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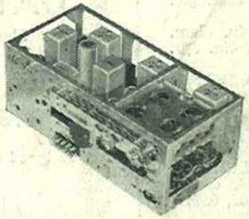

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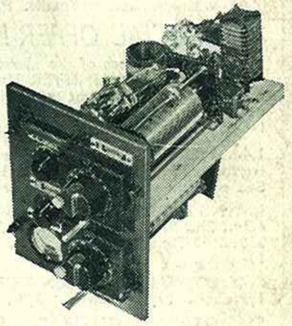

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RADIO CONSTRUCTOR

1/3

Vol. 3 No. 3
OCTOBER 1949

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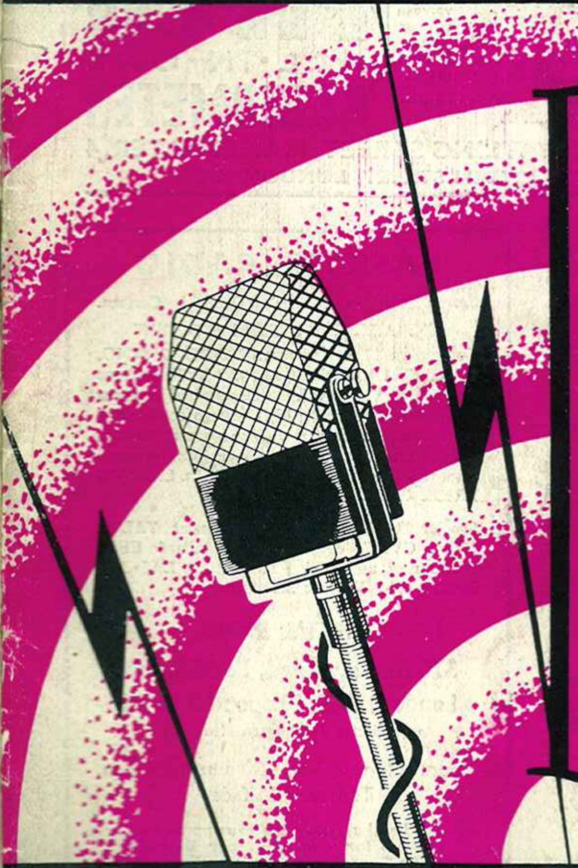

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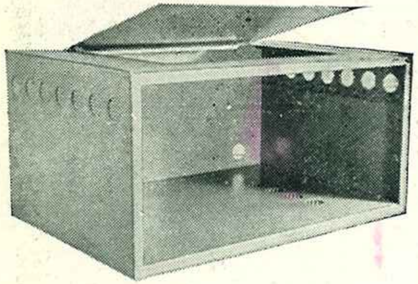

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Radio Constructor

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Edited by: C. W. C. OVERLAND, G2ATV LIONEL E. HOWES, G3AYA

EDITORIAL

RADIOLYMPIA, and the forthcoming Amateur Radio Exhibition, herald the opening of yet another constructional season. We know, of course, that much work is carried on throughout the whole of the year, but there is no doubt that activity falls during the summer months. At this time, then, we think it is opportune to put forward a plea for greater attention to the mechanical as well as the electrical side of construction.

Far too many of the examples which we have seen—and we do see quite a number—have been quite sound electrically, yet the performance has not been up to standard. In many cases the fault has been on the mechanical side.

A rigidly built piece of equipment will always be better than a fragile version—indeed, in the case of VHF gear rigidity is essential, particularly around tuning circuits. Take a signal generator, for instance. This is a piece of equipment which will be used as a reference standard, and doubtless much time and effort will be expended on calibration, with a view to obtaining the greatest accuracy. Why nullify all this effort by using a tinny chassis? Or coils mounted in the wiring? Or a cheap drive which has plenty of backlash and never gives the same dial reading twice?

Then take trimmers. These are used in RF stages, as everyone knows, in order to balance or level up the effect of the stray capacitances in those stages. This is all very well as long as those strays remain constant, but it would be cheaper to leave out the trimmers altogether, if the wiring is going to be carried out in such a fashion that connections can wander all over the place so that the stray capacitance is constantly changing.

There are all sorts of mechanical snags which can arise. It is a wise plan, then, before starting the actual constructional work, to devote a little time to considering procedure, and to make notes thereon with particular reference to such snags. Half-an-hour or so spent thus will be well repaid.

G2ATV.

NOTICES

THE EDITORS invite 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 re-draw 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.

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The latest report from J. Jorum, Esq., describing the results of the Radio-Sonde experiments

Myrtle Cottage,
Hogwash-Major.
October, 1949

Dear Sir,

After the unfortunate *dénouement* of the Radio Sonde episode we resolved to make very certain that this time our experiments would be confined entirely to our headquarters. It was therefore decided to completely screen our workroom before the very powerful oscillator used in the RF heater was tried out. This screening operation was carried out by our Treasurer, Lieut. Jonathan Needy (ex-R.N.), who, under the crazily admiring eyes of our Female Member, Miss Lavinia Twittering, proceeded to cover the outside of the building with a conglomeration of chicken wire, corrugated iron and intermeshed barbed wire all bonded together and earthed to the mains earthing wire.

All the Members came outside to watch the final piece of screening being put into place and even the Treasurer himself, pleased with the result of his labours, modified his language as the last hammer blow accidentally splintered his thumb nail.

The earthing lead was then connected. Unfortunately our Treasurer had made a slight mistake and, as our President went to open the door he received a violent shock. Indeed, it was found impossible for anyone to get inside, and the Society was left in the somewhat humiliating position of being unable to enter its own Headquarters, despite the fact that the doors and windows were unlocked. It was only after a valiant and painful charge on the door by our Treasurer that we were at last enabled to enter.

Our Heating Apparatus was then tested and proved to be an unqualified success. Half-way through our operations our electronic timer broke down, but our ex-Naval member immediately rose to the occasion, producing an enormous gold watch which, he stated, had been in the Needy family for four generations. The Society was just about to adjourn after a very successful afternoon, when our Treasurer, again in the best of good moods, made a sudden proposition. This was to the effect that we should have an Electronic Dinner, everything being cooked by means of our Heater. He himself could provide a whole chicken, and with the help of our Female Member, it should be possible to produce an excellent repast.

This idea was immediately taken up with the greatest of enthusiasm and the meeting broke up for the Members to ransack their private pantries, for Miss Twittering to obtain the crockery and cutlery, and for Lieut. Needy to don his old battle-dress preparatory to obtaining the chicken (a somewhat mysterious process).

Our Headquarters presented a very pleasant, domestic scene that evening. Our Treasurer, still in his battle-dress, now somewhat muddied, was surrounded by a sea of feathers. Miss Twittering happily frisked around seeing to the table. Finally everything was prepared and the last plate was laid. Our *pièce de résistance*, the newly-plucked chicken, was reverently placed in the Heater.

With his face screwed up in concentration as he gazed at his watch, our Treasurer finally announced that the chicken was cooked. On removing the bird from the Heater it was found that its colour was now a beautiful golden-brown. It was then placed on the table and the Treasurer, beaming with delight, proceeded to carve.

