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1950

For Every Radio Enthusiast

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Contents

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Edited by: C. W. C. OVERLAND, G2ATV

EDITORIAL

Panel Sheets.

IN this issue we introduce a series of sheets which we think will be helpful to many of our readers.

We have seen many examples of home-built apparatus, ranging from very poor specimens indeed to gear which has a really professional looking finish. Now we'll admit that very often the performance will not necessarily be adversely affected by the appearance. We also appreciate that finish does depend to a large extent on the workshop facilities available. Nevertheless, it is also a fact that a job which does not look right will never give complete satisfaction.

How to overcome this? Obviously, we cannot do anything about the amount of care taken by the individual constructor, his workmanship, neatness of layout and wiring, and so on, beyond exhorting him to do his best in these matters. But we recently received suggestions from two readers to the effect that we print a series of control panels which could be used by readers to improve the panel appearance of apparatus built by them.

Our panel sheets are the result, and, incidentally, the first one may be used straight-away in conjunction with the article entitled "Calibrating Your Own Signal Generator" which also appears in this issue. This first sheet consists of two dials, one of 100 and the other of 180 divisions. Each has additional scales which may be calibrated for individual wavebands; a note of warning is necessary here. These dials are not suitable for marking with ordinary ink—we suggest a ball-point pen is best for this job.

Some protection against handling and dirt will also be necessary, and thin sheet celluloid or perspex will do fine for this. The appearance would be further enhanced by the use of an escutcheon. This could be built up out of wood moulding or metal sheet, but another idea, much simpler to do, occurs to us. This is to place the covering material over the dial, after the latter has been calibrated and then bind the edges with passe-partout, so forming a complete unit which can then be bolted on to the panel.

Incidentally, one of the readers previously mentioned wrote that such panel controls and dials could be photographed, and then, from the negatives, copies could be made to any size required. This is quite a good point, particularly in the case of the dials, which could be photographed after calibrating. We are obviously unable to give a dial large enough to suit some requirements, and this would solve the problem. Again, some of the panel controls to be given later in this series may be too large for, say, a receiver using miniature components, and photography will also take care of this. By the way, these sheets will not be concerned only with receivers; we hope to cater for test equipment as well. We should be very pleased to receive comments on this series from readers, and any suggestions for additions which they might have.

New Look.

The next issue of this magazine, which starts another volume, will be appearing in a new cover, which will incorporate a different photograph each month. The colour will continue to change as per the present rota.

G2ATV.

NOTICES

THE EDITOR invites original contributions on construction of radio subjects. All material used will be paid for. Articles should be clearly written, preferably typewritten, and photographs should be clear and sharp. Diagrams need not be large or perfectly drawn, as our draughtsman will redraw in most cases, but relevant information should be included. All MSS must be accompanied by a stamped addressed envelope for reply or return. Each item must bear the sender's name and address.

COMPONENT REVIEW. Manufacturers, publishers, etc., are invited to submit samples or information of new products for review in this section.

ALL CORRESPONDENCE should be addressed to *Radio Constructor*, 57, Maida Vale, Paddington, London, W.9. Telephone: CUN. 6518.

BUILDING YOUR OWN VALVE TESTER

By W. G. MORLEY

PART TWO

Using a Home Constructed Tester.

HAVING borne the previous remarks well in mind, it may now be seen that, for a home-constructed valve tester to give useful results, it will be necessary to set the voltages for each valve plugged in to those recommended for optimum results, and then check the mutual conductance reading so obtained against that given by the makers for those voltages.

This method has been adopted in the tester which is described in these articles: and the procedure for testing a particular valve is described in the following paragraph.

The valve which is to be checked is plugged into the appropriate base in the valve tester. The voltages on its electrodes are then set up as closely as possible to the optimum figures recommended by the manufacturers. The mutual conductance of the valve is then read from the meter fitted to the tester. If this is found to be above, say, 80% of the mutual conductance claimed by the manufacturer, then the valve may be considered as being in good condition.

After an unfamiliar valve has been tested in this fashion, the constructor can then take a note of the various readings and switch positions that he used to obtain the required voltages, and index them for future use. After say, about three months' use, he should then be in possession of a very useful card-index dealing with most of the valves which he may meet in the future, this index enabling him to set his various switches at a glance for any future valves of those types that come his way. Of course, should an unfamiliar valve again be found, all that is needed is to find the performance figures in the appropriate manual, check the valve and—once more—note the figures and settings for future use.

It will be appreciated that the card-index system is used simply to avoid the necessity of looking up valve literature and working out the switch positions for each valve as it is encountered. The beauty of the scheme lies in the fact that the valve tester is **never** " stumped " by any valve it may be reasonably be required to check so long as the user has a set of performance figures for that particular valve, and has provided a suitable socket for it on the tester. In addition, cards for the more popular types may be made up from the valve literature **before** the valves are actually encountered and tested, thus enabling a good foundation for the card index to be built up right from the beginning.

Additional Facilities.

It will be noticed that the writer has used a not inconsiderable amount of space in explaining the system of obtaining mutual conductance readings in valve testers, and in the one described in these articles in particular; and that he has made very little comment on the other facilities fitted.

The reason for this is that the other facilities are fairly obvious in application and may be explained later as they are met, where the tester is described as a whole; whereas the measurement of mutual conductance is somewhat complicated, and needs a little introduction, not only to explain how it is done, but *why* it is done in a particular way in this case. Besides this, the whole *raison d'etre* of the tester lies in the fact that it may be used to measure mutual conductance. The other tests may point to obvious faults but they do not give the all-important measure of the *efficiency* of the valve.

So far, we have discussed theoretical methods of testing the mutual conductance of a valve, in particular dealing with the procedure that would be best used in a valve tester built and designed by any amateur constructor. We will now go on to practical details and examine the circuit of a valve tester which may be made at home by any enthusiast. The circuit was, incidentally, expressly designed for this series of articles in the *Radio Constructor*. The versatility of the tester and the facilities which it offers were mentioned in last month's introductory article.

One of the more important items for consideration in the tester is the circuit used for the power supply. Since, as far as possible, the tester will be used for checking valves under dynamic conditions, all tests are made

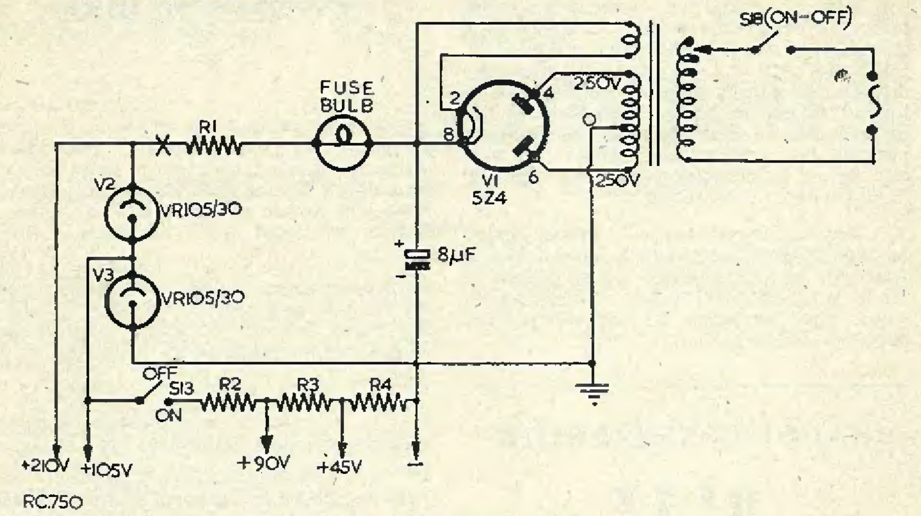


Fig. 2. Circuit of the HT Power Supply.

with DC applied to the valve's electrodes, (apart from the heaters.) In addition, to ensure that readings are always accurate, the HT and grid bias supplies are stabilized.

The HT Supply.

The circuit of the HT power supply is shown in Fig.2. The HT secondary of the mains transformer is wound to give 250-0-250 volts and should be capable of giving a current of 50 mA. After being rectified by a valve type 5Z4 (V1), the HT is passed to an 8 µF reservoir capacitor. The two stabilizers are connected to the capacitor *via* a limiting resistor, R1.

By connecting the other circuits of the tester to the two stabilizer valves, it is possible to obtain regulated voltages of 210 and 105 volts. (The VR 105/30 regulates at 105 volts.) In addition, by closing the switch, S13, voltages of 90 and 45 may be obtained from the potentiometer network R2, R3 and R4. These voltages are intended for testing valves which have only a low permissible maximum HT supply. The values used in the network allow a current of 15 mA to flow through it, therefore any currents up to 5 mA which may be drawn from it will not seriously alter the voltages obtained. Some 1.4 volt output pentodes which take currents up to 10 mA will slightly alter the voltages given by the network, and the mutual conductance readings obtained will then be slightly smaller than would otherwise be the case. This factor should be taken into consideration when the data for these particular valves is made up.

A fuse bulb is connected in series with the HT positive feed to the stabilizer valves. This fuse is fitted to prevent damage to the mains transformer and rectifier should any serious overload occur. A flash-lamp bulb will do quite well here, this type of fuse possessing the advantage that it is cheap, readily obtainable and easily replaced.

It may be noticed that in Fig. 2, no value has been given for the resistor R1. This component is the limiting resistor for the stablilizing circuit and, owing to the fact that individual mains transformers will have different characteristics, its value can only be found by experiment.

The correct value for R1 may be found by connecting a milliameter between the resistor and the stabilizer valves (at the point marked X, in Fig. 2) and adjusting R1 until a current of about 32 mA is shown in the meter. The mains input tapping on the transformer should be correctly adjusted whilst this is being carried out. Once the correct value has been found and connected in permanently, it may then be assumed with certainty that the stabilizer circuits will function for all HT currents between zero and about 28 mA. It will be found that the correct value for R1 will vary considerably for different types of transformers, and it may even be found that the required current reading can be obtained with no resistance in circuit at all, the losses in the transformer and rectifier taking its place. When the value of R1 is being experimentally adjusted, care should be taken to see that the stabilizer valves do not get " burnt " owing to too high an energizing current. For this reason the best course to follow is to start with a resistor of about 5,000 ohms, dropping in 1,000 ohm steps to 2,000 ohms; and after this, in 500 ohm steps, until the required value is found. After the best value has been discovered, the resistor R1 may be properly installed as a permanent component. Its wattage should be sufficient to pass the necessary 30 mA without overheating.

It may be noticed that an indirectly-heated rectifier (5Z4) is used in the circuit of Fig. 2. This type of valve is used to ensure that, so far as is possible, HT is not supplied to the valve under test before the grid bias rectifier has come into operation.

"RADIO CONSTRUCTOR"

QUIZ

Conducted by W. Groome

(1) Mr. Braine, our stooge, erected an indoor dipole for television reception, and although it was only a simple affair of copper tubing fitted to his own side of a party wall, it worked quite well, as is often the case in good reception areas. At times, however, the otherwise excellent picture would collapse for a few seconds, and then recover. He noticed that this happened when one of the family approached rather near to the dipole, and so warned the household to avoid doing this during reception hours. Although this request was dutifully obeyed, the trouble still persisted, though not so often. Explanation, please.

(2) How would you identify the leads of a mains transformer if you had no information about the component? Test instruments could, of course, be used, but it is fairly easy without, and this question means identification without tests—that is, by observation alone.

(3) In high-quality equipment employing heavy negative voltage feedback from the secondary of the output transformer, the loudspeaker is of the 15 Ω type, a 3 Ω unit often being considered unsuitable. Why?

(4) If the North Poles of two magnets repel each other, what would the two South Poles do?

(5) What causes "snowstorms" on the TV screen?

(6) Beware—"catch" question! How many complete pictures per second are screened in British television?

(Answers in next column)

ANSWERS TO QUIZ

(1) The aerial was fitted to a party wall, and Mr. Braine's neighbours were able, quite innocently, to approach within a foot of it from the other side of the wall, so causing the same effect as when his family went near to it. It is worth while to take a little care in siting an indoor dipole. There is usually less human activity upstairs than on the ground floor, less ignition interference at the back than on the street side, and more certainty of success if one avoids fitting the dipole near to metallic objects such as cisterns, cables, conduits and pipes. Although they may be out of sight beneath the wall plaster, or even outside, as in the case of rain pipes, such objects have a big influence in some circumstances. The above remarks have exceeded the scope of the question, but will be useful to those contemplating the erection of an indoor aerial. The purpose of the Quiz is to instruct rather than to tease!

