0.65 amps. (The 5 ohm resistor would, of course, take 0.8 amps at 4 volts). Unfortunately an HVR2 or similar valve was not available, nor was it possible to reliably measure the voltage obtained across the 4-volt tapping on load. As, however, the secondary is intended to give 2.5 kV, it may be fairly safely assumed that when the output on load (with the 5 ohm resistor connected) is above, say, 2.2 kV, that there should be sufficient voltage to heat the rectifier.

Finally, after the regulation curves had been completed, the effect of a limiter between the cathode of the rectifier and the reservoir capacitor was tried out. Using circuit conditions similar to those used to obtain the curve of Fig. 3, and supplying the 6V6 with a 1,200 cps note, it was found that the addition of a 0.5 M Ω resistor caused the output to drop by 0.4 kV, and, with the addition of a 1 M Ω limiter, by 0.7 kV.

**Conclusions**

Let us now analyse the results given above and see if they are sufficiently attractive to make this form of EHT supply capable of useful application.

The first thing that is needed in a power unit of this type is the AF oscillator. At first sight, the input required for the 6V6 from this oscillator seems to be fairly high, *i.e.*, at least 40 volts AF peak. However, this is by no means as difficult to supply as may at first appear since hardly any grid current at all is taken by the valve. A 6J5 would be more than capable of supplying the very small power needed to drive the 6V6. A well-designed single-valve oscillator should be quite sufficient, and the main components needed would consist only of the oscillator valve and an odd AF transformer. However, it must be remembered that the output of the oscillator should be as pure as possible.

The second thing that is needed is the valve driving the EHT transformer. In this particular case the valve has to pass a fairly heavy cathode current, rising as it may to 65 mA. Really, therefore, a 6V6 would be somewhat overloaded in this circuit. In practise, however, it was found that, after all the tests were completed, the valve was only warm, and was by no means as hot as is the usual output valve in a domestic receiver. A larger valve could be used in a practical circuit, if desired, but the 6V6 seems to cope quite happily.* (The *efficiency* of the valve is discussed in a later paragraph).

And finally, to obtain our EHT by this method, we need the EHT transformer. This is where the beauty of this method of EHT generation becomes apparent, because the 1,000 cps transformers which are needed are found in all surplus RAF EHT power units and have previously been considered useless owing to their high frequency of operation. It is very probable that almost all 1,000 cps transformers available as surplus would cope in a circuit of this type; and, as their monetary value has previously been nil, there are probably many constructors who have picked them up in equipments previously bought for components alone.

*Of course, if any suitable valve other than a 6V6 is on hand, this may be used quite successfully. A 6V6 was chosen for the experiments as it is a very common and popular valve.





**The Efficiency of the Circuit**

Let us now discuss the efficiency of the circuit. The two main components to consider are the EHT transformer and the driving valve (*i.e.*, the 6V6 of Fig. 2).

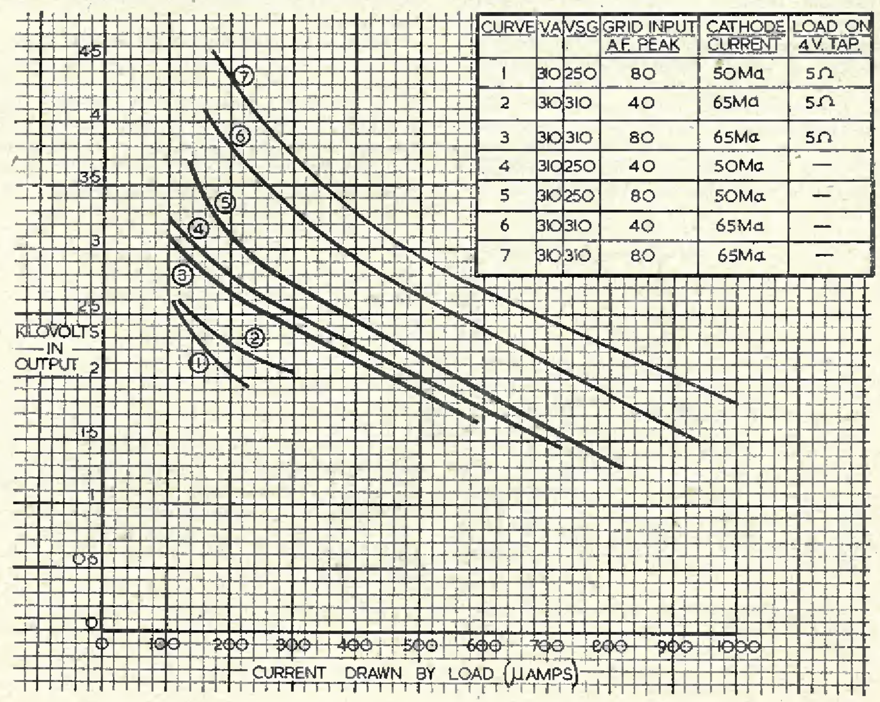
The valve can really be considered in two lights. It may be looked upon as a power amplifier, converting the half-cycles on its grid to anode power at a certain optimum impedance. Or it may be considered as a form of "electronic switch," which "closes" when a positive half-cycle is applied to its grid.

Considering the first interpretation we may obtain a very rough idea of the impedance offered to the valve anode by assuming that the EHT current is, say, 700$\mu$A at 2.5 kV. This, again speaking very roughly, would mean that the EHT transformer secondary is feeding into a resistance of approximately 3.5 M Ω. The ratio of secondary to primary is approximately 22.1. The impedance reflected into the primary would then be $3.5M\Omega \times \frac{1^1\Omega}{22^2}$ 7.3K. Ω This is rather low for a 6V6 in class C. However, it must be remembered that these figures are arbitrary and may be very misleading. In addition, the load is only taken on half-cycles and the 700$\mu$A load may not be entirely typical.