However, as soon as his knife pierced the outside of the chicken, a most peculiar smell assailed our nostrils ; it being so vile that the Members were forced to retire. The Treasurer, his smile now replaced by a frown, stated his complete inability to understand the result as he'd wrung the damned thing's neck only a few hours before. The Junior Section, Master William Westinghouse, volunteered a solution stating that, as the heating effect started in the middle of the chicken, and that as, in our eagerness, we had forgotten to clean it, and that as the bird had apparently been in a good state of health . . .

Further explanations were stopped in deference to our Female Member and the Society returned indoors after having discharged the chicken through a window. The Electronic Dinner was hardly a success without the main dish but nevertheless it proved fairly diverting and even our Treasurer had recovered his spirits until he suddenly discovered that he had mislaid his watch.

It was eventually found to have been left near the Heater, and outside examination showed that no damage had occurred. On opening the case, however, it was found to have suffered something of the same fate as that undergone by our chicken and that the works had become a solid molten mass. . . .

Apart from all this, however, the results of the experiments were extremely encouraging and all members are looking forward to the outcome of our next investigation, an enquiry into the behaviour of Rontgen rays, details of which will be available next month.

Until then, and with the best of good wishes,

I remain,
Yours sincerely,
J. Jorum, Esq., Hon. Sec. S.D.E.R. (H-M).

MAGNETIC PICK-UPS

By R.E.H.

IF you are inclined towards audio amplifiers and gram reproduction the following, it is hoped, will be of some use to you in your experiments. To many the few points here will not be new but the author hopes they will be a guide to the less well informed.

The basic pick-up available is the Moving Iron type, which is cheap in comparison to the many more specialised types, it also has the advantage of being very robust, and therefore this type will be discussed in detail.

First of all consider the manner in which the pick-up works. Fig. 1 shows the pick-up head broken down into its component parts. In Fig. 2 we show a view of an enlarged cross section of the working parts. It can be seen that the pole pieces are split into a top and bottom section between which rests the coil.

Assume now that the needle point is resting in a record groove, the record revolving at the normal rate. As the record turns the needle point moves from left to right following the groove variations.

At one instant in time the needle point may be over to the right, as shown in Fig. 2. The whole of the needle-moving-iron portion being pivoted at T, the top end of the moving iron, or more correctly the armature, moves over to the left. Thus the top end of the armature has come in close proximity with the top section of the split pole piece. If the pole piece is as shown, a north pole, the armature will assume south polarity. Lines of magnetic flux will now thread through the armature down to the bottom right section of the split pole piece (which is a south pole).

At another instant in time the needle point will be moved across to the left, as in Fig.3, and the upper part of the armature will be in close proximity with the opposite pole piece, which is of south polarity. This will give the upper part of the armature a north polarity, and lines of magnetic flux will thread the armature from the bottom left pole piece to the top right. This will be in reverse to the previous direction of magnetic flux lines through the armature when the needle point was over to the right.

These two actions taking place very rapidly, in sympathy with the variations in the groove of the record, cause a voltage to be set up in the coil which surrounds the armature, due to it being in the rapidly changing magnetic field. The magnitude and frequency of these voltages will depend upon the variations of the groove cut in the record.

The Moving Iron Pick-up can be obtained in high or low impedance forms (*i.e.*, many windings on the pick-up coil—high impedance, and the reverse for low impedance). The low impedance type will of course need a local step-up transformer before it can be fed into the grid circuit of a standard amplifier.

Despite many published claims for various pick-ups the author has found little to compare with this type, when all-round performance, price, etc. is considered. The bass response depends upon the freedom of movement of the armature, which as can be seen from the diagram is damped at the top by a rubber pad and at its axis by mere clamping in rubber tubing. The high frequency response or "top," depends upon the stiffness and lightness of the moving parts.

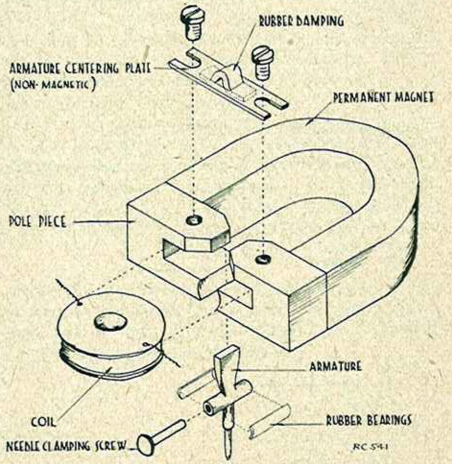


Fig. 1.

Exploded view of typical magnetic pick-up assembly.

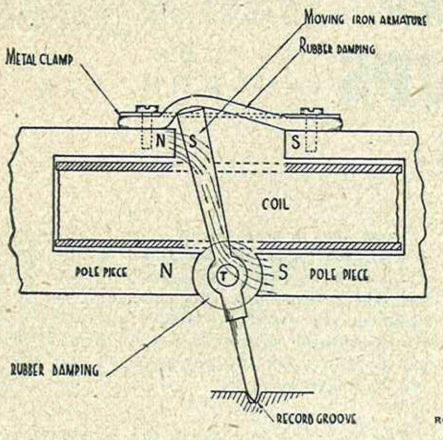


Fig. 2.

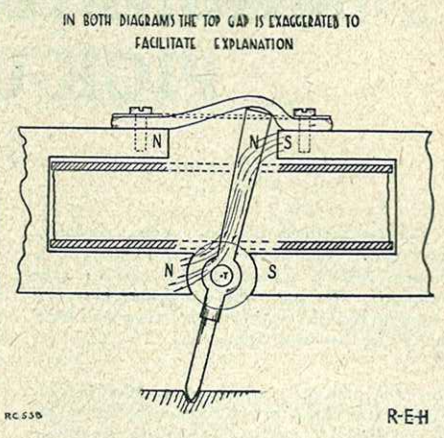


Fig. 3.

Diagrams showing path of magnetic flux.

The main faults to be encountered are :—

(*a*) Armature touching one of the pole pieces—usually due to misplaced top damping rubber.

(*b*) Rubber pivot bearings rotted, causing armature rattle—bicycle valve rubber does admirably here.

(*c*) Distortion, due to the fact that armature is not centrally placed between pole pieces. A lesser condition of (*a*).

(*d*) Weak reproduction, is often due to the gap between the pole pieces being too large—this can occur over a period of time where vibration has loosened fixing bolts and pole pieces are allowed to shift their position.

(*e*) Distortion, can often happen due to small particles of dirt or metal filings becoming wedged between the pole pieces. In the case of dirt, a camel hair paint brush will clear it. In the case of metal the author has found some plastic material such as plasticine will induce the particles to stick to it, making their removal easy.

Not quite a fault, but if the rubber pad at the top of the armature is too stiff then this will

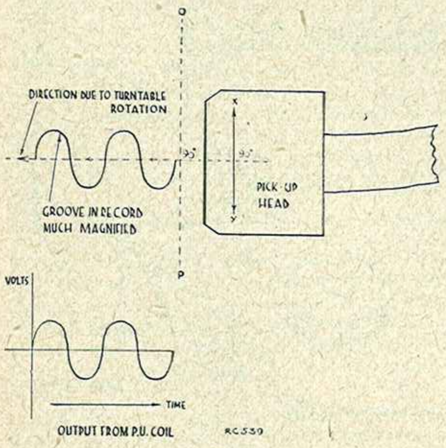


Fig. 4.