(2) The primary is nearest to the core and there will be two leads for mains connections, or more if the primary is tapped. The lead nearest the core and the one (of this group) farthest from it, will together form the highest mains input—usually 250V. Any intermediate leads will be tappings for lower voltage inputs. Next will be a single wire, often in the form of a bare braided lead, which will be the shield between primary and secondaries (assuming that the transformer is fitted with one). Next will be a group of three leads, usually two of one colour and the third of another. This is the HT winding, and the odd colour—centre lead—is the mid-point of this section. The outer windings are the LT's, easily recognisable as they consist of heavy gauge wire. As a rule, the rectifier winding is wound with a thinner wire than the valve heaters. Any twisted wired associated with the LT windings will be centre-taps.

(3) A 15 Ω loudspeaker provides a higher feedback voltage than a 3 Ω unit.

(4) Repel.

(5) Electrical interference, notably from the ignition system of passing cars. The "snow" is caused by each pulse driving the CRT to the "peak white" region. Also see answer (1) above.

(6) Twenty-five, each presented in two "scans," one of even and one of odd lines. Twenty-five pictures per second is sufficient to give the effect of movement, but flicker would be apparent. So the "flicker" rate is doubled without increasing the number of complete picture repetitions.

Design of the SUPERHET

PART 9 By R. J. CABORN

IN the first eight articles of this series we considered the theory of the simpler type of superhet receiver, such as would be encountered in normal domestic use. Having dealt with this, we can now carry on to more advanced designs which, whilst not constituting part of the average set, will very often be found in the more expensive receivers and almost invariably in sets of the communications type. Proceeding therefore with these more specialized circuits, we shall begin in this article by considering the theory of noise limiting circuits, and their use in practice.

Noise.

There are two main types of noise which may mar the output of a receiver. There is firstly the obvious "valve noise" or "hiss," usually reduced by increasing the gain of the aerial circuits and that of the first valve; and secondly there is the noise which may be picked up in the aerial circuit from external interference. This interference may, again, be subdivided into two different types. Firstly there is the continuous interference caused by, say, a continuously running motor, or by any other appliance in which the rate of sparking is sufficiently high to be recognisable as a hiss, and secondly there is what may be described as "impulse" noise, this being given by intermittent sparks or discharges. This second form of interference would be given by the spark-plug circuits of a car, by sudden circuit breaks such as would be caused by switches being operated, by transmitter key clicks, and so on.

Nearly all noise limiting circuits are designed to minimise the effect of the second type of interference. The nature of the noise itself assists considerably in designing noise limiters, because it usually consists of sudden short pulses of energy, whose amplitude is considerably larger than the amplitude of the intelligence-conveying signal. Fig. 1 (a) shows a diagrammatic representation of several noise pulses superimposed upon a modulated carrier. The effect of the ideal noise limiter circuit would be to cut out all reception during the period occupied by the pulse, giving the effect shown in Fig. 1 (b). It will be seen that the very short cessation of signals is very much more desirable than are the pulses of noise shown in Fig. 1 (a). In practice, the short periods of absence of signal would hardly be noticeable at all, unless repetition rate was fairly high.

A practical noise limiter would not be able

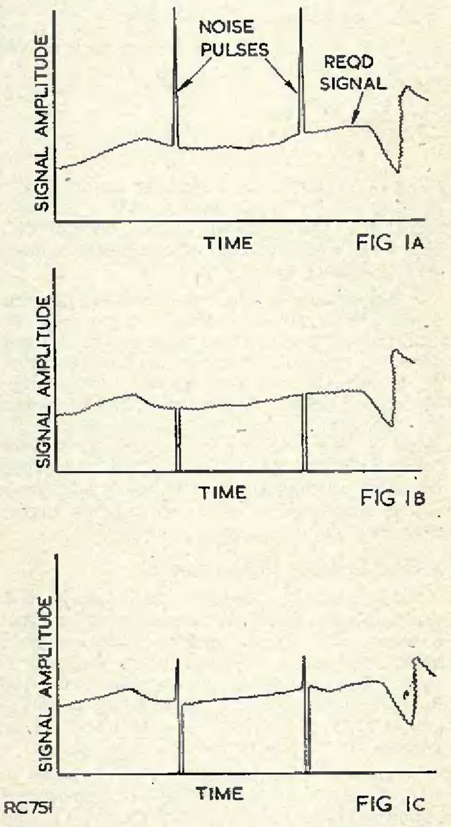
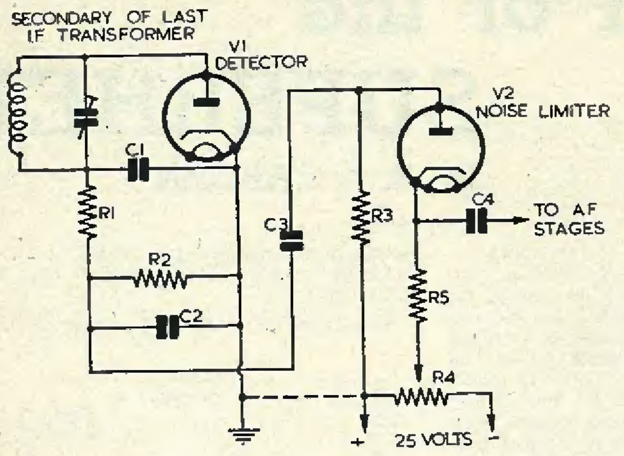


Fig. 1(a) Showing two noise pulses superimposed upon a required A.F. signal.

Fig. 1(b) Ideal noise limiting would remove the pulses, (and the required signal), for the period of the pulse, as shown here.

Fig. 1(c) In practice, a small amount of the pulse would pass through the limiting circuits before limiting took place.



RC 752

Fig. 2. A simple noise limiting circuit with a pre-set control for the limiting "threshold."

to function so well as to give the results shown in Fig. 1 (b), and would more probably function as shown in Fig. 1 (c). The curve of Fig. 1 (c) is still, of course, considerably more desirable than that of Fig. 1 (a).

A better state of affairs is sometimes possible when CW signals are being received. As the audio amplitude of these signals can, in some cases, be made much more constant than that of a normal "entertainment-" or speech-modulated signal, it is possible to limit increases in voltage to a relatively small range. By using a panel or pre-set control to set the "threshold" at which limiting will take place, the receiver may be made to reject all signals whose amplitude is even only slightly higher than that of the required signal itself.

Second-Detector Noise Limiter.

Noise limiter circuits may be fitted either in the audio or in the IF stages of a superhet receiver, the simpler method consisting of using the audio circuits. Noise limiting is usually carried out immediately after the second detector in this case. The limiting action is given by a diode (or by a rectifier of the germanium crystal type.)

A simple noise limiting circuit is shown in Fig. 2. The output of the IF transformer secondary is detected by diode V1, the AF then being developed across resistor R2. (The resistor R1 and the capacitors C1, C2 are used to filter out the IF component appearing in the detected signal.) The AF voltage found at the junction of R1 and R2, and which is passed *via* C3, to the limiting diode V2, is negative with respect to chassis.

By reason of the potentiometer R4, a steady pre-set voltage is applied to the cathode of the diode, this voltage being negative with respect to the anode and therefore allowing cathode emission within the diode. The diode thereupon conducts, and allows the AF signal to be fed to the following AF stages. However, should the AF voltage, (which is, as we said above, negative) rise to such a value that it is greater than the steady voltage applied to the cathode of V2, then the anode of that valve will be negative with respect to the cathode and, for the duration of the increased AF signal, it will not conduct. Therefore, during a period of excessive AF voltage, no signal whatsoever will be applied to the audio stages of the receiver.

This, of course, is what is required of the limiter. The only preliminary adjustments necessary consist of setting the potentiometer R4 until it is at such a position that the diode will just allow the required AF signal to be conducted.

There is, incidentally, no necessity to have a direct connection between the "positive end" of R4 and chassis. Should it prove to be more convenient, the chassis connection may be taken to the negative end of the potentiometer. The reason for this is that the limiter circuit is isolated, so far as DC is concerned, from the detector and AF circuits by C3 and C4, and the steady DC potential effects only those components connected in the limiting circuit proper.

If it is desired to use the limiter circuit of Fig. 2 with an infinite impedance detector, both the diode and the polarity of the 25-volt supply should be reversed. The detected AF voltage from the detector cathode load should then be applied to the limiter *via* C3. The reversal is necessary because the audio output of the infinite impedance detector is positive with respect to chassis, and not negative as is that of the diode.

With slight alterations, the circuit of Fig. 2 may be changed so that, instead of using a pre-set DC voltage for the limiting circuit, the required potential is obtained automatically from the audio signal itself. Fig. 3 shows a practical method.

In this diagram, the detected audio voltage is built up across R2 and R3 in series. Half of the audio voltage is applied, from the junction of the two resistors, to the anode of the limiting diode V2; whereas the entire voltage is passed to capacitor C4 by R4. By reason of the relatively large value of R4 and C4, the charge built up across C4 varies only slowly according to the average voltage of the detected AF. The voltage on the upper plate of C4 (see Fig. 3) will, of course, be negative, and it corresponds (insofar as the limiting action is concerned) to the negative voltage obtained from the potentiometer R4 in Fig. 2. The advantage in this case is that the voltage used for limiting is always proportional to the average peak voltage of the AF signal detected, As the limiting voltage must always be greater than the normal required audio voltage, only half of the latter is passed to the anode of the limiter valve. This proportion, (1 : 2) between required signal strength and limiting voltage should then strike a fairly good compromise between effective limiting of noisy peaks and the danger of cutting out any sudden increases in modulation level.

Should an infinite impedance detector be used, the diode V2 of Fig. 3 should, again, be reversed. The reference voltage obtained from C4 with the infinite impedance detector will automatically be positive with respect to chassis.

A further method of noise limiting is shown in Fig. 4. In this diagram it may be seen that the diode is used in a different fashion to that of Fig. 3. This time its purpose is to *short-circuit* the AF voltage from the detector, should this exceed the reference level given by C4. As the short-circuiting action is not very effective on AF voltages which are only slightly higher than the voltage built up across C4, a somewhat larger AF voltage is passed to the limiter diode (*via* the potentiometer R2, R3) than occured in Fig. 3.

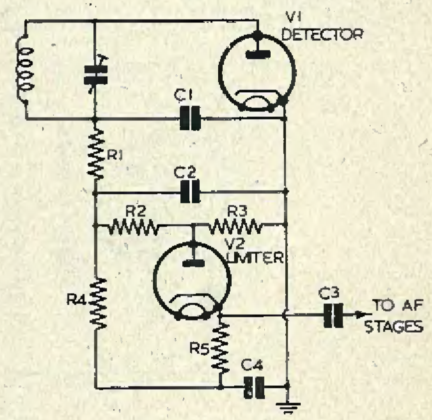
The circuits shown in Figs. 2, 3, and 4, all make use of diodes for limiting purposes. If desired, the limiter and the detector diodes may be combined together in one envelope, using such valves as the 6H6, etc. Alternatively, a separate diode, (or germanium crystal, as mentioned above), may be used for limiting in which case the detector diode may be part of a double diode triode. If this latter type of valve is used, and if it is fitted with cathode bias for the triode section, the chassis returns shown in Figs. 2, 3, and 4 should be taken to the cathode of the double diode triode, this then being connected to chassis (so far as IF and AF are concerned) *via* the decoupling capacitor across the bias resistor. The 25 volt DC supply of Fig. 2 may, however, still have one of its "ends" connected to chassis.

The circuits shown up to now have consisted of limiters which function on the audio signal after detection has taken place. They all have their advantages and the most popular, (so far as the writer is aware), seems to be that of Fig. 4. However, the circuits of Fig. 3 and Fig. 4 are not of much use for CW work, owing to the difficulty of obtaining a steady reference voltage from morse signals. There is, of course, no reason why a "Phone-CW" switch should not be fitted to the limiting circuit of a communication receiver if so desired, this enabling the limiting circuit to be switched either to the capacitor C4 of Figs. 3 and 4, or to a steady DC voltage such as that given by the potentiometer of Fig. 2.

All the limiter circuits mentioned above suffer from the disadvantage that, although quite effective, they do not prevent overloading of the stages before the detector. For this reason, it is sometimes advantageous to use a noise limiting circuit in the IF stages.