If we consider the valve as an "electronic switch" we might arrive at a more helpful result. In this case the 700 $\mu$A current in the secondary would be represented as 700$\mu$A x 22=15.4 mA in the 115-volt primary. As this current is supplied only during half-cycles (*i.e.*, for half the time), the valve should be capable of supplying at least 30 mA anode current when it is conducting. (These figures again are meant only as a guide. The *average* anode current, of course, would still be only 15.4 mA).

However, looking at the cathode currents given in the data we find that our valve is not working in too inefficient a manner. When, for instance, the valve is taking a cathode current of 50 mA (as in curve 6) we can assume an efficiency of transference of anode power to the transformer secondary of some 30%. In other words, out of the 50 mA consumed in cathode current, 15.4 mA are actually instrumental in giving us our EHT. The losses in the circuit will, of course, be found in the method of driving the transformer. Looking upon the valve as an amplifier again, we might say that it is feeding into too low an impedance. Counting it as an "electronic switch" we could say that the by-no-means-sinusoidal current induced in the transformer primary is responsible for the losses.

(*continued on page* 209)




| CURVE | VA | VSG | GRID INPUT A.F. PEAK | CATHODE CURRENT | LOAD ON 4V. TAP. |
|---|---|---|---|---|---|
| 1 | 310 | 250 | 80 | 50Ma | 5Ω |
| 2 | 310 | 310 | 40 | 65Ma | 5Ω |
| 3 | 310 | 310 | 80 | 65Ma | 5Ω |
| 4 | 310 | 250 | 40 | 50Ma | — |
| 5 | 310 | 250 | 80 | 50Ma | — |
| 6 | 310 | 310 | 40 | 65Ma | — |
| 7 | 310 | 310 | 80 | 65Ma | — |

R.C.658.

Fig. 4.

# Design of the SUPERHET

## PART 4: POOR SELECTIVITY

By R. J. CABORN

**Tracking**

THIS month we shall commence our article by discussing the question of "tracking"; that is, the process of accurately ganging the oscillator and signal tuned circuits.

Now, it is obvious from even the most casual of inspections, that the process of getting, say, a two-gang tuning capacitor to tune both the oscillator and signal tuned circuits of a superhet is going to be a very different operation from that of tuning the RF and detector stages of a straight receiver. In the straight receiver both tuned circuits resonate at the same frequency whatever the position of the tuning capacitor; in the superhet the two tuned circuits cover entirely different ranges.

Now what exactly must we accomplish to track the superhet? Firstly, the oscillator frequency must be such that, when combined with the aerial signal, the resultant difference frequency is always equal to the intermediate frequency. Secondly, the aerial tuned circuit must always resonate accurately at the signal frequency so as to enable that signal to be received at its strongest. Therefore, aerial and oscillator tuning must be so arranged that the frequency difference between them is always constant.

**Above or Below?**

The next thing to decide is whether we are going to tune the oscillator at a frequency *below* the signal frequency or *above* it. Numerical examples will help to make this problem easier to solve.

Now let us assume that our IF is, say 450 Kcs and that we wish our receiver to tune over the frequency range 1,500 to 600 Kcs (this, incidentally, being the medium wave band). Now if our oscillator frequency is to lie *above* the signal frequency it must tune a range of (1,500 + 450) Kcs to (600 + 450) Kcs, *i.e.*, 1,950 to 1,050 Kcs. If the oscillator frequency is *below* the signal frequency then it must tune from (1,500 — 450) Kcs to (600 — 450) Kcs, *i.e.*, 1,050 to 150 Kcs. It will now prove very interesting to see how our oscillator circuit will tune over these ranges in practise.

Firstly let us assume that, at the point of minimum useful capacitance of the tuning capacitor, all capacitances (strays, trimming, etc.) add up to 50pF. Then, to tune the range 1,950 to 1,050 Kcs (above the signal frequency) the inductor we need paralleled across 50pF to give us 1,950 Kcs will have a value approximately equal to 130$\mu$H. For a coil of this inductance to tune to the lower end of the range (1,050 Kcs), we will then need a tuning capacitance of 175pF.

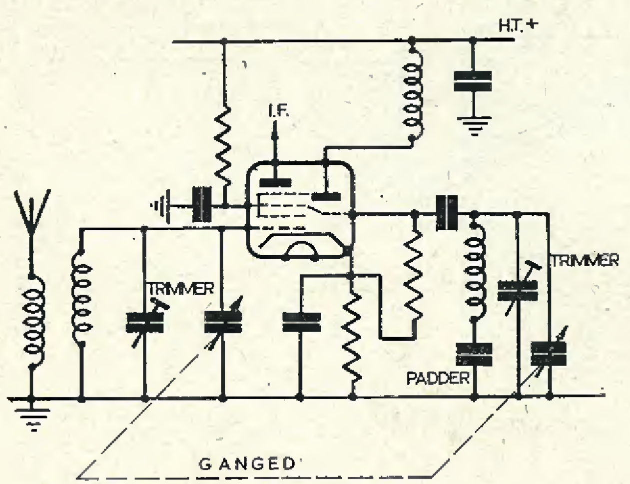



Fig. 1.
*A typical frequency changer stage showing the method of connecting trimming and padding capacitors.*

In the second case (1,050 to 150 Kcs), the coil needed with our 50pF minimum capacitance to resonate at 1,050 Kcs should have a value of 475$\mu$H. The tuning capacitance needed to tune this coil to 150 Kcs would then be approximately 2,300pF*

Analysing these results we find that, to tune the oscillator frequency above the signal frequency, we need a capacitive range of 50—175pF. To tune the oscillator below the signal frequency we need a capacitance range of 50—2,300pF. Now the signal frequency band itself may easily be tuned by a capacitive range of 50—500pF using a conventional tuning capacitor. (It should be remembered that 1,500 to 600 Kcs is the ordinary medium wave band). Therefore, using a standard 500pF two-gang tuning capacitor it will be seen that the large capacitance range of 50—2,300pF is obviously impossible. However, the range of 50—175pF is easily obtainable by the simple process of connecting another capacitor in series with the tuning capacitor. This arrangement is very practicable and so it is common practise on all but specialised receivers to have the oscillator frequency higher than the signal frequency.