Showing correct output waveform

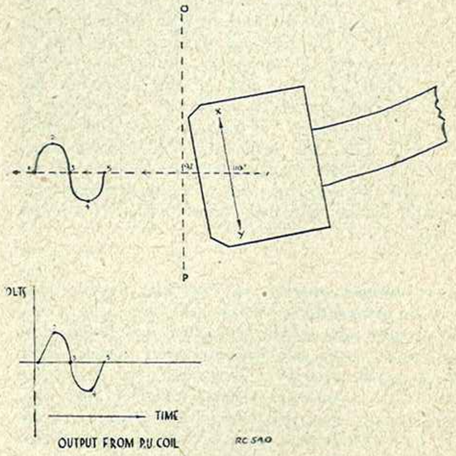


Fig. 5.

Showing distorted output waveform.

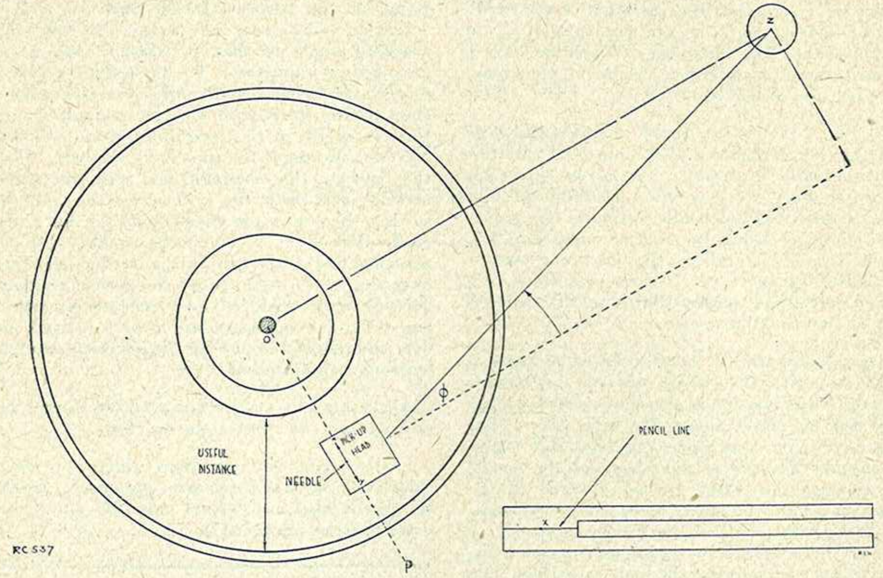


Fig. 6.

Diagram showing arrangement for correct tracking of pick-up head, and template (see text).

increase the wear upon the record besides restricting bass response as already stated.

It is possible for the keen amateur to make one of these types of pick-ups for himself. Several suitable small powerful magnets are obtainable. A few good files and some soft iron and the pole pieces can soon be fashioned. Probably the most difficult task is the needle holder and armature. This I think rests with the individual and his own abilities, and tools available. With a watchmaker's lathe the task is easy but not many of us are that fortunate. It is possible to do without a screw for clamping the needle, merely relying on a good tight fit in the hole provided. It must be stressed that a loose needle will cause horrible distortion.

The coil is relatively easy and any insulated copper wire of about 40 swg or upwards wound on a bobbin will do the trick.

However, as in most things, it is very hard to lay rules about turns, etc., and most of the fun will come from pure experiment. You will find that the secret of good reproduction lies in the armature and the damping.

The author has made one of these pick-ups with fair success and is still pressing on with new ideas. His own pick-up is supported on a $\frac{3}{8}''$ copper tube, suitably curved (see tracking) and counterbalanced at the end with a copper cylinder filled with lead.

It is suggested that if you do go in for counterbalancing do not fall into the trap of making your PU head " effectively " as light as a feather. This may be good for record wear considerations but on real hefty " Flying Dutchman " music, the head is likely to leap out of its groove through sheer vibration and go tearing its way across the record. As will be seen, a lot depends on the *actual* weight of the PU head since this will have an appreciable momentum if a lateral vibration of sufficient magnitude is reached. With this type of head, especially if home made, it is not likely to be very light, so counterbalance just enough.

Some people use springs as their counterbalance but the author finds these need constant adjustment due to temperature changes and gradual loss of temper (not the author's).

Tracking

This is very important where you are setting up your own playing desk, since you may cause, unwittingly, distortion that will have you hunting around the amplifier or pick-up for ever.

We have seen that the vibration of the needle is from left to right, in our explanation of the action of the PU. This axis of vibration, as it is termed, should be lateral to the line of the groove in which the needle rests.

In Fig. 4 the groove in the record is shown as varying in accordance with a sinusoidal variation of some audio frequency. The arrow shows the direction due to the rotation of the turntable. The PU head has the needle resting in this groove and vibrating along its axis of vibration XY, which is also lateral to the groove direction, *i.e.*, at 90 degrees to it. If these conditions exist then the voltage output from the PU coil will also be sinusoidal as shown.

Now assume the PU head to be at an angle as in Fig. 5, then the needle will not be moving laterally with respect to the groove and will be only able to move along the axis XY. Thus taking the Fig. 5, of one cycle with XY representing the PU axis of vibration, as the needle moves along the groove portion covered by the figures 2-3-4 it will have freedom of movement, but along the parts of the groove marked 1-2 and 4-5 there will be restriction and record wear. The voltage waveform will look something like the diagram (Fig. 5), which will amount to distortion in the output from the PU coil.

It is therefore necessary to so place the PU head in respect to the turntable that over a large part of the playing time the axis of vibration is more or less along the line lateral to the groove. This line is in fact any radius line from the centre of the turntable.

The diagram (Fig. 6) shows a turntable with a PU head arranged correctly. To set up one for yourself, arrange the PU head at the mid-point of the useful distance with its axis of vibration lying along any radius line OP. The tracking angle is then Ø when O and Z are arranged as indicated. To check the tracking of any playing desk cut out a piece of stiff card, as shown (the slot should be wide enough to take the centre pin of the turntable), draw a line on the card and mark the spot X on the line. Place the card on the turntable and with the needle resting on X draw the card across the turntable so that the centre pin slides down the slot in the card. The A of V should be in line with the pencilled line on the card (being in effect a radius), over the whole useful range for perfect tracking. This is never achieved and usually two points, one either side of centre, are in perfect track and over the rest of the playing distance approximate tracking is maintained.

All this points to the fact that the longer the pick-up arm the better the tracking.

Lastly a note on recordings which may be of interest. On many records, impressed around the paper label are makers' numbers and signs; some of these are given in Fig. 7.

Fig. 7.

Record makers, numbers and signs, with interpretations.

"RADIO CONSTRUCTOR" QUIZ

Conducted by W. Groome

(1) Our stooge, Mr. Brain, suspected that a hum which modulated the carrier of certain stations was getting in through his mains transformer, which had no primary screen. He attempted to cure it by connecting a small capacitor from each mains lead to earth. Would this be likely to eliminate the hum?

(2) What is a "see-saw" phase-splitter?

(3) What is the main disadvantage of the directly heated type of power rectifier?

(4) In some AF circuits the heater of a high-gain valve is connected via a network to a point of positive voltage. Why?

(5) If lack of space compelled you to mount the mains transformer near to the output transformer, which arrangement would you choose for minimum hum—cores parallel, cores at a right-angle, or cores in line?

(6) Why cannot a pentode or tetrode be used as such with cathode loading?