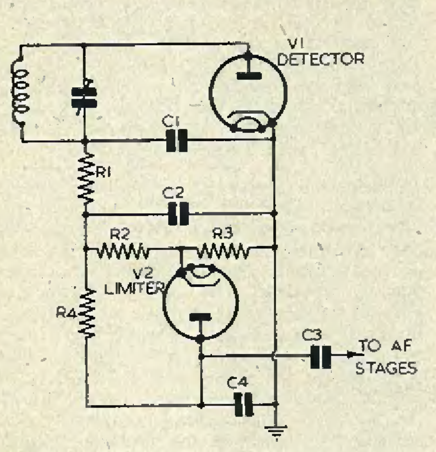
IF Noise Suppression.

The circuit of an IF noise suppressor is given in Fig. 5. To enable a simple form of control over the amplification of the IF stages to be obtained, a 6L7 or similar valve is used as an IF amplifier. This type of valve possess



RC753

Fig. 3. An automatic noise limiting circuit



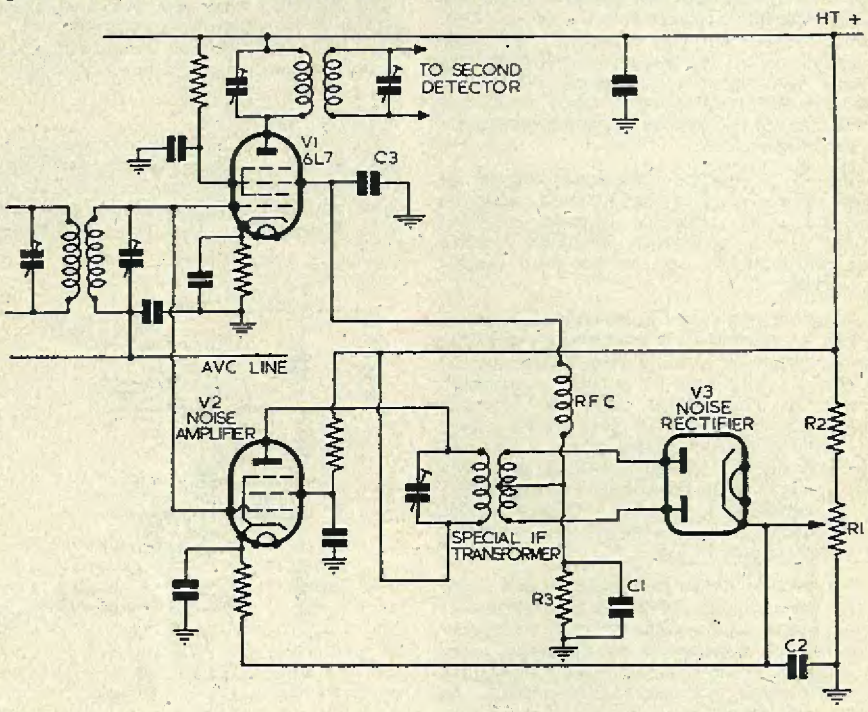
RC 754

Fig. 4. Another automatic noise limiting circuit in which the limiting diode short-circuits the signal on reception of excessive A.F. peaks.

advantages for our present purpose since its amplification factor may be controlled by applying different values of negative voltage to its third grid.

The action of the circuit is quite simple. The 6L7 is used as the last IF valve in the receiver, this ensuring that sufficient IF voltage is obtained to ensure effective operation of the noise limiting circuits. The input to the 6L7 is passed also to the grid of V2, the "noise amplifier" valve. If the receiver is fitted with AVC it is usual practice to supply the AVC control voltage to the noise amplifier (as is done in this circuit.) V2 then amplifies the signal, and passes it to the IF transformer connected in its anode circuit. The voltage on the secondary is then applied to the diode V3, which is delayed by the voltage obtained from the potentiometer R1 connected in its cathode circuit. Should the voltage applied to V3 exceed the delay voltage it rectifies, and a negative potential (with respect to chassis) is built up across R3. This is passed, *via* the RF choke, to the third grid of the 6L7, thereupon reducing its gain.

When the circuit is used in practice there are several points which need some slight additional explanation. For instance, it is usual to utilize a special IF transformer for the noise limiting circuit, although the home-constructor may be able to get good results by using a normal transformer with an untuned secondary and a half-wave diode rectifier. An ordinary IF transformer could be converted by disconnecting the parallel capacitor across the secondary and moving the windings much closer together. Some experimenting would be necessary, however, before good results could be claimed.



RC 755

Fig. 5. An I.F. noise limiting circuit (The unmarked capacitors and resistors are, of course, normal decoupling components, etc.,)

To enable nearly instantaneous action to be obtained, the capacitors C1 and C3 should have as low a value—compatible with stability—as is possible. For this reason, they may be reduced below the figure of 150 pF given in Fig. 5, so long as instability does not result. In addition, to prevent any further instability, a high quality component should be used for the RF choke.

The potentiometer R1 sets the "threshold" at which limiting occurs and it is common practice to use this control to vary the cathode bias of the noise amplifier as well. With multi-wave receivers in which relatively high IF voltages may be passed to the noise-limiting circuits, this method of connection could increase their reliability. However, for the home-constructor who may have difficulty in obtaining sufficient voltage for the noise rectifier from a normal type of IF transformer, it may prove advantageous to use a small constant bias for V2 and utilize potentiometer R1 to change the limiting delay only.

Next Month.

In next month's article, the subject for discussion will be the theory and design of IF crystal filters.

Ex-R.A.F. COMPONENTS

We present the fourth list of ex-RAF components, together with reference numbers and values. This list is compiled from information supplied by readers. As before, all the numbers stated are preceded by the reference 10/C. We regret that no copies are available of issues containing previous lists. Our thanks to those readers who supplied the information given below.

49	HF Choke, 50 turns.
79	HF Choke, 1.5 mH, 4 pies.
80	HF Choke, 1.25 mH, 4 pies.
216	LT HF Choke
217	HT LF Choke
249	Inductance, 125 μH
401	HF Choke, 5 metres
436	1μF, 350V wkg.
442	40 μF, 15V wkg.
445	4 μF, 4 kV wkg.
447	HF Choke, 210 mH.
482	As above, with canister.
578	HF Choke, 8.8 μH, ± 10%
583	HF Choke, 250 μH
836	LT HF Choke, 0.2 Ω DC
837	LT HF Choke, 0.1 Ω DC.
845	HF Choke, 200 μH.
866	HF Choke, LT, 15 μH.
880	HF Choke, 3.8 μH at 1 kcs.
902	LT HF Choke, 7-8 mH.
2019	HF Choke, 6.7 mH 135 Ω DC.
2087	8.8 mH ± 10%, HF Choke
2103	15-197 pF, 4-gang variable.
2110	80 + 80 pF, variable.
2135	HF Choke, 6.8 μH.
2148	50 μF 12V wkg, — 10 + 100%
2172	0.4 μF, 500V wkg, terminals to earth 1 kV.
2178	200 pF, 5 kV wkg, 10% tol., size 4¼" × 2⅜".
2179	500 pF, 5 kV wkg, 10% tol., size 4¼ × 2⅜".
2180	3-18 pF variable.
2181	0.0015 μF, 25 kV, 10% tol.
2185	HF Choke, tubular wire end, 5.6 mH.
2186	HF Choke, 6.7 mH, 135 Ω DC.
2209	0.0012 μF, ± 1%, 500V wkg.
2210	20 μF, 30V wkg, — 10 + 100%
2213	450 pF, ± 2%, 500V wkg.
2218	220 pF, ± 2%, 500V wkg.
2243	0.001 μF, ± 10%, 28 kV wkg.
2244	0.001 μF, ± 10%, 15 kV wkg.
2245	0.01 μF, ± 20%, 15 kV wkg.
2246	0.01 μF ± 10%, 5 kV wkg.
2258	0.07 μF, 350V wkg.
2259	0.1 μF, 750V wkg.
2262	Neutradyne capacitor assembly.
2281	300 pF preset variable.
2282	500 pF preset variable.
2283	100 pF preset variable.
2284	0.1 μF, 3.5 kV wkg.
2285	300 pF moulded mica
2286	0.003 μF, moulded mica
2337	0.001 μF, ± 10%, 5 kV wkg.
2386	0.001 μF, ± 10%, 25 kV wkg.
2401	500 pF, ± 5%, 500V wkg.
2426	2 μF, — 0 + 50%, 250V wkg.
2435	85 pF, ± 5%, 500V wkg.
2653	50 μF, 25V wkg.
2693	300 pF, ± 5%, 1.5 kV wkg.
2965	50 μF, — 0 + 50%, 12V wkg.
3042	1 pF, ± 20%, 500V wkg.
3034	600 pF, ± 2%, 500V wkg.
3035	90 pF, ± 2%, 500V wkg.

TELEVISION PICTURE FAULTS

Part four of a series, illustrated by photographs from a Televisor screen by courtesy of Mr. John Cura.

THE TIME BASES, *(contd.)*

MAGNETIC time bases are liable to faults which are frequently rather complex in their effect, and so are difficult to diagnose. The waveforms produced by the various circuits may give an instant indication if the apparatus is examined by an oscilloscope, but this is a rather specialised method of fault detection not generally available to the majority of constructors. The picture or image on the cathode ray tube of the set itself does virtually the same job, however, and if studied carefully can usually give useful information.

It is very important to remember that the time bases when running free (unsynchronised) will produce an irregular raster, which may flicker or jump about. The only satisfactory method of checking the operation of any time base is with a normal input signal with correct synchronisation, and then preferably on the test pattern radiated by the B.B.C. Signals provided by test oscillators modulated by audible notes, or even square wave modulation, are seldom satisfactory for time base adjustment, as accurate timing of the time base circuits is not easily achieved, and may lead to a lot of unnecessary work being undertaken.

On the B.B.C. Test Card " C " there is an overall background of squares which will show non-linearity of the image very obviously, in both horizontal and vertical directions.

The Frame Time Base.

Control of linearity in the frame time base is usually achieved by the circuits preceding the frame output valve, or by negative feedback, which may be derived from a later part of the circuit. High or low impedance deflection coils are almost equally common and differ, from the point of obtaining correct linearity, in that the low impedance type require an output transformer and the high impedance types are practically directly coupled to the load.

In circuits using transformer coupling, the operation depends a great deal on the design of the transformer, especially at frame frequencies. It is an important point at line frequencies, of course, but as most line transformers are of similiar design, apart from the turns ratio, they will nearly always operate in a similar manner. The inductance of the frame transformer contributes to a large extent to the operation of the frame time base, and if it is impregnated one must assume that it is adjusted to the correct value for the recommended circuit. It may, however, be helpful to the constructor to investigate the effect of increasing or decreasing the gap in the transformer, if this is possible, to see whether adjustment will help to obtain correct linearity. This will be particularly important where the anode current of the frame output valve passes through the primary winding. The transformer gap, as a general rule, will be fixed by the thickness of a piece of interleaving paper or insulation, and may vary between one and ten thousandths of an inch in different types. If the transformer is parallel driven, the laminations will probably be butt ended or even interleaved, and this is probably done to achieve the maximum possible inductance, as little or no direct current flows in the windings.

It is impossible to give here, details of the effects of component failure or incorrect values in time bases, owing to the large variety of circuits in common use, but the following general pointers may help. They apply to both line and frame time bases.

Leakage of capacitors, even of the order of several Meg Ω, may cause considerable non-linearity. They may often be checked, in the absence of specialised equipment, by putting the component in series with a DC voltmeter which has a range which will give a full scale reading when connected across the receiver HT line and chassis. The meter may then be used as a series ohm-meter and will indicate very high leakage resistances. The usual series ohm-meter using a 0-1 mA meter, 1.5V cell and 1500 ohm series resistor will indicate 1 Meg Ω, and with a higher supply voltage provided from the HT line and suitable series resistors it will indicate a proportionately higher resistance for the same deflection.

Check that the resistors used are of the correct value, and bear in mind that some wire-wound resistors have quite high inductances and may " ring " or oscillate for several cycles at their resonant frequency during or after the flyback period and cause unusual effects.

Fig. 1 "Ringing" in Line Time Base, causing vertical dark bars on left of picture.

(John Cura " Tele-Snap ")

Fig 1 shows an example of " ringing " in some part of the line time base circuit. Faint light and dark vertical lines or bars can be seen on the left hand side of the picture (a certain amount of definition has been lost in the process of block making.) They are formed by an alternate increase and decrease in speed of the spot, as it starts each line scan, and may be likened to spot wobble in a horizontal direction. The spot, of course, does not come back on itself, but just varies in speed. The effect should be checked over a long period, as it can also occur in transmission.