**Padding**

We stated just now that a capacitor is connected in series with the main tuning capacitor to enable it to tune over the frequency range needed by the oscillator. This capacitor is known as the "padding" capacitor, or "padder."

A typical and conventional method of connecting this padder is shown in Fig. 1. It will be seen that it is connected between the bottom end of the oscillator grid coil and chassis. Although connected in this manner it is still of course in series with the tuning capacitor and the coil. Very often, to assist us in tracking the receiver it is helpful to make this padding capacitor a pre-set variable component.

The value of the padding capacitor varies considerably for different wave ranges, so a different capacitor is always switched in on different wave bands. If the padder is connected as shown in Fig. 1, then the appropriate padder may be fitted to each oscillator grid coil, these being switched in automatically by simply switching the "top" ends of the coils.

Padding capacitors, generally, have relatively large values. For instance, on medium waves the padding capacitance is usually about 450pF (for an IF of approximately 460 Kcs). To manufac-

*The values of inductance and capacitance deduced from the waveranges and minimum tuning capacitances given in these examples have only been worked out approximately. Readers wishing to check the results may do so by using the formula

$$f = \frac{10^6}{2\pi\sqrt{LC}}$$

where f=frequency in cps, L=inductance in H, and C=capacitance in $\mu$F.

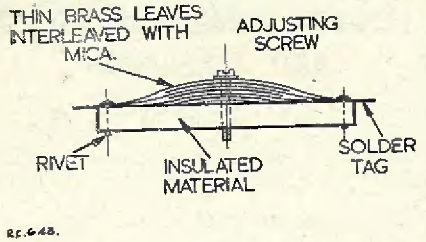



Fig. 2.
*A variable padding capacitor of the compression type.*

ture a variable pre-set capacitor having a value variable around this point, it is usual to adopt the construction shown in Fig. 2. The minimum capacitance of a trimmer of this type is fairly large, and a component designed to be adjustable around 450pF would probably have a capacitance range from 300 to 550pF.

These compression types of trimmer are not used extensively nowadays as they tend to change in value over long periods of time. Another method of obtaining a variable padder is to use a fixed capacitor shunted by a small trimmer. For instance, a 400pF capacitor paralleled by a 20—75pF trimmer would be ideal for the case quoted in the preceding paragraph. The fixed capacitor should be a mica component.

The modern tendency, however, is to use fixed padding capacitors. These padders are manufactured usually to a tolerance of something like $\pm$ 2%, and are nearly always a high-grade component specially designed for the job. Owing to the fact that the padder is fixed, all the other parts of the frequency-changer circuit must be accurately made; the inductances and tuning capacitors should hold their correct values, and the IF transformers should be lined up at their correct frequencies. Often, with fixed padding, iron cored coils are used, so that changes in inductances may be made good by adjusting the iron cores.

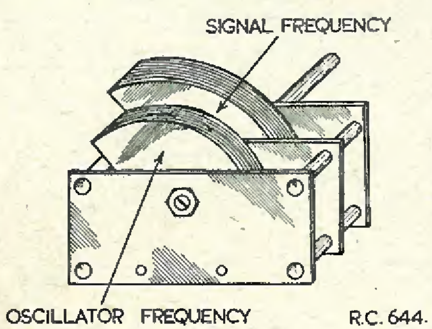



Fig. 3.
*A 2-gang capacitor having reduced capacitance in the oscillator section.*

Before we go any further, however, it must be pointed out that the padding capacitor does not ensure completely accurate tracking. What actually happens is that perfect tracking occurs only at the top, bottom and middle of the range of the tuning capacitor. In practise, however, these discrepancies are not over-apparent, and in a well designed modern superhet it will be found that tracking appears to be accurate at all positions of the tuning capacitor.

A method of tracking a superhet without using a padder at all is to use a tuning capacitor of the type shown in Fig. 3. In this component the oscillator gang has smaller vanes and therefore a smaller capacitance than the signal frequency section. This gives the same effect as using a fixed padder, except that tracking is perfect at all times. There is one big snag, however, and that is that the two-gang capacitor may be used on one range only, padding being still necessary if any other range is required. This type of tuning capacitor is rarely seen in modern British receivers, but is still fairly often found in American portables which are designed for reception on one wave band only.

As the frequency of reception is increased (assuming that the IF is constant) the value of padder needed increases also. On the short wave band 18 to 8 Mcs, for instance, a padding capacitance of 0.005$\mu$F or more is quite common (with the IF around 460 Kcs). Variable capacitors are difficult to make at these values, and, in actual practice, are hardly needed as the padder has less influence on the oscillator frequency than obtains at the lower frequencies. Commercial manufacturers often use paper capacitors for short wave padding, but the constructor is strongly advised to play safe and use mica components.

**Trimming**

To enable the frequency-changer tuned circuits to be accurately set up, both parallel trimmers and a series padder are connected to the signal and oscillator tuned circuits (see Fig. 1). The trimmers consist of small value pre-set capacitors, and their effect is greatest at the high-frequency end of the wave range being adjusted (tuning capacitor vanes unmeshed). The effect of the series padder is greatest at the low frequency end of the band.