(7) What is valve microphony?

(Answers on page 83)

LOGICAL FAULT FINDING

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

By J. R. DAVIES

6: DISTORTION (Contd.)

1. Distortion caused by the Loudspeaker (*Contd.*)

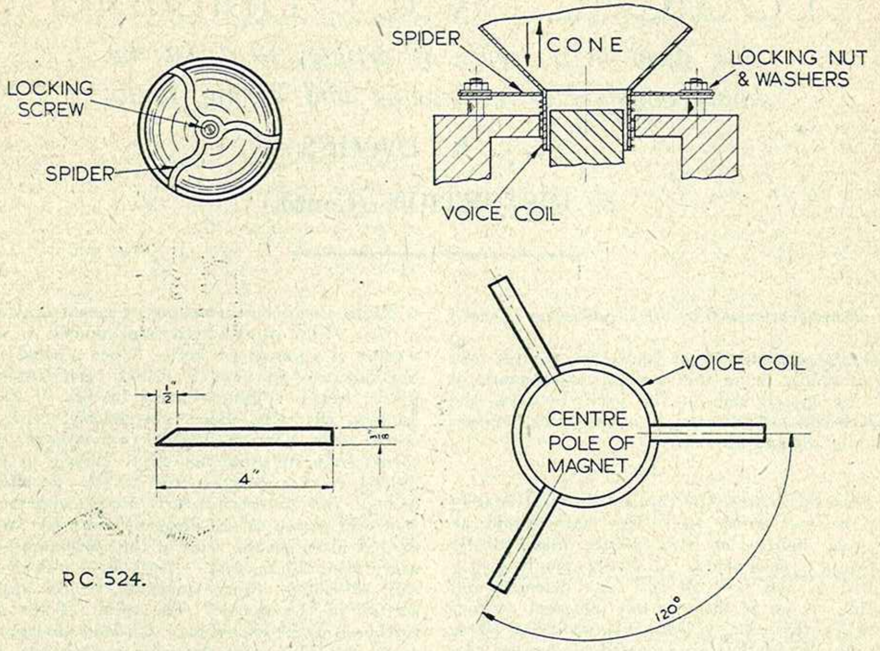
If the cone is not at fault, the trouble will probably lie in the centring adjustment, in the speech coil, in the joint between the speech coil and the cone, or in the joints between the pigtails and the cone.

The centring may be checked fairly accurately by the eye or by feel. The cone should be grasped lightly at two points diametrically opposite to each other. It should then be gently pulled in and out, all the time listening and feeling to see if there is any physical contact between the coil and the magnet poles. This process should then be repeated at another two points at right angles to the first two. If the cone appears to be off-centre, it will need to be re-centred. Fig 28 (*a*) and (*b*) show the two most often met methods of holding the centring spider. To centre the speaker, the screws or nuts holding the spider should be loosened and the position of the cone re-adjusted by hand. If the speaker has a wide magnet gap, the eye will give a reasonably good indication of the position of the speech coil. If the speaker has a small gap, however, it is best to use spacers. For this purpose, three strips of paper should be cut as shown in Fig. 28 (*c*). These should then be inserted between the voice coil and the centre pole of the magnet; the tapered ends being inserted first so as to allow easy entry of the rest of each strip. When the strips are in position, the spider should be tightened. The strips should then be removed, each strip being almost entirely free. If one strip feels tighter than the others the centring should be carried out again until all strips are held with the same degree of tightness. Sometimes, the last turn applied to the spider locking screws has the effect of slightly altering the position of the spider, and this effect must be allowed for during adjustment. (Commercial centring jigs were available for the serviceman before the war, but, in common with many other things, these appear to be unobtainable nowadays.) Incidentally, a loudspeaker should never be centred whilst it is playing. Although this may often afford a quick method of adjustment, the chances of damaging the coil windings far outweigh the saving in time.

Whilst we are on the subject of speaker spiders, a fault which occurs with some models is well worthy of a paragraph here. When a speaker is beginning to age, and if it has been handling pretty heavy volumes during its life, it often happens that the spider (particularly if this is of the type shown in Fig. 28 (*a*)), becomes distorted from its usual flat shape (shown in Fig. 29 (*a*)), to that shown in Fig. 29 (*b*). Peculiarly enough, this distortion nearly always appears in the form shown in the diagram and very rarely in that in which the arms of the spider are bent away from the magnet. (Heat from a field coil can, of course, cause shrinking on the inside surface of the spider.) The result of the distortion in shape is obvious. On loud passages of music the cone joint descends further into the magnet gap than it was designed to do, heavy percussion causing it to smite lustily at the metal and, incidentally, do itself a lot of damage in the process. Although a speaker like this may be considered practically beyond repair, a few more years of life may be obtained if the centre of the spider is brought out a little by the fitting of a spacing washer as shown in Fig. 29 (*c*). The washer should be carefully chosen to ensure that it raises the spider by the correct amount.

Some loudspeakers use neither screws nor nuts to hold the spider in place, the whole suspension assembly being rivetted or welded to the frame. Particularly is this true of small American loudspeakers. Fortunately these speakers very rarely go out of adjustment, so there is usually no necessity to worry about re-centring.

The presence of dirt, etc., in the magnet gap may sometimes cause distortion. In this case it is necessary to remove the coil and diaphragm from the magnet, the gap of which is then cleaned out. Small metal filings which cling to the magnetized surface of the gap are hard to remove; the best method of removing these is to introduce a piece of black insulating tape into the gap, whereupon the filings will stick to its surface. It is very inadvisable to strip the magnet assembly for cleaning purposes, as it is difficult to re-position the centre pole correctly without proper tools.



Figs. 28a and b (top). Two commonly met types of loudspeaker spider.
Fig. 28c (bottom left). Approximate dimensions of spacing strips used for re-centring a loudspeaker.
Fig. 28d (bottom right). Method of inserting spacing strips.

Bad joints between the voice coil and the diaphragm, between the pigtails and the cone, and loose turns on the voice coil are the remaining major causes of distorted output. Bad joints may be cleared by the application of a little adhesive, always giving the job plenty of time to set firmly before re-assembling and trying out the speaker. Loose turns on the voice coil can be fixed by several applications of really dilute shellac varnish, allowing plenty of time for setting between applications.

If an energised speaker is used, it may be found that, after a passage of time, the heat from the field coil has been sufficient to slightly char the voice coil former, causing it to lose its shape and become brittle. There is little that can be done to cure this. There are, however, some firms who undertake speech coil rewinds, and the speaker may be sent to them. Alternatively, it can be returned to the manufacturers, assuming that they undertake repairs on the particular model at fault.

2. Distortion Caused by a Valve Operating under Incorrect Conditions

If it has been found that the speaker is not at fault, or if it is considered by the nature of the distortion that the fault lies elsewhere, then it is very possible that one or more of the amplifying valves, by reason of their operating under incorrect conditions, is introducing the trouble. We are dealing now with receivers which are capable of giving good reproduction but have recently become faulty. For the time being, we shall not consider home-constructed receivers that are not yet in full working order.

Distortion caused by a trouble of the above nature, *i.e.*, incorrect conditions, is usually reasonably easy to recognise. Practically every frequency reproduced is distorted and the trouble occurs at all volume levels, save, perhaps, when volume is set almost to minimum. Sometimes there is a sort of " choking " effect, a loud noise causing the set to become quiter for a second or two before the output returns to its normal level. This latter symptom usually indicates trouble in one of the grid circuits (most probably, an open-circuit grid leak).