Take care not to exceed the anode and screen dissipation limits in the time base valves. This applies particularly to the line output valve, which is capable of dissipating a very large amount of power, especially if not being driven.

(Continued on page 353)

Fig. 2. Non-linearity of Line Time Base, causing extension of left-hand side of picture.

(John Cura " Tele-Snap ")

HOW I BUILT
The Basic Superhet

By A. H. PRATT

REQUIRING an efficient short wave receiver, and also having in mind various spares which accumulated over a period of time, I looked around for a reasonably good circuit. It was found that the *Short Wave News* " Basic Superhet " would fill the bill, *i.e.*, that the valves and spares on hand could be made to suit this circuit.

Construction was commenced, and the chassis was made as follows. On hand was an old sheet steel plate with the two long edges bent over at right-angles, giving a half-inch flange. It was decided to use this as the baseplate. A similiar front panel was made up, and this was bolted to the baseplate, giving a two-inch clearance underneath. Some strip iron was next obtained from the local ironmonger and bent into the shape of a bracket. One side was bolted to the top of the front panel, and the other side to the rear edge of the baseplate, leaving a two inch leg. As the illustration shows, this results in a very effective and easily handled chassis. When wiring up, the chassis can simply be stood upside down, with perfect safety to any component mounted on the top.

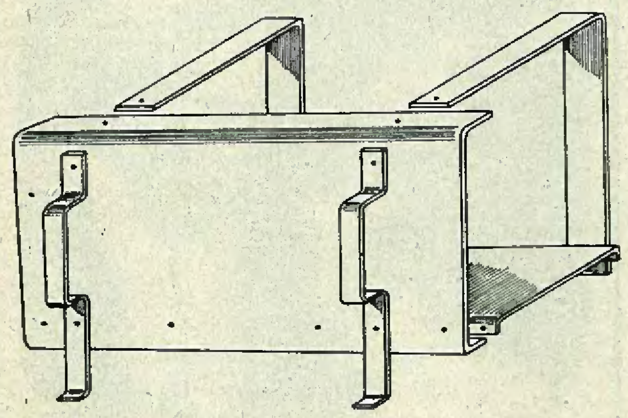
Two further lengths of iron were bent in the manner shown, and bolted on to form lifting handles, and also to make the front panel slope back for easy operating.

A piece of perspex 6ins by 2ins was bolted to the rear flange to take the aerial and earth terminals.

No measurements of the chassis are given, as these are determined by the components and layout used, and this varies in individual cases.

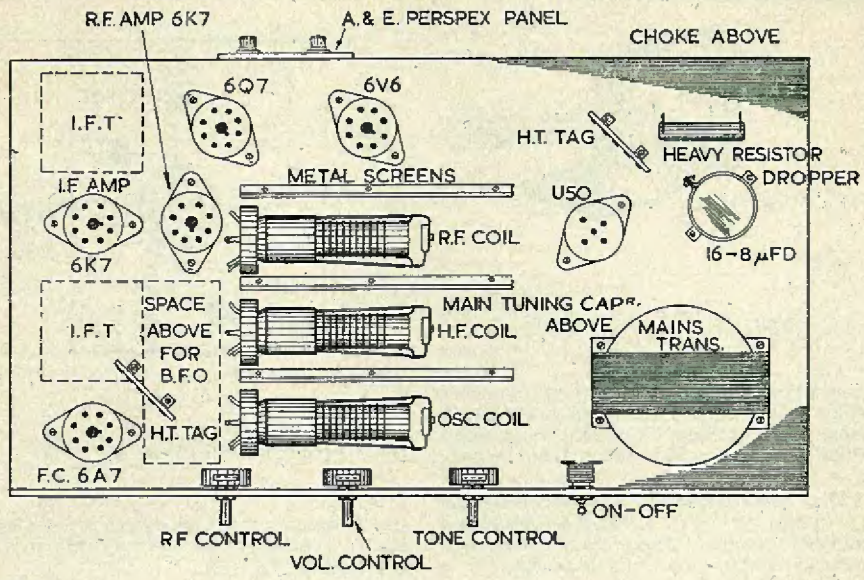
The power pack was modified from the original arrangement given in the book, as follows. A U50 rectifier was used with a 350-0-350V transformer, and a heavy wattage resistor was employed to drop the smoothed rectified voltage to that required for the HT line. I have thus a " dead " 250V (checked by meter).

The coils used were Wearite " P " type, and these were converted to act as plug-in coils. Two old 5-pin and one octal valves were smashed up, leaving just the bakelite bases with pins. The centre pin of the two 5-pin bases were taken out, and the resulting holes used to clamp on the coils. The windings were connected to the remaining pins, and a trimming capacitor soldered across the top of the coil. The value of these trimmers must be in accordance with the maker's instructions.



Showing details of chassis construction.

R.C. 743.



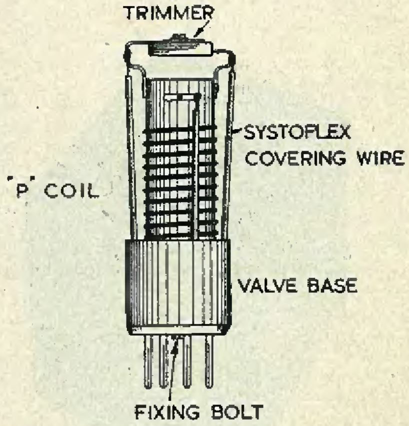
RC.746

Layout of components. Those on top of chassis are in broken outline.

The 5-pin bases are used only for the Aerial and HF coils—the octal base is used for the Oscillator coil. For the latter, a clamping hole was drilled through the locating spigot. In the case of the aerial and RF coils, the pins are kept constant for all ranges, but with the Oscillator coils a separate padder pin is used on each range in order that the appropriate padder may be selected automatically when changing coils.

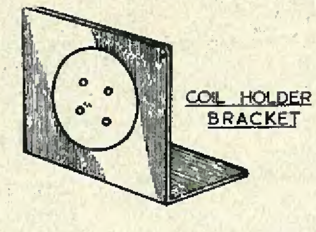
The coil holders are fixed to brackets situated between the metal screens under the main tuning capacitors, as shown in the layout diagram. This gives the position of the main components on both sides of the chassis, those drawn in full outline being those fitted below chassis.

The circuit is well known and needs no explanation.* At the time of writing, only the 40 and 80 metre bands are being used. A BFO Unit is contemplated soon, and space for it has been left on top of the chassis, between the frequency changer and the tuning capacitors. It will be built in a screened box, which will be bolted in position, leaving the switch projecting through the front panel above the RF control. This was one reason for the coils being placed below the chassis.



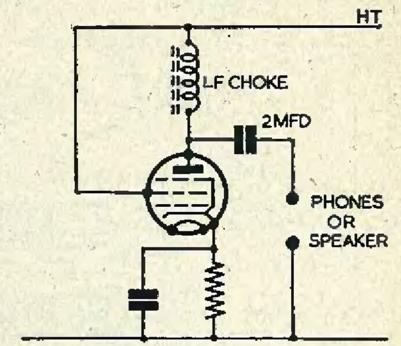
RC.742

Showing method of converting chassis-mounting coils into plug-in type.



RC.744

How the coils are mounted



RC745.

Circuit of modified output stage

Reception is excellent, with good speaker results on all home and continental stations. Tuning is carried out by a 100-1 ratio slow-motion drive, and a 20ft indoor aerial is used.

* The " Basic Superhet " was first described by " Centre Tap " in a series of articles in our companion monthly *Short Wave News*, and was later reprinted as Data Book No. 1. A limited number of copies of this are still available from local booksellers, or direct from us at 1s, postage 2d—Ed.

COMPONENT REVIEW

The WWFB/O Output Transformer

The WWFB/O series of push-pull output transformers is intended for use in equipment reproducing the full audio-frequency range with the lowest distortion. The characteristics are such that these transformers, manufactured by *Partridge Transformers Ltd.*, can be used in circuits where considerable feedback is taken from the secondary winding and injected into a point three or four stages back. A particular application is the well-known Williamson amplifier.

The power rating is 16 watts continuous tone. The peak power is limited by the valves, with a maximum of 80 mA DC per half primary. The anode to anode load is 10,000 Ω. Other load values are available when a different code number is used. The permissible DC unbalance is 20%.

All the secondary windings are brought out as eight separate sections, which may be connected in series, in parallel, or in various combinations of series-parallel, thus ensuring that the performance is unaffected over a wide range of impedances.

The leakage inductance, measured as a series element in the primary, is 15-20 mHy. The self capacitance, measured between either anode connection and the centre tap of the primary commoned to the core and one point on the secondary, is 500-580 pF per half primary. The shunt inductance of the primary measured at 4V 50 cps, is 100-130 Hy. The DC resistance of the primary is 220 Ω per half winding.

A MULTI-RANGE METER for less than £3

By L. E. R. HALL

THIS meter has been in use for over 12 months, and has proved itself an efficient and reliable piece of apparatus. It was built with a view to keeping the cost as low as possible, but without sacrificing accuracy.

The theoretical circuit is given in Fig. 1. The meter is a new " ex-service " 1mA movement with a $2\frac{1}{2}''$ scale. The resistors are $\pm 2\%$ tolerance, and were bought, with the meter from a well-known London firm. It is well worth paying a little extra for the resistors in order to ensure accuracy.

Perhaps the only unusual point in the circuit is that the rectifier is switched out of circuit when not in use. This avoids damage to it from overloading on the DC ranges, and also prevents it presenting a " shunt load " which may introduce undesirable errors.

Two pairs of test terminals are put in the circuit for the sake of convenience. Many amateurs use both ordinary test prods and also a pair of leads to which crocodile clips are attached. The two pairs of test terminals allow both of these sets of leads to remain connected to the meter and to be used as required.

The second pair of terminals may also be used to convert the finished test meter to a low range ohmeter of the shunt variety. As this kind of meter is not very often used, it was not incorporated in the circuit. The second pair of terminals may also be used to increase the current ranges when necessary.

Construction.

The construction is quite straightforward. First the panel is cut out, either in aluminium or in $\frac{3}{16}''$ 3-ply. Figure 2 gives the dimensions for this. When the panel is cut out, the switches and potentiometer are mounted. The components are mounted on a tag-board 6″x2″, and this is fixed to the switches by means of the screwed rods which hold the wafers to the main body of the switch. If necessary, these rods should be replaced with longer ones. Care must be taken to prevent the tags on the board shortening the switch contacts. The rectifier is mounted centrally on the tag-board, using the tapped hole in the centre and a 6BA screw. This is best done before mounting the tag-board on the switches.

The wiring is most easily carried out in the following manner : first solder the resistors to the tag-board, keeping the DC ones in one group, the AC ones in another. The end over S2 should be left for the shunts. Next the switches, potentiometer and terminals are wired up. This is done with 22 swg PVC wire, and great care must be taken to ensure sound joints, both electrically and mechanically. When all the connections possible have been made, the meter is bolted in position and connected in circuit. Two 8″ lengths of thin flex are soldered, one to the positive terminal of the meter, the other to the potentiometer. For preference these two leads should be of different colours, in order to avoid making wrong connections to the battery. It is left to the reader's discretion as to the actual method of connecting the flex to the flat battery. That used by the author is to solder a 6BA solder tag to each lead, drill or punch a $\frac{1}{8}''$ hole in each of the brass strips on the battery, and bolt the leads to the strips on the battery.

Now that the meter is in position the shunts can be made. It is not difficult, but requires a little patience to get them accurate. The method is described in detail below.

First connect a $1\frac{1}{2}$ volt cell-such as a U2-in series with a 2k Ω potentiometer, and connect across a pair of the test terminals. Put all the resistance in circuit, switch S1 to the 'mA' range and S2 to 1mA. Adjust the potentiometer to obtain a full-scale reading. Solder the 10mA shunt to the "common" (S1) end of the tag-board, connect the opposite tag to the appropriate contact on S2 (check the reading of the meter, correcting if necessary), and find the approximate position of the shunt wire on the tag to give a meter reading of 0.1mA (*i.e.* 1/10th of F.S.D.). Solder the shunt to the tag and allow the joint to cool. Check the reading of the meter, adjust the shunt if necessary, allow the joint to cool, and again check the meter reading. Adjust the shunt until the correct meter reading is obtained. It is most important to allow the joint to cool each time an adjustment is made, as a difference in temperature between the two ends of the shunt wire will set up a thermo-electric current which will cause a current to flow through the meter, thus giving an erroneous reading.