Usual trimming procedure consists of adjusting the trimmers for maximum signal strength at the high frequency end and padding for optimum results at the low frequency end. If the receiver is fitted with a dial calibrated in wavelength or frequency it is first of all customary to adjust the oscillator trimmer to enable the pointer to read accurately at the high frequency end. The padder is then adjusted to give accurate calibration at the low frequency end. If the set is badly out of alignment, this process may have to be repeated several times to get the calibration finally accurate. The signal frequency trimmer is then adjusted at the high frequency end. If the set has been well designed and manufactured,





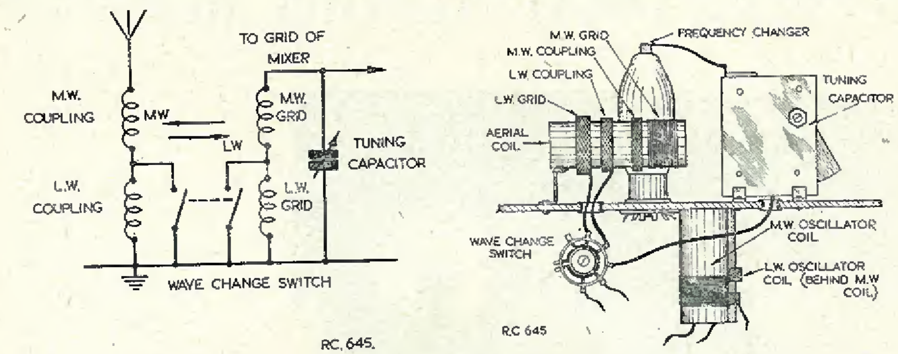



Fig. 4.
*A cross section through the chassis showing a useful layout for a two-band receiver. The equivalent circuit is shown on left.*

the signal frequency trimming should then be at its optimum setting at all points of the dial.

If the set is a " cheap and nasty " job, however, this may not happen, and it is sometimes best to pad for greatest sensitivity and sacrifice dial calibration.

Tracking adjustments should not be attempted until the IF transformers have been lined up at their correct frequency. If the receiver utilises fixed padding capacitors, accurate tracking will *never* be possible until the IF transformers are set to the frequency recommended by the makers.

The test signal used for aligning the receiver should always be connected between the aerial and earth terminals, preferably via an artificial aerial although this latter is by no means necessary. The best test signal to use is one which is just audible with the set working at full volume.

**Noise in the Frequency-Changer**

By reason of the complicated actions carried out in the frequency-changer (the main factor being the presence of the oscillator) this valve often introduces a relatively large amount of noise (valve hiss, etc.) into the receiver. This point is of some importance in receivers where a high degree of sensitivity is needed, since signals whose strength are lower than the frequency-changer noise level cannot be distinguished.

As, however, the noise generated in an RF pentode is usually lower than that given by the frequency-changer, it is good practise to fit a tuned RF stage before the frequency-changer signal grid, so that the amplified signal will then be sufficiently strong to override the noise generated in this valve. The signal-noise ratio is then increased because the aerial signal now has only to overcome the lower noise occasioned by the RF valve.

Introducing the RF valve naturally complicates the design of the receiver. As it has to be tuned, the two-gang capacitor must be replaced by a three-gang component, more complicated switching and coils are needed, and so on. However, the added valve gives a very welcome amount of extra sensitivity, and a further advantage is that, by reason of the extra tuned circuit, second channel interference is considerably reduced.

Nevertheless, for normal broadcast reception, the RF stage is rarely necessary, and it is only the more expensive domestic receivers which boast an RF amplifier.

**Constructional Points in the Frequency-Changer**

When the constructor is designing his own superhet a certain amount of care should be paid to the positioning and wiring of the components grouped around the frequency-changer valve. It is necessary to have all grid and anode leads as short as possible.

Design is sometimes simplified by the fact that most frequency-changer valves have their signal grid brought out to a top cap. Fig. 4 shows a typical example of good component layout in which the signal frequency coils are mounted above the chassis, whilst the oscillator coils are mounted below. The two sets of coils are therefore entirely screened from each other, thus reducing interaction to a minimum. Wave-change switching may be effected by shorting the the LW grid coil and the LW aerial coupling coil to chassis, as shown in the inset.

(*continued on page* 194)

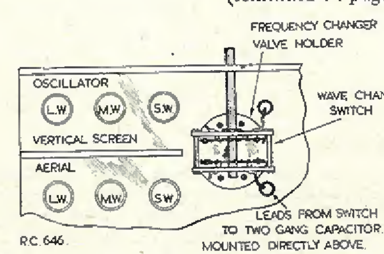



Fig. 5
*A good coil layout for an all-wave superhet, looking at the underside of chassis.*

# 2-VALVE LOCAL STATION RECEIVER

A SIMPLE, INEXPENSIVE AND EFFICIENT RECEIVER FOR THE LOCAL PROGRAMMES

*by* S. T. EVANS

THIS receiver has no pretensions to being a highly selective and super-fidelity unit, as it is intended to do a particular job and no more. The prime mover in the construction of the receiver was the pressing need for a simple provider of the two main BBC medium wave programmes. It had to be simple in design, easy on the pocket, of good but not critically good quality and of reasonable sensitivity. The gain was to be sufficient to operate the receiver at a little over normal room volume with a short internal or throw-out aerial—and no earth.

It speaks for the simplicity of the construction when it is recorded that work was commenced one Sunday morning and the receiver was working satisfactorily in the early evening. And only one minor alteration was made to the original circuit.

For those needing a receiver of high selectivity, capable of bringing in all those European stations, this is *not* the set. But for those wanting a bedside receiver or one for ordinary domestic use, they could do much worse than build the set about to be described. It does all it is claimed to do—provide the local programmes at good speaker strength on a very short aerial—and it has the advantages of being built quickly and extremely cheaply.