Fig. 30 gives a typical circuit of the AF section of a battery superhet. It shows a triode followed by a pentode output valve, resistance-capacitance coupling being used between the two stages. The voltages that require checking are those at

the anodes of the two valves, at their grids, and at their filaments. Also, the screen-grid voltage of the output valve my need checking.

Following the procedure of checking each component in order of its unreliability, the first thing to suspect is the 0.01μF capacitor C1. If this were to develop a leak or short-circuit, then the grid of the pentode would be biassed more positively than the original design allowed,

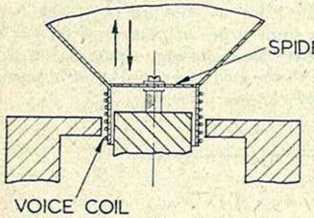


Fig. 29a.

Side view of spider shown in Fig. 28a.

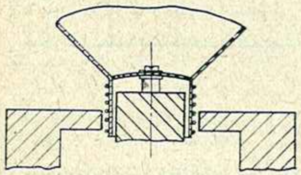


Fig. 29b.

How spider may become distorted in shape after heavy use (see text).

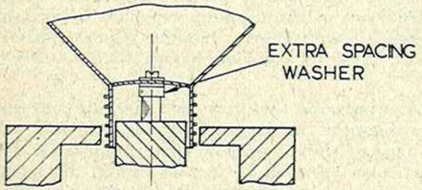


Fig. 29c.

Method of effecting a temporary repair to the distorted spider.

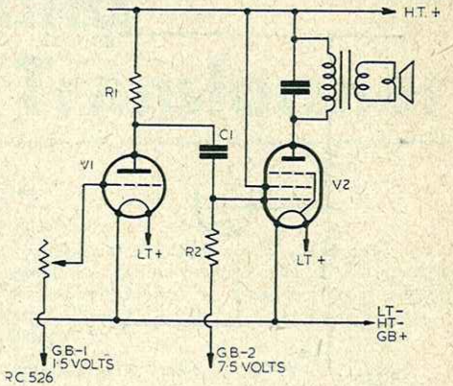


Fig. 30.

Typical circuit of AF section of a battery superhet ; Component values ; R1—100k Ω, R2—500k Ω, C1—0.01μF.

thereby introducing distortion. Before proceeding any further it will be of interest to digress a little and to see how what may be considered a very small leak in the coupling capacitor may cause a suprisingly large change in the grid bias voltage of the output valve.

Let us assume that the HT voltage in the receiver is 120 volts, and that the coupling capacitor has developed a leak of 10M Ω. We may then re-draw the diagram to give the equivalent circuit shown in Fig. 31, in which capacitor C1 is replaced by R3, a 10M Ω resistor. It will be seen that we now have a voltage potentiometer between HT positive (120 volts positive with respect to earth), and GB negative ($7\frac{1}{2}$ volts negative to earth). The total resistance offered by R1, R2 and R3 is 100K Ω+500K Ω+10M Ω which equals 10,600K Ω. As the voltage across the whole potentiometer is $127\frac{1}{2}$ volts (HT..GB voltages), then the voltage developed across R2 is equal to

$$\frac{500}{10,600} \times 127\tfrac{1}{2} \text{ volts} = 6 \text{ volts, approx.}$$

Therefore, although we are applying $7\frac{1}{2}$ volts grid bias to the bottom end of the grid leak R2, the voltage actually applied to the grid of the valve is $7\frac{1}{2}$—6, which means that the valve is biassed by only $1\frac{1}{2}$ volts! If the coupling capacitor developed a leak of lower resistance than 10M Ω the grid bias applied to the output valve would soon reach a positive value, causing grid current to flow with possible damage to the grid structure in the valve itself.

Unfortunately, unless the leak in the capacitor happens to be of a comparatively low ohmic resistance, it is difficult for the average constructor to check this point using the instruments he has at hand. The best method of testing the capacitor is to see if there is any positive voltage at its " grid end " by means of a sensitive voltmeter whose negative prod is connected to chassis.

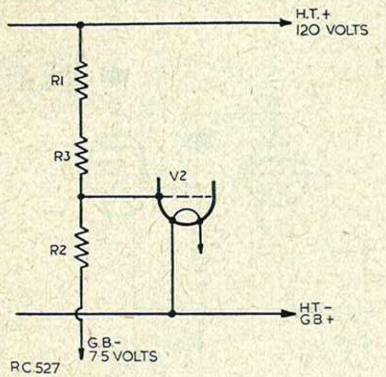


Fig. 31.

Equivalent diagram showing how a leak in capacitor C1 in Fig. 30 may cause incorrect bias to be applied to the grid of the following valve. Values; R1—100k Ω, R2—500k Ω, R3—10M Ω.

With the battery circuit shown in Fig. 30, it is first necessary to remove the grid-bias voltage. With the mains circuit of Fig. 32, the grid leak may be left in circuit as it is, in any case, connected to earth. In both cases, the output valves should be removed from their sockets as the electron path between cathode and grid inside the valve will effectively reduce any positive voltage found at the grid. Should the voltmeter needle, when connected, show the slightest indication that a positive voltage exists at the grid, then the capacitor may be assumed faulty and should be replaced. (It should be remembered that no accurate reading of voltage is obtainable here as the comparatively low resistance of the meter will considerably reduce the value of positive voltage applied to the grid.) An alternative check, and one which is particularly useful in the case of AC/DC receivers in which it is impossible to remove a valve without breaking the heater chain, is to connect the meter across the cathode resistor and see if there is any change in reading when the grid of the valve is short-circuited to earth. The circuit shown by the broken lines in Fig. 32 illustrates this idea. If the biassing arrangements of the stage under consideration happen to be somewhat more complicated than those shown in Figs. 30 and 32 (*e.g.*, the bias circuit used in some types of phase-splitter), it is best to unsolder the coupling capacitor at the end connected to the grid and simply test between its free end and chassis. See Fig. 33.

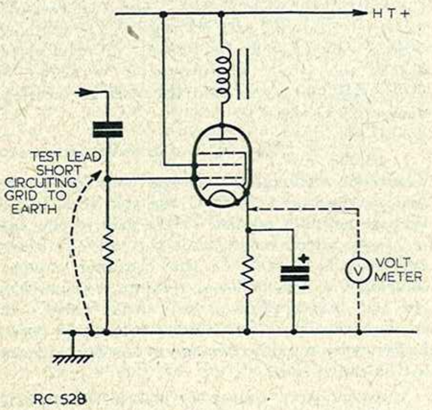


Fig. 32.

Input circuit of mains pentode. The broken lines indicate an alternative method of checking for breakdown of the coupling capacitor. When the grid is short-circuited to chassis, there should be no alteration in the voltmeter reading.

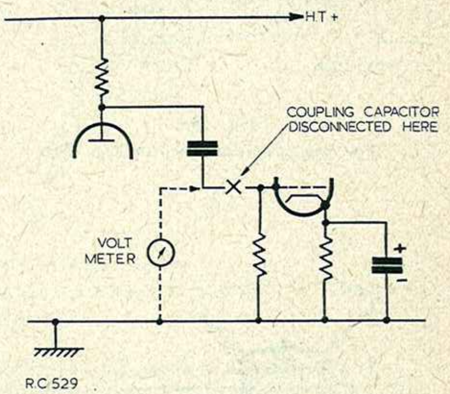


Fig. 33.