When the 10mA shunt is satisfactory, the

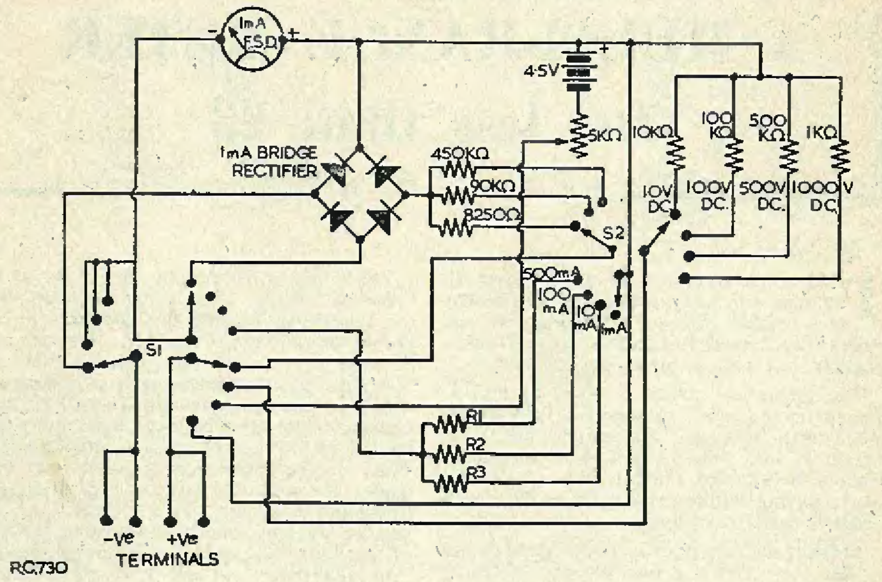


Fig. 1. Circuit of the Test Meter.

potentiometer is adjusted to give a full-scale deflection of 10mA. The same procedure is followed with this, and all other shunts, as was followed with the 10mA shunt. The maximum current range can be either 500mA or 1A. On the circuit diagram the three shunts are labelled R1, R2, and R3. Suitable wire is : R1, (10mA) Eureka ; R2, (100mA), Eureka ; R3, (500mA or 1A), 22 SWG Copper.

When the electrical circuit has been completed and checked, the next step is to make a wooden case to protect the components. This is made from ½″x2½″ wood, which should be of a fairly close grain, in order that a good finish may be applied with paint or varnish. the dimensions are shown in Fig. 3. It will be seen that the top side is hinged, to allow easy access to the battery box when the battery needs replacement. The battery box itself may need a little explanation. It consists of a piece of tinplate or aluminium cut and shaped by bending round the battery and then screwed to the base of the containing box with ⅛″ wood screws. It is safest to keep the battery box in the position shown on Fig. 3, as this will avoid any possibility of its shorting the meter terminals, though adequate clearance is given in the measurements.

The screws labelled 'A' and 'C' on Fig. 3 are 1″ or 1¼″ countersunk wood screws ; the screws marked 'B' are dummies, made by cutting off the ends of two screws of the type used for 'A' and 'C' so as to leave a length of ⅜″-½″. The screws marked 'A' secure the lid, and are removed to open the lid ; those marked 'B' give the case a uniform appearance. The 3-ply base is fixed to the sides, as is the front panel, with ½″ countersunk brass wood screws.

When complete, the box is finished to the constructor's liking. Brushing cellulose as used by model aircraft constructors is very suitable for this.

When the paint is dry the panel around the two switches is marked with the appropriate ranges, etc. Fig.1 shows the two switches in the AC position. The method of marking the panel is as follows : fix the pointer knobs to the switches, rotate them and mark the position of the knob pointer in each of the four positions. Opposite these marks paint in the ranges. For S1 these are, reading clockwise on Fig. 1, 'AC Volts'; 'DC Volts'; 'Ohms'; and 'mA DC'. For S2, again reading clockwise, " '1mA", 10V AC/DC.' "; " '10mA', 100V AC/DC"; " '100mA', '500V AC/DC' "; and " '500mA', 1000V DC".

The resistance for a given deflection on the meter is given in graph form in Fig. 4. The values have been calculated for a mean battery

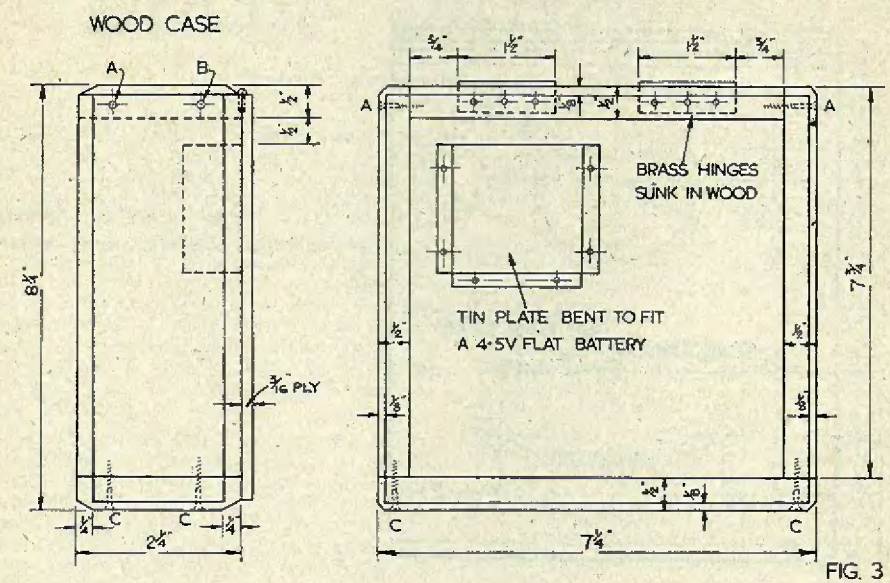


FIG. 3

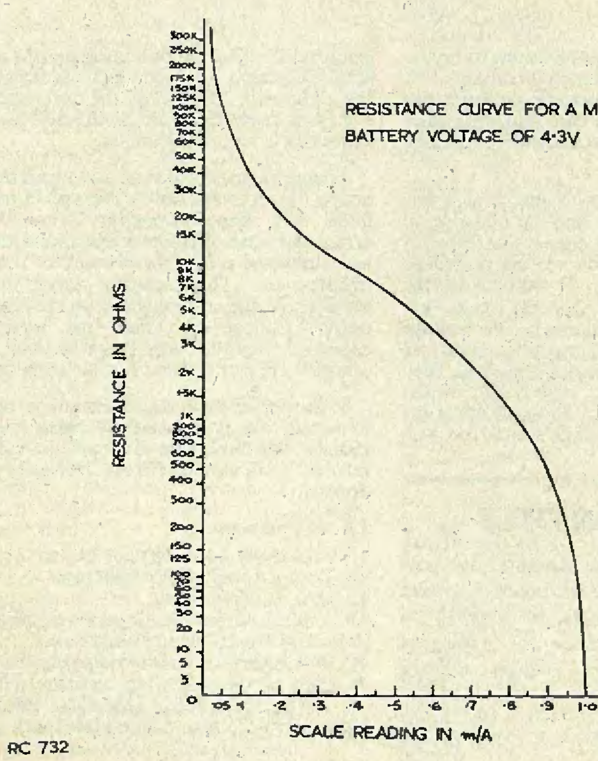


FIG. 4

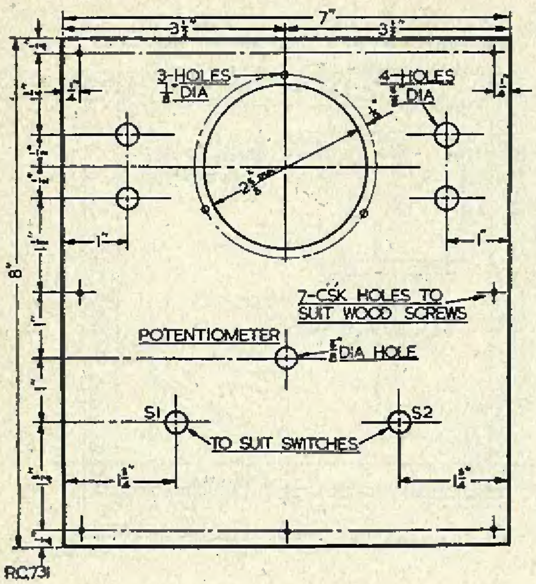


Fig. 2. Panel layout and drilling diagram for the Multi-range Meter.

voltage of 4.3 volts, as this was found to be the usual voltage of a flat battery "on load". A copy of this graph may be made, or the meter movement taken out of its case and the values carefully marked on the scale with a fine pen and Indian ink.

The meter is now ready to use, and a few words on its employment may be of value to those not accustomed to using this type of instrument. The test leads are connected to one pair of the sockets, S1 turned to the appropriate range, and the test leads are connected across the unknown for voltage and in series for current readings, and S2 turned to the minimum range that will keep the pointer on the scale. The value of the unknown is then read off. For resistance the procedure is similiar. First short the test leads, and adjust the potentiometer to give full scale deflection, then connect the leads across the unknown. Read off the resistance from Fig. 4 or from the scale, if this has been calibrated as is suggested above.

To use the instrument as an output meter for lining up receivers the AC range is used. A 500V wkg. paper capacitor is connected in series with one of the test leads, and the leads are connected across the primary of the output transformer. The capacitor serves to block the DC voltage, and only allows the alternating output voltage to affect the meter. The capacitor may have any value between 0.1 μF and 6.0 μF, but it must not be an electrolytic.

It is hoped that the instrument described above will find a place in many amateurs' shacks, and those who do construct it will find in it an extremely useful and versatile piece of apparatus.

List of Components.

1 1mA FSD Moving Coil Meter.
2 3-pole, 4 way rotary switches.
1 5k Ω potentiometer.
4 (2 black, 2 red) Belling-Lee terminals, type L315 or L316, and plugs to suit.
1 Westinghouse 1mA bridge rectifier.
1 each of the following resistors, all $\pm$2%: 10k, 100k, 500k, 1M, 8250, 90k, 450k Ω
Wire, aluminium, and wood (see text).
2 1½" brass hinges, wood screws.
1 6"×2" tag-board.

Radio Miscellany

SEVERAL readers have expressed their surprise that there should be so many class D wavemeters in circulation, and that the supply, despite their enormous popularity, has still not dried up. The answer is, of course, that a surprisingly high number of them were used by all arms of the Forces, and that in many branches they were supplied with at least one (and a spare) to every "net" of certain types of trans/receiver. Just in case there may be an odd reader here and there who is uncertain of what a "net" is, it simply means a group of stations set up to work on one frequency.

In many armed formations the radio would be linked in two nets, sometimes one for communication between themselves, and the second linking them to an entirely separate group (such as in the case of tanks co-operating with infantry or artillery.) Alternately, the two channels might be used for communication with forward units and with higher command. Mechanism for locking the tuning to the two frequencies is found on a number of types of Service equipment, and the switching from one to the other gave rise to the term "flicking." Even so, at first sight the need for these nets would not appear to account for the vast number of Class D's.

They were used to ensure that every station in the group was "spot-on" the frequency, but the obvious way of achieving this would seem to be a short check call from each station, and those off tune given a chance to re-net.

True, nothing could be simpler, but in action it would be a highly dangerous procedure.

Each side had highly efficient Interceptor Units—listening posts who constantly monitor every possible frequency. They could not fail to hear the check calls and it would not require a master mind to deduce the type and probable strength of the force and take bearings to plot its position. Within a few minutes their defences would be warned, their reserves moved into position and their dive bombers zooming overhead.

Radio is a double-edged weapon, and until an action starts the transmitter is used only for something of great importance or urgency. It would be senseless to take up position under the cover of darkness and secrecy, and then betray your strength and position by actually radiating a net.

Hence the importance of the Class D wavemeter and the reason why there are so many of them.

For security reasons the frequency of each net is secret until the last minute, and then the wavemeter is passed round to each operator and the net is set up under conditions of "wireless silence." To ensure on-the-nose tuning, the same wavemeter is used throughout the net, so that the variation which must occur with separate meters is obviated.

Silence is Golden.