**The Circuit**

The theoretical circuit is shown in Fig. 1 and a cursory glance will bear out the previous statement that there are no frills contained in the design. It is a simple and straightforward two-valve straight receiver of the 0-v-1 variety. In the interests of selectivity it was first considered necessary to include a third stage—a stage of RF amplification—but the question of keeping the cost down and the time taken weighed against this. Finally it was decided to construct the receiver in such a way as to allow for the later inclusion of an RF stage should greater selectivity be required. However, on completion it was found that the selectivity was perfectly adequate for the needs required—the easy separation of the Light and Home wavelengths, with no suggestion of any break-through. The writer hastens to agree that the easy separation of these two stations does not necessarily indicate very high selectivity! The important point is that this was sufficient for the purpose of the receiver.

Loose coupling of the aerial to the detector stage helps very considerably in attaining the selectivity required, though, of course, the gain will be cut somewhat by thus isolating the aerial. Even so, there is still ample volume for ordinary domestic purposes and the volume control has to be kept slackened off for comfortable listening. Which is all that is required of the set.

The detector is an EF50, a popular type these days and one that is easily obtainable in its "service" guise of VR91 at a most reasonable price. It is used in a normal leaky grid circuit with no unusual features at all. No panel reaction control is used, the reaction capacitor C4 being a preset on the chassis itself (this will be dealt with later when adjustment is discussed).

R2, a 10,000 ohm resistor, is used in place of the RF choke more normally used, merely because the writer had no chokes on hand at the time! The resistor will, however, be found to be a suitable substitute. The anode load and decoupling components are R4/R5 and C7. Coupling to the output valve is by resistance-capacity feed. This is simpler and cheaper than transformer coupling, though the gain will not be quite as great. Against this, it is not uncommon for instability to occur when using transformer coupling. The writer was in a hurry and did not want to take any undue risks! The output valve is an EL32 in civilian life or if the surplus type is used it will be a VT52. Alternatively a 6V6 or KT63 could be used equally well in this position.

The potentiometer R6 is the volume control and C9/R7 constitute the tone control. In the first instance it was not intended to include a tone control but since it only needs the two components and it balanced the front panel layout, the final decision was to include it (somewhat grudgingly!). Auto bias is applied to the output stage with R8 and C10 in the usual circuit.

**Power Supply**

Something a little less expensive than the usual half-wave valve rectifier circuit was obviously indicated. As a matter of fact, the writer did toy with the idea of making the receiver for AC/DC operation but being rather allergic to line cords and suchlike decided against this. In any case it was only meant for use on AC mains. Readers who are unfortunate enough to be supplied with DC mains may care to refer to Fig. 2 which shows the necessary modification necessary to convert it to AC/DC operation.

The solution was arrived at by using a selenium metal rectifier for supplying the HT. These are quite plentiful and are eminently suitable for such duties. Make sure that the capacitor C13 is included (and, incidentally, that it is efficient) as this will definitely cut out that last faint trace of mains ripple. Providing that good components are used in the smoothing circuit, there will be hardly a trace of hum in the speaker—even with the gain turned to maximum. You will, quite naturally, hear *something* off a station but it should be very faint indeed.

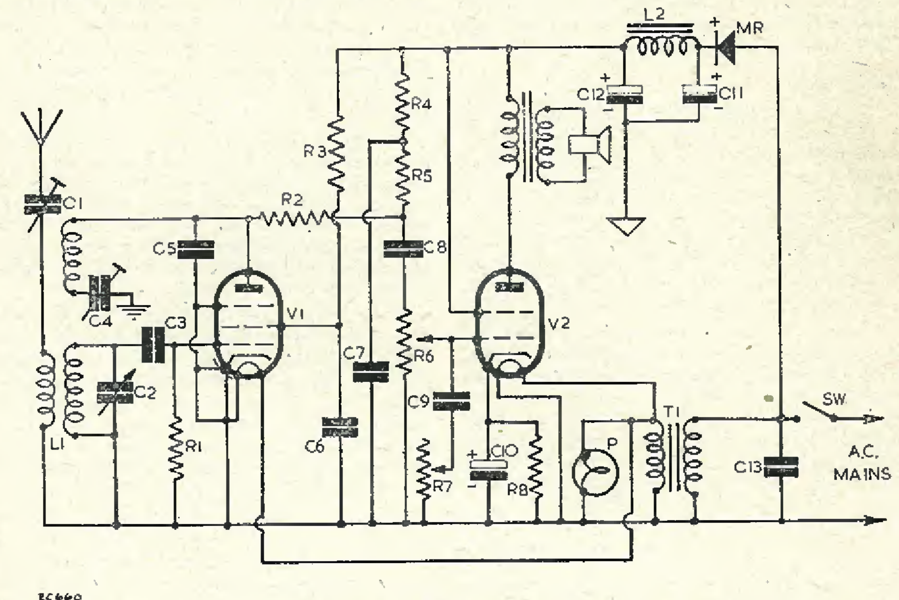



Fig. 1

*Circuit diagram of the receiver. Note that a direct earth should NOT be connected to the chassis.*

*List of Components*

C1, 50pF variable (preset)
C2, 500pF variable
C3, 300pF mica
C4, 250pF variable (preset)
C5, 300pF mica
C6, 0.1μF paper
C7, 0.5μF paper
C8, 0.01μF paper
C9, 0.04μF paper
C10, 25μF 25 V wkg
C11, 16μF 450 V wkg
C12, 16μF 450 V wkg
C13, 0.1μF 500 V wkg
(C10, 11 and 12 may be a combined capacitor)
R1, 4 Megohms
R2, 10,000 ohms
R3, 1 Megohm
R4, 50,000 ohms
R5, 100,000 ohms
R6, 500,000 ohms
R7, 10,000 ohms
R8, 240 ohms
V1, EF50 or VR91
V2, EL32 or VT52 (alternatively 6V6)
T1, Heater transformer 6.3 V secondary
MR, Selenium rectifier 250 V at 60mA
L1, Standard 6-pin MW coil
L2, Smoothing choke 60mA
P, Pilot lamp 6.3 V 0.3 A