In difficult cases, the coupling capacitor may be entirely disconnected from the grid of the valve and checked as shown.

Should the coupling capacitor prove to be fully serviceable then we must look elsewhere for the cause of distortion. The anode, screen-grid and cathode resistors should all be checked, as should the cathode by-pass capacitor. The valves themselves should be tested, and replaced, if necessary. If one of the valves has been working for some time with a positive grid (due to the breakdown of the coupling capacitor mentioned above), it will almost certainly require replacement, since its emission has probably suffered.

Another point that may need checking concerns the filament or heater supplies. Should the voltage of these be below that specified for the particular valve under consideration, distortion often creeps in. And finally, in the case of a battery receiver, the grid bias battery should be tested for correct voltage.

——To be continued——

How to Rebuild A Mains Transformer

By H. Dudley Stilton

I think I ought to have my brains tested.

Have you ever studied basic radio? I'm just going to!

A chap came into the shop the other day and asked for me.

"I've just built a radio set," he explained, "and everything works O.K., but the transformer gets red-hot, can you help me at all?"

Well, when someone asks you decently like that, what else can you do but oblige?

"Certainly," I said, "bring it along, we'll soon have you fixed up."

He brought it and I got it on the bench for test and told him to come back for it next day.

You know there is one thing, I *am* an optimist.

I roughed through the HT circuit for shorts and found none. Skimped through the LT circuit and found none. Ploughed right through the set—and found nothing.

There's a catch here somewhere, I thought—but could I find it?—I could not.

Only one thing left to do. Try it out.

It was a very good set. . . . Now don't get me wrong, it still *is*, I hope.

After about five minutes running, I felt the transformer to see if it was getting warm.—You know that chap was really telling the truth!—I let out one yell. Scared all the customers out of the shop, and really gave vent to my feelings. I hopped about with my hand under my arm, I stuck it in the sink, I howled and raved but, boy! It was at least ten minutes before I dare ook at my hand. I've still got the serial number branded right across my palm and by the look of it, that's one number I shall not forget in a hurry.

I whipped it out of the chassis (the transformer I mean, not my hand), and replaced it with a new one. The set worked a treat. As I hadn't a thermometer handy, I tried my mother's trick of wetting the finger, and weighing the steam. It was as cold as ice. After an hour's running it was barely warm. The fault, therefore was in the transformer. (Brilliant deduction).

I checked all the leads for bad insulation and found everything in order. Put a meter in series with the primary lead and switched on. That nearly cost me a new meter.

Instead of reading two or three mA, as it should do (no load remember) it was reading nearly one Amp. No wonder it was getting hot! This, I thought, is a re-wind without a doubt.

Even then I nearly missed it.

I stripped the laminations out. Checked the voltage of the rectifier fil, and then counted the turns on the rectifier winding. Fifteen, that then is three turns per volt. Next off came the filament winding. That was O.K. Then the HT winding. A bit burned, but not bad considering. Then the screen, which was just a copper strip folded round the primary, with the two ends soldered together to secure it.

Then came the —— Holy smoke!!!! A copper strip WITH THE TWO ENDS SOLDERED TOGETHER. No wonder that baby got hot, that was equal to a dead short and would try to pass heaven knows how many Amps.

After that I decided the best thing to do was to work out how many turns were needed, instead of relying on my initial test, for by now I was quite prepared to believe that that was wrong.

As it was a PM speaker, I reckoned that an HT secondary rated at 250-0-250 would be satisfactory, with filament voltage of 6.3 and a rectifier voltage of 5.

The area of the core was 2.1 sq. ins. so the formula worked out at = .1332 x 2.1 x N. Where N equals number of turns required. Therefore 1 = .28N, and N = 1/.28 = 3.5 approx.

So the primary would be 250 x 3.5, or 875 turns, tapped at 770 turns for 220 volts and at 700 turns for 200 volts. The secondary would, in the same way, be 1,750 turns, tapped at the centre, and a filament winding of 22 turns, with a rectifier winding of 17.5 turns.

Incidentally, when winding the filament and rectifier windings, add another turn for losses incurred.

The set was ready for him next day and with an innocent expression on my face, I asked him where he got his transformer from.

"Oh, I wound it myself," he replied, "rather neat wasn't it?"

Yes, it was——very neat!

SOMETHING FOR THE XYL

BY W. GROOME

Before readers write in to tell us so, we admit that this article is a little out of the usual run. It is meant as an interesting diversion, and should prove useful as constructional practice for the beginner. It is electrical, even if it is not radio, and, besides, it will—or should—promote harmony in the workshop!

A FEATURE of many magazines nowadays is the kind of "agony column," wherein readers receive the advice of a kindly "aunt," "uncle," or "friend" in their "heart-throb" troubles. The introduction of a similar column in this publication would create radio history, and also play havoc with the circulation figures.

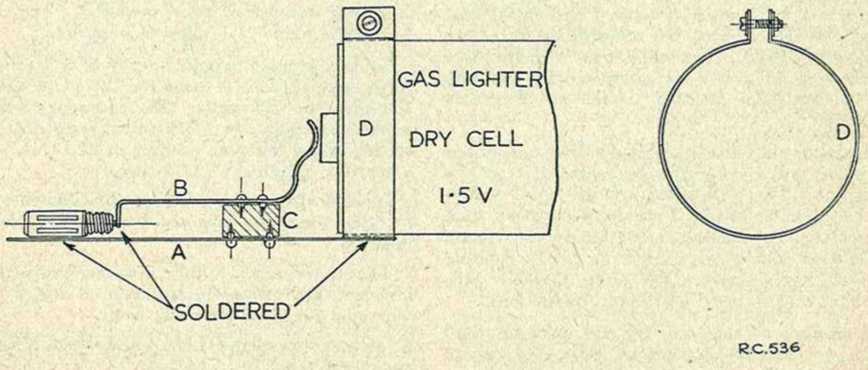
Yet there lurks in the life of almost every constructor an XYL or YL who, without knowing the difference between a volt and an amp, can have a most profound influence on the happy conduct of the hobby. Brother, do you realize that a dislike of your dots, dashes, whistles, and slush, your screws, wires, tools and litter can lead to desertion, divorce, or banishment for life.

It behoves us, therefore, to impress our XYL's that our interest in things electrical can be of benefit to her. Woo the girl with a useful gadget, and you win two or three weeks of freedom to do your best, or worst, to the radio.

If, like the writer, you have a patient and understanding wife, she deserves to see something useful emerge from the "shack." As our editors have indicated that many readers would welcome an occasional departure from ordinary radio articles the writer has "dreamed up" a few simple and cheap-to-make articles of real use in the house. "Dreamed up" is hardly correct, for the subject of the present article, an electric gas-lighter, has been in use since July 26th last year, and the battery has not begun to fail yet, in spite of daily use. The date was written on it the day it went into service, to check its life. Actually, if it were used as many as fifty times a day, that would probably amount to only one minute's active service per day, leaving nearly 24 hours for the large dry cell to exert its excellent recuperative powers. Hence the long life.