Under active service conditions the operator rarely transmits. He spends most of his time listening—to nothing—and doing something else at the same time. When he has to pass information he has to do it clearly and quickly, in such a way that it conveys little or nothing to hostile eavesdroppers. All he gets in reply is "Roger, out" snapped back like a pistol shot, and his most important job is to know what to send in code and what to send in clear. For instance, to say a bridge has been destroyed or where a river may be forded, at a map reference or place name in code, deserves a Court Martial. The enemy knows what bridge he has himself smashed or where the river is fordable and he has a number of points of our code handed to him on a plate. He can soon fill in the gaps.

In using radio you never know who is listening to what you are saying, and this is a point which might well be drilled into a few transmitting amateurs who by bad manners or foolish chatter can easily create a wrong impression in the minds of the ordinary listener tuning round on his all-waver.

Question Time.

Quite a number of readers would have noticed the accounts in the daily papers of the examination candidate in Turin who used a walkie-talkie to communicate with an outside help. The details of the version you read of the incident depends on what particular paper you favour. One said it was hidden in the desk, another that it was concealed in a head-bandage and another, worn in a cast fitted to a "broken" arm.

As with most snappy newspaper stories, one can disregard the details and merely accept the fact that somebody in some place in Italy found a novel use for a midget walkie-talkie at an examination centre.

I recall in the days when flying was a more hazardous business than it is to-day, how the engine of an aircraft passing over the Channel was reported to be mis-firing. It seems that the words "engine missing" were used for brevity in passing the information to a News Agency. Written up by a bright sub-editor,

CENTRE TAP
TALKS ABOUT
Class "D" Wavemeters — The HRO — Coil Boxes

the final account told of the pilot's amazement to find one of his engines missing when he landed.

Disregarding the details of the Turin report, whatever they really were, the story is a good one, and I leave it to the readers' ingenuity to devise the best means of concealing a tiny trans/receiver to successfully accomplish this modern form of cribbing.

Never too Old to Start.

My recent comments about constructors who have taken to radio late in life, brought several interesting letters. One, from F.W. of North Wembley, tells of his making his debut at the age of 63, and how he spent nearly the whole of his first year trying to get an all-dry kit receiver to work. It failed to work even then and cost pounds in replacement valves! Worse still, the firm who supplied it were far from helpful.

Happily he then ran across a copy of R.C., and despite his previous discouragement, tried the Beginners One-valver. To quote his own words, "a good set it was, too." Then followed the "Economy Two" (highly successful) and a string of others without a single failure. So much so that he is now quite an R.C. fan and even has a few kind words for your columnist. Despite his limited leisure hours, he is now planning to build something on the lines of the Basic Superhet and to prepare himself for the Amateur exam in 1951.

Good work, F.W., and the best of luck. I hope you found the suggestions in my reply helpful.

Long Wires.

No doubt the interest of many readers was aroused by the account of the B.B.C's Monitoring Post at Caversham Park, in a recent *Radio Times*; and envied them their wonderful array of aerials hanging from the 100ft masts.

To obtain the best signal/noise ratio, an amplifier system has been devised in the "lead-in" before the signal is passed via an underground feeder system to the main building. Thus the best possible electrically quiet signal is provided for the monitors to follow.

For resolving very weak signals which would ordinarily be lost in the background mush, Beveridge aerials 900 to 3,000ft long, placed at a height of 10ft from the ground, are used. If, like a number of correspondents, you have to manage with a mere twenty feet of wire, drooping from a bent and knobbly pole at the far end of the cabbage patch, you may well wonder what you are missing. Now the better weather is here, why not get cracking with a coil of aerial wire and see?

A Popular Favourite.

The point which captured my attention more than the aerials, was the receivers. There are literally stacks of H.R.O's—my old favourite!

I think I have tried them all at some time or the other, and as much as I admire the AR88's and 77's and what have you, none has ever delighted me more than the H.R.O. My own special super-de-luxe receiver in which I have put so many hours patient labour, even with its limited frequency coverage compares well with the H.R.O. except in one respect—amazing sensitivity COMBINED with a remarkable low noise level.

It is easy to get a bit more gain but it is of no use to you unless you can keep the noise down. That, and that alone is the reason for my enthusiasm for the H.R.O. and it has plenty of other admirers, some of whom seem to think that there are only two sorts of communication receivers—H.R.O's and others!

Keeping up Appearances.

Many communication receivers with their impressive appearance, sleek modern lines, magnificent scales with detailed calibration and hair line tuning, make the H.R.O. look positively dowdy, and I have often wondered why their designers have not given this point more attention.

Perhaps it is a matter of taste, but with its coil-box capacitor assembly, and ganged line-up, it should lend itself well to a geared fly-wheel control with a vernier scale to be read in conjunction with the main tuning and a compensator to adjust for individual coil-boxes. A heavy fly-wheel would enable spinning from one point of the band to another, and offers easy control in slow rotation for serious band searching.

The idea of interchangeable coil-boxes (both bandspread and general coverage) is still the best thing ever in receiver design, and why other manufacturers have not developed the idea is, to me, one of the major mysteries of that class in the industry. I wonder, too, if a British manufacturer tried to produce such a model whether the purchase tax would be charged only on the coil boxes covering the broadcast bands! Yet I shudder to think how long it would take to wring such a concession, or even a ruling from a Government Dept. For export only the production would probably be uneconomic.

Manufactured coil-boxes for home winding would appear to have some appeal, but the market is at low ebb just at present. The chief private user of this type of set rarely builds his own nowadays. The price of the ex-W.D. models is too attractive, and after the time spent on other construction and operating he has little opportunity for building receivers of more elaborate design.

Snappy Ending.

I recently wrote of the feeling of satisfaction one gets from using a switch that makes and breaks with a realy smart snap action.

A correspondent now asks if it isn't about time somebody got down to designing one that switches off with a snap that could be heard in the studio.

Idea passed to our old friend Ambrose Fandermere, and others. For urgent attention please!

Query Corner

A "Radio Constructor" service for readers

C.R.T. Electrons.

"*I have been puzzled for some time now by the manner in which the electrons which constitute the electron beam of a cathode ray tube return to the cathode of the tube. Presumably these electrons do not remain on the screen of the tube, as they would in a short time build up quite an appreciable negative charge.*"

D. Vernon, Manchester.

During the early years of the development of the cathode ray tube, there was much discussion as to the manner in which the electrons, after striking the screen, found their way back to the cathode. Most scientists believed that they returned along the walls of the tube, but it has since been shown that there is no voltage drop between the screen and the electrode assembly such as would be occasioned by the returning electrons. The true explanation is that electrons striking the screen result in the emission of secondary electrons from the screen which are attracted to the final anode. By this means, the screen is prevented from acquiring a high negative potential due to its collecting an excess of electrons.

Shifting Image.

"*I have recently constructed an oscilloscope, and find that the results are satisfactory apart from one minor defect. Upon turning up the brightness I find that the whole image moves on the screen, and the shift controls have then to be adjusted in order to re-centre the trace. Does this phenomena indicate a faulty tube?*"

F. Wills, Warwick.

This effect is invariably apparent when the DC voltage used for shifting the trace on the tube screen is obtained from tapping points on the main EHT resistance network. With this arrangement, the final anode of the CRT is fed from the junction point of two equal value resistors, and the shift voltage is that which appears across these two resistors.

By this means the shift potential can be made

"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.

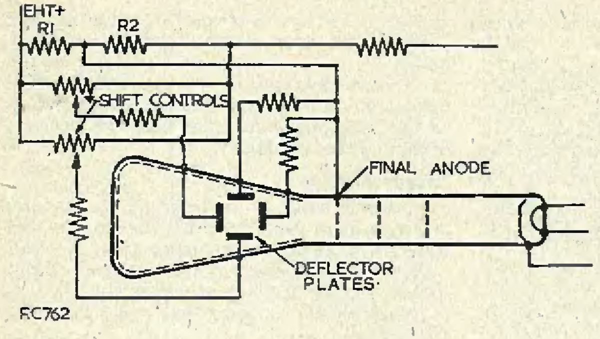


Fig. 1. The shift circuit, in which the controls form part of the main EHT resistive network.

adjustable by an amount which is either positive or negative with respect to the final anode; and therefore if this voltage is applied to one of a pair of deflector plates, the other plate being joined to the final anode, the spot or trace on the tube screen can be shifted to either side of the screen centre. The Inexpensive Television receiver employs such a shift arrangement, and the relevant part of this circuit is reproduced in Fig. 1.

Now it will be seen that the final anode current of the tube flows through R1 and thus changes in this current such as result from changes in the image brightness alter the voltage which is produced across this resistor. Because R1 forms part of the shift network, any change in the voltage across it results in a change in the position of the image. The effect under consideration is inherent in this type of shift circuit, but it can be minimised by arranging that the current which passes through R1 and R2 and then through the remaining resistors which form the EHT dividing network, is as high as possible compared with the final anode current of the tube. In fact, when using an EHT rectifier which is capable of passing 3mA it is desirable that the sum of these two currents should equal the 3mA. A milliameter connected in the EHT negative lead will indicate the total load current, and enable the permissible increase in current to be determined. In order to obtain this increase whilst at the same time retaining the normal tube electrode potentials, it is necessary that all the resistors which are series connected to form the EHT divider network are reduced in value by the same percentage. For example, if it is found that the EHT current may be increased from 2.5 to 3mA, an increase of 20% each of the dividing resistors should be decreased in value by this amount.

Finally, when constructing an oscilloscope it is normal practice to use an earthed positive EHT supply, which means that the potential of the final tube anode with respect to the chassis is probably in the region of 150 volts. The shift voltage may then be obtained from the HT source which is used to supply the time bases and amplifier, and under these conditions the resistors used in the shift network may be of relatively low value, as an additional drain of 5mA or more on the HT supply is easily accommodated. The general arrangement is shown in the circuit diagram Fig. 2.

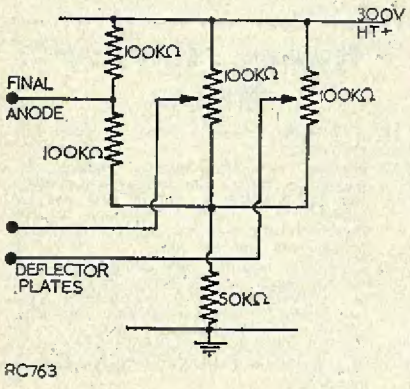


Fig. 2. A method of obtaining the shift control voltages from the HT line. This method is only applicable when an earthed—positive EHT supply is employed.

TV Aerial Connection.

"*My television receiver consists of sound and vision amplifiers which are entirely separate units. Each of these units is intended to be fed straight from the aerial, but I am not certain whether it is permissible to directly connect two receivers across the same 80 ohm co-axial aerial feeder.* *A. Scott, Dorking.*

The connection of the two separate receivers directly across the aerial feeder would considerably reduce the impedance into which the feeder is working. This might easily result in certain defects appearing in the received picture and to overcome this trouble the sound receiver should be supplied from the feeder via a low value resistor as shown in Fig. 3(a). The general arrangement is for the feeder to enter the vision channel as close to the first tuned circuit as is possible; the resistor is located at the input socket, and is joined to a further length of co-axial cable which is taken to the receiving chassis. A similiar arrangement may be employed to enable two television receivers to be operated from the same aerial, but in this case a slightly more complex arrangement is necessary to ensure that the signal voltage is equally divided between the two receivers. See Fig. 3(b). The loss in signal with this system is quite small and in the majority of cases may be ignored. For fringe reception, however, where every microvolt is important, a matching transformer must be employed in place of the resistive network indicated in the diagram. The three resistors which comprise the matching unit are of equal value, and may conveniently each consist of two 47 ohms components in parallel. The matching unit should be enclosed in an earthed metal box, and may be located at a suitable point between the two televisors which it is feeding.

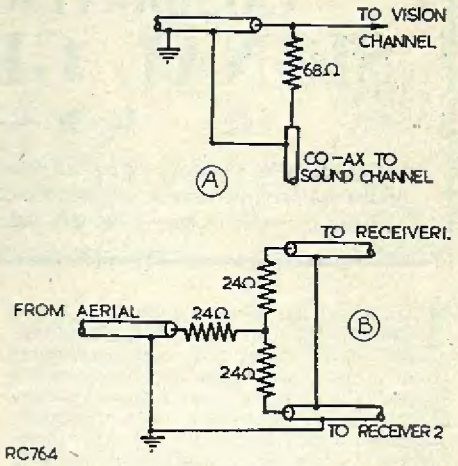


Fig. 3.