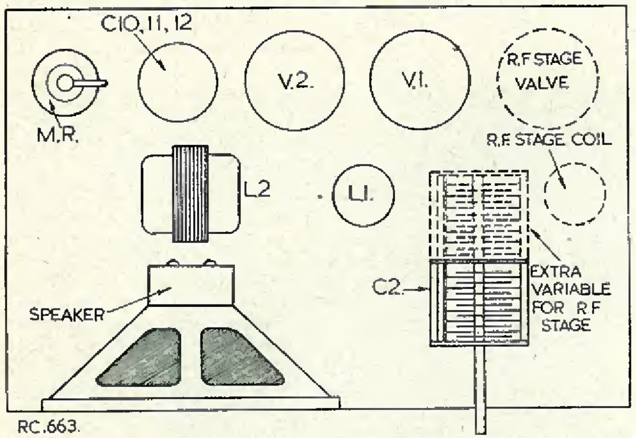



Fig. 4

*Above chassis layout showing disposition of the components. The RF stage components, if used, are placed where shown by dotted line.*

To take care of the valve heater supply, a sma l mains transformer giving 6.3 V output with 240 V input, did the job nicely.

**Elaborations**

The circuit of Fig. 1 shows the completed one of the receiver shown in the photograph. As previously mentioned, it is simple—but it is intended to be. Naturally, individual constructors may have their own ideas on small or large refinements. Several come readily to mind, but it should be stressed that for a local station receiver (all that the average person needs for medium wave reception) the circuit of Fig. 1 is quite definitely adequate.

However, it is common knowledge and experience that no matter how closely a constructor follows a published design he may well obtain slightly different results with small (and sometimes major) effects not noticeable in the original model. A different choke may be used, the mains supply may vary, a valve may not be highly efficient, the wiring may vary and the layout may alter. All these things *may* sometimes cause unaccountable effects to arise. And straight receivers are prone to this sort of inconsistancy; instability being the chief offender. There is really very little risk that such instability will occur in this particular instance but it is well to note some precautions should the necessity arise. In the first place care should be taken to ensure that all by-pass capacitors are definitely efficient; it is only too easy to fit one, taken from the component box, that is open circuited! This is probably one of the commonest causes of instability.

Then there are positive methods of approach such as fitting grid stoppers, etc. A resistor of between 20,000-50,000 ohms—the value is by no means critical—wired directly to the output valve grid pin will prevent any RF leaking through from the detector stage to the output stage. Again, quite frequently the cause may be the output valve oscillating. A cure in many cases is to insert a capacitor in parallel with the primary of the loudspeaker transformer. The value should be of around 0.005$\mu$F. A larger value will tend to cut the treble response and boomy reproduction will result.

Thirdly, if instability does occur, it might be advisable to replace R2 by a suitable RF choke. Then again, it is often advisable to insert a capacitor (of about 0.01$\mu$F) across the heater supply. This sometimes gets rid of any suggestion of mains ripple there may be present. In the original model this was not necessary, but in some cases it may be an advantage.

Going further, one may wish for a receiver to pull in at good loudspeaker strength those European stations. There are two courses open here and obviously it would be better to employ both. The first consideration would be the addition of an RF stage to give the necessary extra selectivity and, incidentally, some extra gain. The circuit of Fig. 3 shows a suitable arrangement for adding this stage to the receiver.

Next, the reaction control would have to be at hand for adjustment. By bringing this out as a panel control it can be adjusted in the orthodox manner when tuning in the weaker stations. The straight receiver is at its most sensitive point when just on the verge of oscillation and therefore reaction must be easily controllable if the receiver is expected to provide European station reception.

**Construction**

The first matter to be decided was the question of housing the receiver; it is easier to build a receiver round a cabinet than to try and find a cabinet to suit a chassis! This was not a difficult problem, as a tour of the radio shops revealed a surprising number of reasonably priced cabinets suitable for the job. The one ultimately selected can be seen in the photograph and reader swill agree that this solid mahogany cabinet looks very neat. Together with a chassis to suit, the whole





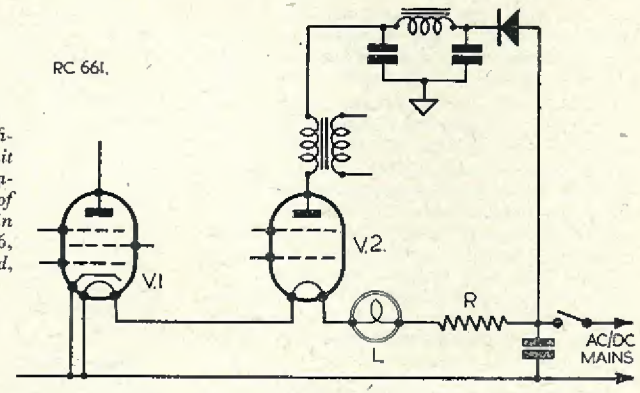



Fig. 2.

*Skeleton circuit showing modifications to the heater circuit necessary for this type of operation. Note the valves are of different types to those shown in Fig. 1. V1, 6J7, V2, 25A6, L, 6V 0.3A bulb R, Line cord, 680 Ω 0.3A.*

outfit cost only 10/6 at a well-known West End radio store. Nobody can grumble at such value. And there were many others which may appeal more to individual taste.

No trouble was encountered in coming to a suitable layout for the set and the sketch of Fig. 4 will show clearly the positions of the main components—including space reserved for an RF stage should this be required. Along the lower part of the cabinet—see main photo—are the controls, reading left to right: Tone, Volume and On/Off switch (ganged) and the pilot lamp. Supposing that it is decided to bring out the reaction control to the panel, this could very conveniently be put in the place now occupied by the pilot lamp indicator.