The gadget will cost about three shillings to make. Many readers will get the idea from the drawing without further explanation. "A" and "B" are made of brass strips $\frac{1}{4}''$ to $\frac{1}{2}''$ wide, of fairly stout gauge to ensure strength and springiness. They should be bent to the shapes shown (note that "A" is not perfectly straight) and each drilled to accommodate the screws which will secure them to the small wood or fibre block "C."

"D" is a circular clip made from brass strip, which will be clamped on the end of the dry cell, which the makers most obligingly leave bare. The sketches show how a screw, nut and two washers are used for tightening.



Constructional details of the battery gaslighter

Fasten strips "A" and "B" to block "C," using short wood screws to avoid their meeting in the block. No holder or socket is used for the element; it is less trouble to solder it in permanently, for it will last for ages without needing replacement. File it along its edge to remove the nickel plate and tin the exposed brass. Use a really hot iron, and get it done quickly to avoid melting the manufacturer's soft solder. Perform this operation on the opposite side to where the element wire is anchored.

After tinning, solder it to strip "A" with its end contact touching strip "B." The end contact is merely a blob of soft solder, so it can be easily united to the end of "B" with a hot iron. The other end of strip "A" must be firmly soldered to the clamp ring "D," as shown in the drawing.

Clamp the whole arrangement to the bare zinc portion at the top end of the cell. It may be necessary to bend the strips slightly so that the curved end of "B" is clear of the centre contact of the cell by 1/16th" to 1/8th".

To use the lighter, your XYL presses the business end on the gas-burner, causing "A" to bend slightly. "B," of course, goes with it until its curved end contacts the cell terminal and closes the circuits. The circuit opens automatically as the lighter is taken from the gas-burner, "A" springing to normal and carrying "B" away from the cell contact.

A final word. Warn the dear girl that your creation should always be stood upright, as laying it on its side may switch it on and ruin the battery.

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. The unit described below comes into the second category (b).

Modulator Type 189 (10DB/8054)

Some of these units are being offered in brand new condition and a glance at the contents list given below will show that the units are useful purchases. The case is a strong steel louvred box with a heavy gauge front panel spanned by a single bright metal handle, all enamelled light blue grey. The chassis is of plated steel with a shielding screen.

CONTENTS LIST

2 Valves, type VR91 (EF50), 10E/92.
1 Valve, type VR92 (EA50), 10E/105.
1 Potentiometer, insulated slotted stem, 25K Ω, 10W/16760; 2.5K Ω, 10W/16761; 500 Ω, 10W/16762.
2 Valveholders, ceramic B9G, with locks, 10H/18070.
1 Valveholder, polystyrene, EA50 type, 10H/.
1 Plug, 6 pins small shell (Breeze), 10H/392.
3 Plugs, coaxial (Pye), 10H/528.
2 Capacitors, electrolytic, 25μF, 25VDC, 10C/14302.
2 Capacitors, mica, 300μμF.
2 Capacitors, tubular, 0.001μF, 1kVDC, 10C/1120.
3 Capacitors, mica, 0.001μF, 10C/5549.
1 Capacitor, mica, 500μμF.
1 Capacitor, mica, 100μμF.
1 Capacitor, mica, 0.01μF.
1 Capacitor, tubular, 0.1μF, 350VDC, 10C/11126.
2 RF Chokes (VHF).
2 Iron Dust Cored Coils.
2 Square Standards to support a group-board.
2 Vertical Clamps to hold capacitors, Ref. 10C/14302.
3 Tie Points and 1 Group Board.
2 Resistors, 560 Ω, ½ watt, and 390 Ω, ½ watt.
1 Resistor, 6.8K Ω, ½ watt; 3.9K Ω, ½ watt; 2.2K Ω, ½ watt; 1.2K Ω, ½ watt; 22K Ω, 1 watt; 22K Ω, 2 watt; 470 Ω, ½ watt.

Query Corner

A " Radio Constructor " service for readers

Television Waveforms

"I have recently constructed an oscilloscope and now wish to use it for checking, and if possible improving, the performance of my television receiver. This class of work is new to me and consequently I am not familiar with the type of waveforms which should appear at the various stages of a televisor. Can you please help ?"
R. Smith, Guildford.

The oscilloscope is a very big asset when servicing television receivers as its use eliminates much of the trial and error work which might otherwise be necessary when endeavouring to locate a fault . The major faults which occur in television receivers may be classified under the following six headings.

(1) Power Supply Failure

The trouble is usually indicated by the complete lack of any signs of life in the receiver and is frequently caused by the failure of a smoothing capacitor. If a capacitor has to be replaced the rectifier valve will also be suspect as it will have been called upon to supply the breakdown current of the replaced capacitor. The EHT voltage may be checked by measuring the current in the earthy end of the EHT resistive network. Then knowing the value of the resistance in circuit the voltage may be calculated by Ohms Law. In connection with power supply operation the CRO is an asset for measuring ripple voltages and hence checking those components used for smoothing and decoupling.

" 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.

(2) No video signal

A failure of this type is indicated by the appearance of the raster on the tube screen but with no signal modulation. The component at fault may be quickly found by tracing the signal progressively through the vision channel with the aid of an oscilloscope or valve voltmeter. The stage at fault is at once indicated as the signal will disappear at one point in the circuit showing that either the valve or one of the components immediately prior to the point of disappearance is in need of replacement.

(3) Failure of a time base

This is at once indicated by the collapsing of the picture in either the vertical or horizontal direction resulting in the appearance of a straight line across the tube screen. The procedure for locating the trouble is once again to trace the time base signal from the oscillator through the amplifier and hence to the deflector coils, or plates, of the cathode ray tube.

(4) Difficulty in synchronising picture

This is a very common fault which appears all too frequently in home-built television receivers. The trouble is often characterised by the appearance of flyback line across the picture and the well-known vertical drift of the image. Its cause is invariably due to the synchronising pulses which are either of too small an amplitude or badly distorted. If the former is the case some improvement will be obtained by increasing the vision gain (contrast) of the receiver and reducing the brightness. More frequently however there is ample amplitude but the waveform of the pulses is unsatisfactory. It is essential that each pulse has a steep leading edge in order that the time base is triggered at exactly the same point in each cycle. It is also most important that the correct pulses, and only the pulses, are fed to the respective time bases. In other words the frame time base must not be triggered by means of indifferently shaped pulses, together with some unwanted mains hum. As this base operates at 50 cycles per second it sometimes happens that it tends to synchronise with the mains frequency. The shape of the sync. pulses is governed mainly by the time constants of the R-C network in

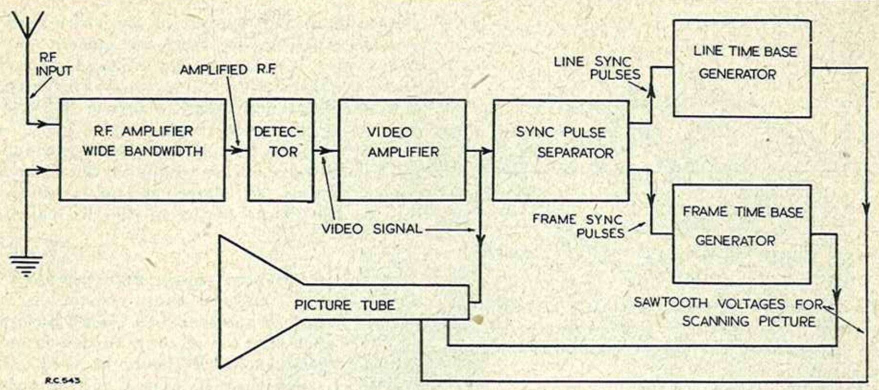


Fig. 1.