TELEVISION PICTURE FAULTS—*(continued from page 341)*

Very high voltages appear in some parts of the time bases, when operating. They may be far in excess of the DC HT voltages applied, and insulation becomes very important, particularly when one's person becomes involved! It should also be pointed out that misleading voltage readings may be obtained at some points; for example, it is almost impossible to measure the DC anode voltage of the line output valve owing to the presence of a sawtooth voltage with peaks rising to 2.5 kV.

Linearity adjustment is usually provided in the case of line time bases, and occasionally in frame time base circuits. Line correction circuits usually consist of a capacitor and variable resistor in series, connected across the secondary of the line output transformer. The components have a fairly low impedance to the line frequency and, as a considerable amount of current flows, the resistors need to be robust and capable of withstanding this current without excessive temperature rise. Variation of line linearity or picture width may be due to a low wattage component in this part of the circuit. It should be borne in mind that the line amplitude control may affect the linearity to some extent, and should always be adjusted in conjunction with the line linearity control.

Frame linearity control is obtained in a wide variety of ways, probably the most common being by means of negative feedback. Little general information can be given here of how to correct linearity, owing to the wide variety of methods in use, and reference should be made to the original design.

Fold-over effects are quite common when initially testing time base circuits, and occur when some non-linear part of the valve characteristic is invaded. It is a good point to check the bias conditions of the valve in question when this occurs, as it may be due to grid current flowing or the valve running into cut-off at some part of the cycle. It must also be remembered that if the valve has an inductive load (a transformer or choke in its anode circuit) the actual anode voltage at some instant may be far above or below that of the HT supply to the valve, and this makes it difficult to obtain a clear idea of what is causing the fold-over. Examination with an oscilloscope can be very helpful if the problem is difficult to solve.

Non-linearity on the right hand side of the picture is not usually affected by the line linearity control. The values of resistors and capacitors connected between the anode of the oscillator valve and earth, and the grid of the output valve and earth, should be checked to see if incorrect values have been used. An output transformer with low primary inductance or shorting turns may also be responsible.

CALIBRATING YOUR OWN
SIGNAL GENERATOR

By W. G. MORLEY

In this article W. G. Morley gives full details of how the signal generator may be calibrated against broadcasting stations, the only extra item of equipment needed being an ordinary domestic receiver. He also deals briefly with the avoidance of harmonics.

THE writer has received quite a few letters from constructors concerning the calibration of the home-built signal generator, including some notes from one or two readers who state that they are in no position to borrow an additional commercial, or previously-calibrated, signal generator; and who therefore find it very difficult to obtain the necessary frequency checks.

Now, although calibration without the use of another model may prove somewhat more difficult, it is still quite simple if a little care is taken. The best method of carrying out the calibration, in this case, is to connect the signal generator to a receiver, (as shown in Fig. 1 (a)), and beat the output of the generator with commercial stations whose frequency is known. It will be necessary to use an all-wave receiver to obtain sufficient frequency coverage, and the usual domestic model should do quite well for this. The coupling between the signal generator output and the receiver aerial connector should, at first, be very loose indeed. In many cases it will be sufficient simply to position the "hot" output lead close to the aerial lead as shown in Fig. 1 (b). Although no direct connection is made and only an inch or two of wire projects from the screened lead coming from the signal generator, there should still be sufficient pick-up (even with the signal generator fully attenuated) to cause audible whistles to be heard beating against the carriers of the stations received. The loose coupling is used in order to reduce the risk of working on harmonics from the signal generator. This point will be dealt with more fully later on in the article.

The next thing to do is to roughly calculate the frequency ranges covered by the various coils used in the signal generator. If commercial coils have been used, then it should be quite safe to assume that the top and bottom frequencies of each range can be calculated to an accuracy of, at worst, $\pm$ 10%. These approximate limits may be worked out by calculating the resonant frequencies of the coils when paralleled by a minimum capacitance of, say, 50 *pF* and a maximum of 500 *pF*.* (The inductance of the various coils can be obtained from the manufacturer's literature.)

When home-wound coils are used, things may become a little more difficult, since it is customary to find their inductance empirically. Nevertheless, if only rough results are required, a value for their inductance may be calculated from formulae. A formula for solenoid-wound coils was given on Page 153 of the January issue. For pile-wound coils an approximate figure may be obtained from the following:—

$$L = \frac{a^2 n^2}{5(3a + 9b + 10c)},$$

where L = inductance in μH
a = average diameter of coil in inches
b = length of winding in inches
c = depth of coil in inches
and n = number of turns

The dimensions referred to are shown in Fig. 2†

Using one or other of these formulae it should be possible to calculate the coverage of the various signal generator ranges to a accuracy of better than $\pm$ 25% when home-wound coils are used.

Knowledge of the approximate ranges covered is of importance when calibrating the signal generator, as it greatly assists in ensuring that readings which are obviously absurd (and these may quite possibly be found!) can be ignored.

A scale should now be fitted to the tuning capacitor of the signal generator to enable references of its degree of rotation to be obtained. A temporary paper scale and pointer, the former calibrated accurately in degrees from zero to 180° will do excellently here. (See page 359—Ed.) Assuming that the pointer is attached to the tuning capacitor spindle, a right-angled cross is marked on the paper at the point where the spindle protrudes through the paper. Fig. 3 shows how, when

* $f = \frac{10^6}{2\pi\sqrt{LC}}$, where f = resonant frequency in kcs.
L = inductance in μH
C = capacitance in *pF*
and π = 3.1416

† An article describing the construction of home wound coils is in preparation—Ed.

the calibration is complete, the various positions for each range may be marked by drawing lines from the centre to the degree calibrations; the final scale is then traced from the temporary one.

When all the above points have been carried out, everything is ready for the actual calibration. By beating the signal generator with stations received on the long, medium and short wave-bands of the receiver, it will be possible to obtain calibration points between approximately 2,000 and 1,000, 500 to 200, and 60 to 15 metres. (The writer assumes that the constructor is tied down to the restricted range of the average domestic receiver.) In terms of frequency this gives us ranges of 150 to 300 kcs, 600 to 1,500 kcs, and 5 to 20 Mcs. Before proceeding further, the generator must now be provisionally calibrated against the frequencies found within these ranges; if necessary, graphs should be used to obtain sufficiently "spread-out" results.

Now, our signal generator will have a frequency coverage altogether of, at most, 100 kcs to 40 Mcs. Therefore, using the frequency coverage of the domestic receiver, this leaves us with the ranges 100 to 150 kcs, 300 to 600 kcs, 1.5 to 5 Mcs, and 20 to 30 Mcs, uncalibrated.

Using Harmonics.

To cover the gaps in the ranges it is necessary to use the harmonics present in the output of the signal generator. The processes are quite simple, but a certain amount of care will be needed if good results are to be obtained.

It is best to start with the easiest part first; the gap between 100 and 150 kcs. (It is realised that not all signal generators will "go down" to 100 kcs; nevertheless, the system used here is illustrative of those described later and is therefore worthy of consideration). To enable the necessary harmonics to be received, the coupling between the signal generator and the receiver should be considerably increased. If necessary, a direct connection may be used.

The signal generator is then modulated and set to give a signal (fundamental) whose frequency we know from the previous calibration to be 280 kcs. The receiver (on the long-wave band) is then tuned-in to the signal generator. Leaving the receiver alone, we then tune the signal generator just below the 150 kcs reading previously found, until we once more hear the modulating tone in the receiver. This time the signal will probably be much weaker. The new position of the signal generator is then almost certainly that corresponding to 140 kcs, and we may safely assume that we are now receiving the second harmonic.

We then keep the receiver and the signal generator (which may remain modulated) in step with each other, as we tune down to 200 kcs on the receiver and 100 kcs on the signal

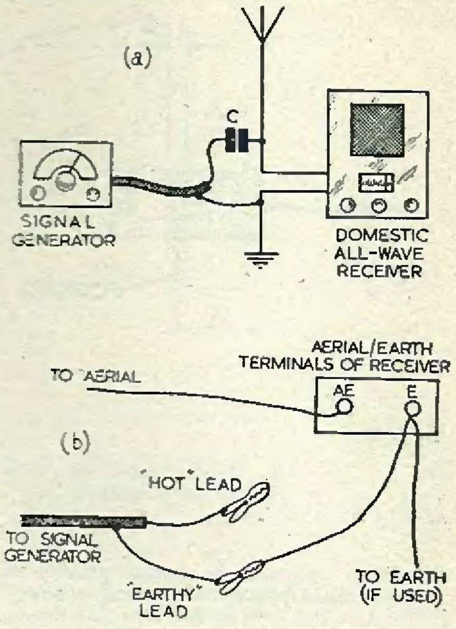


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Fig. 1 (a) How the signal generator being calibrated is connected to the receiver. The coupling capacitor C should have as low a value as possible.

Fig. 1 (b) Sufficient pickup from the signal generator will often be possible by simply positioning the output lead from the generator close to the aerial lead as shown here.

generator. During this time we will have been able to get more calibrations from stations received on the long-wave band of the receiver; and, by halving their frequencies we will have been able to get further calibration points.

Utilising harmonics in this way, it is possible to calibrate the signal generator over nearly all the gaps left in the ranges offered by the receiver. However, from the above, it will also be seen that two very important points need consideration when carrying this out. First of all, as previously mentioned, it is desirable to know the approximate range of the coil in use, so that manifestly absurd readings caused by using incorrect harmonics may be ignored. Secondly, it is necessary not only to get the *right* harmonic and be able to *definitely identify it*, but also to "hang onto it" once it has been found. Little difficulty will be experienced on frequencies below 150 kcs; but, when the short waves are used for calibration, the receiver and signal generator tuning must both be varied only by very small amounts whilst the harmonic is moved along

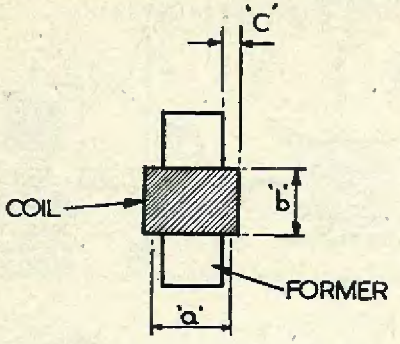

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Fig. 2. Illustrating the dimensions of a pile-wound coil referred to in the formula for inductance given in the text.

the scale. Otherwise it is quite possible to start with one harmonic and end with another !

The next gap—600 to 300 kcs—can also be tackled quite easily. The constructor may start either by identifying the second harmonic of a *known* 300 kcs signal by receiving it at 600 kcs and working upwards in frequency, or by receiving a known 600 kcs second harmonic at 1,200 kcs and working downwards. As there may possibly be a change in signal generator ranges between 300 and 600 kcs, it might be advisable to use both courses and check the results against each other.

The next gap to bridge is the large one between 1.5 and 5 Mcs. This may necessitate the calibration of one, or more, signal generator ranges almost entirely by their harmonics, and care must be taken in the original identification of the required harmonic, and in ensuring that only the chosen harmonic is used until calibration is complete. It may even prove necessary to guess that the correct harmonic has been found, relying on the fact that it appears more or less at the point at which it should. This will cause no trouble in the end, because only low order harmonics are used and, when the chosen harmonic has been checked at all the different positions of the signal generator tuning capacitor, should it be incorrect it will give results greatly at variance with the approximate wave ranges of the signal generator which we already know.

It is inadvisable to use harmonics higher than the second and third when covering this gap. Although the third harmonic of 1.5 Mcs is only 4.5 kcs and not 5 Mcs—the lowest short wave frequency offered by our domestic receiver—the small gap resulting will not be of much importance.

Using Receiver Oscillator Harmonics.

All that now remains to be done is to calibrate the section from 20 to 40 Mcs. As it is obviously impossible to use signal generator harmonics to do this, the best method consists of utilising the second harmonic of the frequency changer oscillator in the receiver (assuming the latter to be a superhet, as it almost certainly will be.) Only four or five checks should be needed, and the process is not so drastic as it may at first appear.