At a considerable saving in space (and cost) the capacitors C10, 11 and 12 are taken care of by a combined unit which comprises 16+16+25$\mu$F. The 16's are 450 V wkg and the 25$\mu$F is 25 V wkg. These are readily obtainable and they do, apart from other advantages, make for simpler wiring. The capacitor unit is situated to the right of the smoothing choke. The heater transformer is quite a small component and it is mounted beneath the chassis comfortably. If it is decided for any reason to mount it above the chassis and near to the smoothing choke, make certain that the cores of the two components are in different directions, *i.e.*, at right angles to each other. Incidentally, if one is not certain which winding is which on the transformer the secondary should read a very low resistance (perhaps 10 ohms) and the primary will be of the order of 500 ohms. A simple check with the test meter will sort out the windings.

Make certain also that the selenium rectifier is installed the correct way round! The positive

Fig. 3.

*An RF stage, showing coupling to existing detector stage (shown in dotted outline). The valve is another EF50.*

**Extra components needed for RF stage if added:**

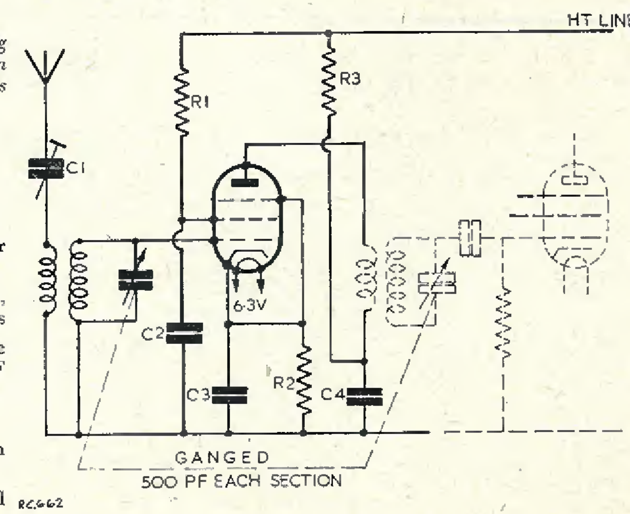
Resistors: R1, 1 Megohm R2, 50 ohms R3, 50,000 ohms

Condensers: C1, 50pF variable (preset) C2, 0.1$\mu$F C3, 0.1$\mu$F C4, 0.1$\mu$F

Valve: EF50 or VR91

Twin gang: 500pF each section (replacing C2)

Coil: Standard 4-pin MW coil



end is marked by a red spot and this terminal should be taken to the smoothing choke side. The rectifier has bolts at either end and it can be mounted vertically on the chassis by one of these.

A word or two now about the tuning dial and its associated items. The cabinet shown was one of a large quantity left over from a commercial contract and originally used a large dial assembly where the tuning control now is fixed. So, in its bought state, there was a complete cut-out of about $4\frac{1}{2}''$ x $7\frac{1}{2}''$. To form a panel for the tuning capacitor an aluminium sheet and a paxolin sheet were fitted to the interior of the cabinet. The metal, of course, was to counteract any possibility of hand capacity effects (remember to connect it to chassis) and the paxolin was used for the sake of appearance.

The tuning capacitor C2 was not fitted with any form of slow motion drive on the original model as this was not necessary in view of the receiver's intentional limitations and requirements. Tuning is perfectly easy without a reduction drive for the purposes for which it is used. However, should the constructor wish to elaborate it, it is an easy matter to fit a drive unit. Indeed, if the other refinements, such as an RF stage, are to be added in order to bring in those extra stations then a slow motion drive becomes an essential feature. And if reaction is to be controlled from the front panel, as it would be in such an instance, this, too, could with advantage be fitted with a slow motion drive; one of the small epicyclic units would serve the purpose admirably.

**Adjustment**

Assuming that the model to be built is as the original one (circuit as in Fig. 1) there are just two preliminary adjustments to be made. These are to C1 and C4.

The very nature of a detector circuit such as is shown in Fig. 1 produces one inherent disadvantage; that of the variation of regeneration according to frequency. That is to say the amount of capacity needed to set the detector valve into oscillation will vary as the wavelength tuned varies. Therefore, C4 must be set at such a point as to give maximum signal strength and yet avoiding oscillation on the two main stations. There will be more feedback at the high frequency end; that is the Light programme end. So, tune in the Light programme and slacken off C4 until regeneration ceases, but be sure to slacken sufficiently as otherwise, if left almost at oscillation point, the signal will appear to be slightly distorted.

Then there is C1. This will depend on the sort of aerial used. In the original model six feet of rubber covered wire was wound round the bottom of the cabinet. This gave comparatively little damping on the grid circuit, but a longer aerial would cause greater damping. As the capacitor controls the coupling to the detector it will therefore affect selectivity. It remains for the individual constructor to do a little judicious juggling between C1 and C4 until the best results consistent with signal strength and selectivity are reached. Obviously the aerial will have much to do in this decision, but the six feet of wire on the original receiver was ample for a little more than comfortable room volume.

Little else remains to be written. The actual construction need not cause any anxiety to even the rawest of beginners. For those who need an inexpensive and quickly built local station receiver (of quite surprising quality) the circuit of Fig. 1 will suffice. For those who need something a little more ambitious the notes and circuit of Fig. 3 will provide the necessary information.

# TRADE REVIEW

We have received from Messrs. Duke & Co., 219, Ilford Lane, Ilford, Essex, a sample of the 22 Set chassis which they are offering for 7s. 6d.