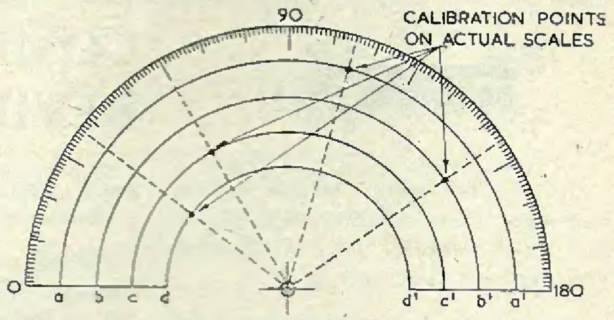
The signal generator, after having been calibrated up to 20 Mcs, should have its output disconnected from the aerial terminal of the receiver. The output should then be loosely coupled to the signal-grid of the frequency changer. As the signal-grid of this valve is nearly always the top cap connection or as, failing this, a connection to the fixed vanes of that gang of the tuning capacitor which supplies the signal-grid, may be found above the chassis, this process should not incur any violent upheaval in the receiver. For coupling, a capacitor formed by two insulated wires twisted together should be quite adequate.

Let us assume that the IF of the receiver is 450 kcs. The receiver is then tuned to a station whose frequency, let us say for ease of reckoning, is 10 Mcs. The oscillator in the receiver will then be oscillating at 10.450 Mcs, and its second harmonic will be 20.9 Mcs. The receiver should then respond to frequencies from the signal generator of 20.9 minus 0.450 Mcs and 20.9 plus 0.450 Mcs; *i.e.* 19.450 and 21.350 Mcs. These will beat with the signal being received, but to enable the harmonic to be kept in step as the frequencies above are explored it will be necessary to modulate the signal generator.

If, using this method, the modulation of the signal generator cannot be heard, the coupling to the signal-grid can be tightened until it is. Unfortunately, this process will reduce both the sensitivity and the second channel rejection of the receiver, and not only may it be difficult to pick up the required station but it may also be possible to obtain incorrect readings.

An alternative process consists of marking or making a note of the position of the receiver dial at various points where known commercial stations are found. The signal-grid connection in the receiver is then broken and the signal generator connected straight between signal-grid and chassis. If the receiver is set to one of these points, enabling an *identified* receiver oscillator second harmonic to be found, the receiver and signal generator may then be tuned in step, calibrating the generator at every point on the receiver dial where the known station was previously received. It must be remembered that, using this method, no beat notes will be heard. However, as the coupling is very tight the signal generator

Fig. 3. After calibration, the actual ranges may be marked out by laying out each range on semi-circular lines concentric with the original 0-180° reference scale. aa' to dd' represent the additional scales. Lines drawn from the centre to the degree calibration previously found then cut the range scales at points corresponding to the frequencies for which degree readings were formerly obtained.



RC760

modulation should be audible; the sound of the modulation then enabling it to be "tuned-in" in the same manner as a broadcast station.

It may have been noticed that, for all the methods described above, only actual stations are used for calibration purposes. This is due to the fact that, although the dial calibration of the receiver may prove helpful in obtaining original rough readings, it cannot be relied upon. The tuning scales of some domestic receivers, especially on the short waves, will often be found to have inaccuracies as high as ± 10% or worse !

Making the Final Calibration.

When all the various readings have been taken they may then be correlated by drawing graphs. About seven or eight "spot" frequencies on each range should be sufficient for accurate results. The frequencies should of course, be plotted against the degree of rotation of the tuning capacitor.

Owing to the fact that the capacitance of the tuning capacitor does not always vary regularly with the degree of rotation over the first four degrees or so at the minimum capacitance end, it is inadvisable to extend the graph at this end further than, say, the first six degrees. In addition, frequency checks should not be taken beyond this six degree position as they are liable to upset the results of the readings taken elsewhere. The loss of this small part of the scale should not cause much reduction in the various frequency ranges; and, in any case, for many of the ranges, the few degrees of rotation that do not appear on the graph may be calibrated afterwards against that part of the next range which "overlaps," if a suitable receiver is available.

When the graphs for each range have been completed, the scale may be made up as shown in Fig. 3 above. Some constructors may desire to use their signal generator calibrated in degrees only, relying upon their graphs to obtain the actual frequencies. This is quite in order, of course; but the convenience of having a directly calibrated scale soon makes up for the time spent in originally marking it out.

Harmonics.

The writer has also received queries concerning the avoidance of working with incorrect harmonics when the signal generator is calibrated against a commercial model. (See Page 242, April issue.)

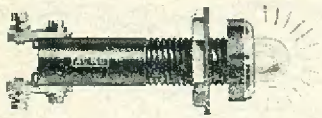
In this case, the main sources of possible error lie in the fact that both the home-made and the commercial signal generator will give rise to harmonics. If the commercial generator is a good, well-designed model its harmonics will very probably be weaker than those given by the home-constructed job.

There are several ways of eliminating the risk of working on harmonics. First of all, the constructor should obtain a rough idea of the coverage of the various ranges offered by his signal generator, as was mentioned above. He will then be able to reject any inaccurate readings.

A second and additional method of guarding against using harmonics is to reduce the output of both signal generators until the sound given by their beating together is only just audible. The harmonics, being weaker than the fundamentals, will then almost certainly be inaudible. Should it prove impossible to sufficiently attenuate the generators, their coupling to the detecting device may also be reduced.

Editorial Note.

(Of course, from the constructor's point of view, the great snag about this method is to know the exact frequency of the stations used for calibrating. Also, there may be some difficulty in identifying these stations. All this can be easily solved, by using a copy of the "World Radio Handbook." The latest edition which can be obtained from us at 6s. 9d. post-paid, covers long, medium and short wave stations, and includes the latest frequencies of such stations as are on new channels because of the change in wavelengths through the Copenhagen plan. Useful information regarding the latest changes of short wave frequencies is given every month in our companion journal, "Short Wave News."—Editor)



COMPONENT REVIEW

The illustration shows a versatile indicator lamp which is being manufactured by *The Acru Tool Manufacturing Co. Ltd.*, of 123, Hyde Road, Ardwick, Manchester 12.

This indicator uses a miniature neon lamp, and these are available to work on mains voltages from 50 to 400. This means that the indicator can be used on any mains equipment, whereas the ordinary pilot lamp needs a low voltage supply which is not always easily obtainable. The current consumption is below 1 mA, which is negligible for all practical purposes.

Yet another advantage is that neon lamps are far more reliable than the ordinary pilot lamp. An indicator is no use unless it is working—and the neon has an average life of 25,000 hours. The unit is small, physically, and all that is necessary for fixing is a single ½″ diameter hole.

The indicator is supplied in various styles. There are three shapes of dome, giving 100, 120, or 180 degrees angle of visibility. The domes are of transparent plastic, and may be red, amber, yellow or clear. The ring holding the dome can be in bright chromium, bright brass varnished, or black bakelite. One model has a machined perspex dome which requires no locking ring. Yet another has no dome, but is fitted with a disc showing numerals, letters of the alphabet, or an arrow. The latter may be set at any position wanted.

An illustrated leaflet giving full details, dimensions and prices of complete indicators and spares, is available from the manufacturers.

SURPLUS RADIO EQUIPMENT

described by B. Carter

In this series of articles it is intended to describe units that have (a) immediate application, after some modification perhaps, in the amateur world, and (b) to list the contents of those units that can best become sources of valuable components. This month's unit comes under category "B."

Junction Box Type 246 (10AB/6497)

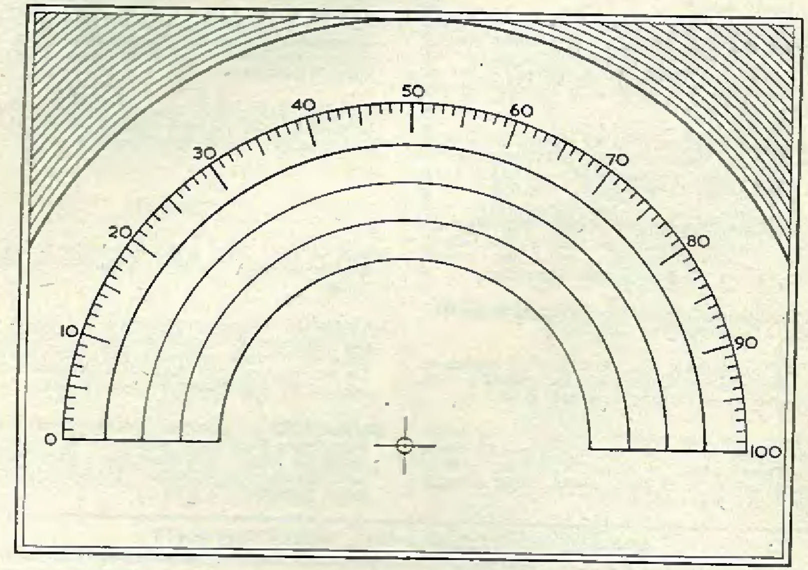
If you use "W" type plugs and sockets on your equipment, this small unit will provide you with some clean plugs—the majority of these units are unused—and a relay, besides the box which could be rewired to suit your own needs. The box is fitted with feet so that it could be screwed down, and the lid from which all the "works" are suspended is fastened to the box by two captive screws and pillar nuts.

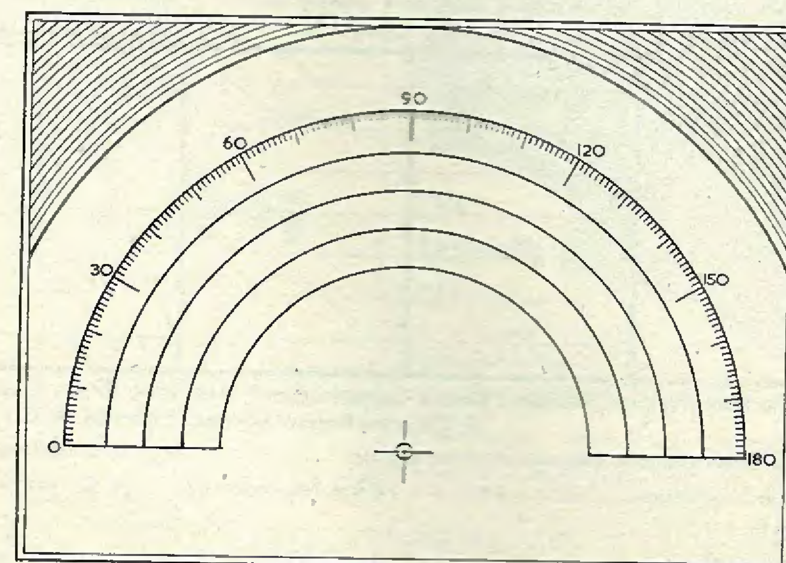
List of Contents.

Two "W" type 202 Plugs 12 pins	10H/395
Two "W" type ? Plugs, 6 pins	10H/393
One "W" type 204 Plug, 2 pins (thick)	10H/397
One "W" type 198 Plug, 4 pins	10H/391
One Relay 1,000 ohms N 41191 BB	10FB/651
One Switch contact, Single pole change over	N 65828
One Switch contact, Single pole On/Off	N 65835
One casing, 6 inches by 6⅝ inches, 2 inches deep, enamelled in dark blue-grey.	

RC PANEL SHEET No. 1

(See Editorial)





RC761

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PRIVATE

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DX STATION for sale, Hambander as new, with 28mcs converter and pre-selector (EF39-EF39) with power pack. £16 or offer. Carriage paid.—P Todd, 3 Yard Row, Philadelphia, Co. Durham.

SIG-GEN ex-RAF 100Kc/s - 20Mc/s with crys-cal. Perfect. Calibration charts and spare valves. Complete £6. Conrad AC rim-drive motor 30/-. Sheefi P.U. £2.—Bower, 20, Star Lane, St. Mary Cray.

ELECTRICAL radio television surplus bargain list free. Jackson, 3, Terminus Place, Eastbourne.

R107 No conversions log available for inspection. First offer over £8 secures.—G3516, I.S.W.L., 43, Strattondale Street, Millwall, London, E.14.

CANADIAN Marconi receiver No. 52. 13 valve, variable selectivity, crystal check, range 1.75-16m/cs 230 volt power pack, 6v6 output, 8" speaker. £10/10 or nearest offer.—D. B. Wilson, 102, Tibland Road, Acocks Green, Birmingham 27.

Amateur wishes to dispose of various CRT's, EHT transformers, 1355's, etc., etc., suitable for Inexpensive Television. Also complete Time Base and Network for VCR97. Clearing cheap as space is required. Also Atkinson coil Pack, RF-mixer-oscillator, 5-2,000 metres, with circuit, £4.—A. Torrance, 13, Bryanston Mews West, London, W.1.

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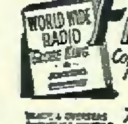

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