This chassis has been partly stripped, but still contains a very large and useful selection of components. In our sample there were, for example, over 50 capacitors, nearly the same number of resistors, half a dozen RF chokes, a dozen trimmers most of which were of the Philips concentric type, a 4-gang 500pF capacitor, a dozen octal valveholders, couple of Yaxley switches and one toggle, five control knobs, one jack, five octal valve caps, three spring-loaded substantial terminals, three 465 kcs IF transformers, an output and a microphone transformer, three potentiometers—one of which is ideal for the zero set in a multirange meter, having a resistance of 550 $\Omega$, three 500$\mu$A meter rectifiers, a single-gang capacitor and another of low value suitable as a bandspread, and a variable coil variometer. This last has definite applications as a transmitter coil, or in an aerial tuner. Then there were sundry other items, such as tag boards, screws, drives and so on.

Altogether, a really good bargain with very little that cannot be used. As a matter of fact, we are shortly publishing an article by Centre Tap on a Superhet for the Beginner. Out of curiosity we checked up, and found that this chassis provides the bulk of the components needed, pretty well everything except coils and valves in fact.

The chassis is supplied with a case, and even this is useful. It has no holes, and so would make a handy container for gear, spare parts, etc. We are using ours as a waste-paper basket!





## "INDUSTRIAL PHOTOCELLS" — A NEW MULLARD BOOKLET

This 20-page publication, MV1824, recently issued by the Communications and Industrial Valve Department of Mullard Electronic Products Ltd., is intended to serve as a guide to the use of the Mullard range of Emission Photocells which have been specifically developed for industrial applications.

It contains notes on the principles of operation of both vacuum and gas-filled cells, together with characteristics, operating data and a summary of potential applications.

This booklet should prove of interest to all electronic and industrial engineers who are concerned with the design, maintenance and applications of industrial photoelectric equipment.

## MULLARD ULTRASONIC SOLDERING IRON SOLVES THE PROBLEM OF SOLDERING ALUMINIUM

The soldering of aluminium and other light metals and alloys is made easy by means of an Ultrasonic Soldering Iron, Type E7587, recently announced by the Electronic Equipment Division of Mullard Electronic Products Ltd.

Developed in the Mullard Electronic Research Laboratories, this device consists essentially of a removable copper soldering bit and a magnetostriction transducer. The soldering bit which is heated by means of a conventional resistance winding, is secured to a brass block held in firm contact with the nickel core of the transducer. The ultrasonic power necessary to drive the transducer is supplied by an electronic amplifier comprising the power supply unit.

In this new soldering iron the problem of temporarily destroying the refractory oxide film, which forms on most light metal and alloys, is solved by ultrasonic stimulation. This provides a clean surface and greatly facilitates the soldering of aluminium and other metals which form refractory oxides.

The soldering iron is simple to use, and has the advantage that no flux is required, and that standard soft solders may be employed. To avoid electrolytic action, however, it is advisable to use a solder with a tin-zinc base instead of the usual tin-lead alloy.

In application, the soldering bit is allowed to heat to the usual operating temperature. The transducer is then energised, and the bit is tinned by applying a soft solder. After this, soldering is carried out in the normal way, care being taken to maintain a good liquid contact between the bit and the work. This ensures the maximum acoustic efficiency, and enables positive and uniform joints to be obtained.

The ultrasonic frequency chosen to operate the bit is well above the normal audible range, so that no discomfort is experienced by the operator.

## TV AERIALS ON COUNCIL HOUSES

**LCC Lead for Local Authorities**

Before banning or discouraging the use of outdoor television aerials on council houses a number of local authorities consult a special panel of aerial experts formed by the Radio and Electronic Component Manufacturers Federation. The majority of other councils who discourage outdoor aerials without technical advice, prove very amenable to reason and willing to be guided when approached by the panel.

This information given on Friday, February 3 by Mr. D. S. A. Gardner, lecturing on behalf of the RECMF to the London branch of the Institute of Housing, at County Hall, London. He was explaining the various types of aerials on the market and their functions in regard to good television reception.

In his talk Mr. Gardner emphasised that no hard and fast rule for aerials could be laid down. Every case must be judged on local conditions, and the amount of electrical interference in the area. It was impossible to predict the minimum standard of aerial which would give satisfactory reception in any aera. A case was on record of an indoor aerial giving very satisfactory results while on the other side of the street an outdoor television aerial was absolutely necessary.

Mr. Gardner suggested that other councils and local authorities might follow the lead given recently by the LCC who have indicated that they will consult the RECMF panel if difficulties are encountered in the choice of aerials. The panel were prepared to carry out tests and make recommendations for aerial installations which would provide adequate reception for tenants without interfering more than was absolutely necessary with the architectural amenities of the building concerned.

Housing and municipal organisations and authorities interested in the problem of television aerials are invited to contact the Secretary, RECMF, 22, Surrey Street, London, W.C.2, who will be pleased to provide a speaker or offer technical advice.

*(EHT FROM AF TONES—*

*continued from page 199*)

The above conclusions tempt one to use a power triode to drive the EHT transformer. This was later attempted but it was found to give very disappointing results, a very large drive having to be passed to the grid to obtain any worthwhile output. The lower amplification factor would be responsible for this, and it appears that a pentode or tetrode valve offers the best results.

**Conclusion**

In conclusion we would like to say that by means of the above tests and conclusions which were made by us in obtaining material for this article, we think we have shown that the provision of EHT from an audio source is not only practicable but cheap and efficient. In addition, not only is the scheme kind on the constructor's pocket, but it could form the basis for an EHT supply in AC/DC receivers as well.

# SMALL ADVERTISEMENTS

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**HAMBANDER** with Matched Preselector and matched 8in. Speaker with factory circuit blueprint, only used a few months, one owner. Cost £34, must sell, will take £21.—R. Burrows, 37, Bramford Road, Wandsworth, London, S.W.18.

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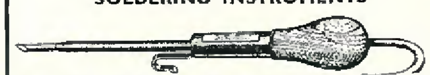

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