Block diagram of a television receiver showing the signal progressing through the various stages.

the sync. separator and it must be remembered that these time constants may be upset by the presence of stray capacitances due to long leads and unsatisfactory screening. Owing to the existence of a number of sync. separator circuits it is impossible to quote any preferred circuit values, but a little experimental work carried out whilst examining the shape of the pulses on the CRO should result in a cure.

Poor interlacing of the lines, sometimes accompanied by the appearance of ragged edges to the picture is the result of interaction between time bases or the presence of mains hum on either of the time base output voltages. The cure for both of these troubles may be found to lie in improving the HT decoupling.

It is often found necessary to employ individual decoupling circuits for each time base. Also in this connection it is worth while trying the effect of a metal screen placed between the two time bases as stray capacity coupling may be sufficiently great to upset the interlacing.

(5) Poor linearity

The linearity of the time bases is best checked with the aid of the test patterns radiated by the BBC before each transmission. In severe cases of non-linearity however, the picture appears to fold over on the right hand or bottom edge. This folding effect is the result of a time base waveform similar to that shown at B (Fig. 3) and an attempt must be made to correct the form to that indicated at A. If a magnetically deflected tube is used, a check should be made to ensure that there are no short circuited turns on either the deflector coils or their associated coupling transformers. This is most easily achieved by means of an ohm-meter and the makers' published resistance measurements for these components. Shorted turns are a not uncommon cause of poor linearity.

(6) Poor definition

Poor definition in spite of a well-focussed spot is almost certainly due to insufficient band width in the RF or video amplifier stages. This fault is sometimes accompanied by the additional symptoms of poor picture synchronisation due to the mutilation of the sync. pulses in the amplifier stages. The cure lies in the alignment of the RF and video stages in such a manner that they are capable of a band width of two to three Mcs. If a signal generator is available this is a quick and simple matter, but if not good results may be obtained by adjusting the tuning of the RF stages by trial and error whilst noting the effects on the BBC test card transmission when received on the screen. The best scheme is to first tune all circuits to resonate on the vision channel as indicated by maximum picture brightness and then to detune each circuit slightly so that alternate ones are adjusted on opposite sides of the vision channel. Final adjustment should be made in order to obtain the best possible definition.

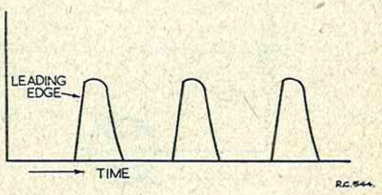


Fig. 2.

Sync pulses. The shape may vary according to the type of sync separator employed, but in all cases a steep leading edge is essential.

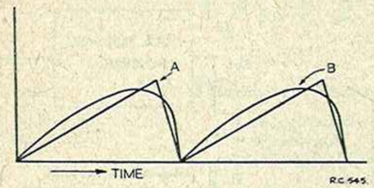


Fig. 3.

Showing linear (A) and distorted (B) time base waveforms.

The procedure is perhaps a little tedious but the results are invariably as good as could have been obtained by the use of a calibrated signal generator.

By-pass Capacitors

"When looking through some circuits of audio amplifiers I have noticed that occasionally the by-pass capacitor which is normally connected across the cathode bias resistor of a push-pull stage is omitted. Can you tell me why the use of this component appears to be optional?"
P. Walters, Leeds.

In push-pull audio output stages it is normal practice to employ a single cathode bias resistor in the cathode lead which is common to both valves as indicated in Fig. 4. When the two valves are operated on the centre of their characteristics, that is under Class A conditions, it is quite unnecessary to shunt the bias resistor with a high value capacitance. In fact the omission of a capacitor reduces the effects of slight differences in the characteristics of the two valves and hence improves the balance of the amplifier. The reason for this being that as the signal voltage causes the cathode current of one valve to increase it reduces that of the other valve by a corresponding amount, thus the current flowing in the bias resistor remains at a steady value and consequently so does the bias.

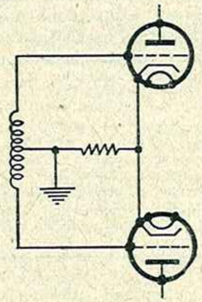


Fig. 4.

Showing use of a common bias resistor in a class A push-pull stage.

Now should the current of one valve tend to increase more rapidly than the current of the other valve is reducing, the voltage appearing across the bias resistor will increase. This increase in bias will not only tend to reduce the rate of increase of current in the first valve but it will also increase the rate of decrease of current in the second valve. This results in the balancing action referred to above and also tends to equalise the characteristics of the two valves.

So far it has been shown that the use of a non-by-passed cathode bias resistor is not detrimental to the operation of a Class A push-pull amplifier stage, but for all other modes of operation a by-pass capacitor should be used. This statement covers Class B. Class C or intermediate classes of operation where a state of unbalance is deliberately introduced into the stage in order to increase its power efficiency. The reason for this will be apparent when it is considered that in a Class B push-pull stage one valve passes current whilst the other is biassed to cut-off. Now the presence of a non-by-pass resistor in the cathode circuit of the conducting valve will reduce both its amplification and also that of the stage as a whole.

Intermediate Frequency

"I have a pair of IF transformers taken from an ex-W.D. No. 18 walkie-talkie set. What is the operating frequency of these transformers?"
H. Deacon, Watford.

The No. 18 set is a walkie-talkie which appears large when compared with more modern equipment, but which is nevertheless capable of providing excellent results. It employs valves from the standard 2-volt range and has an IF of 465 Kcs.

THE EDITORS INVITE . .

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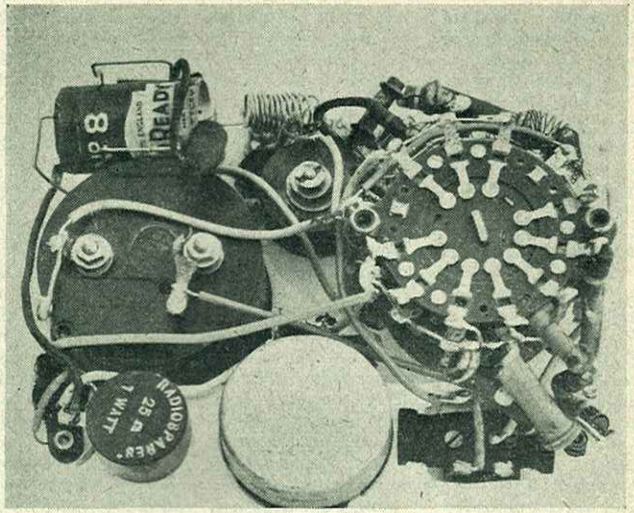
FOR THE AMATEUR



AN INEXPENSIVE MULTI-RANGE METER

By
H. W. J. GUMBRELL

EX-GOVERNMENT milliammeters are easily obtainable nowadays and it is a fairly simple matter to construct round one an efficient little multi-range meter which will have a thousand and one uses. All that is required is a three-bank Yaxley type switch, a two-way switch half-an-ounce or so of covered eureka wire, gauge 30 and, if AC measurements are required, a small full-wave metal rectifier, together with a few odd resistances etc., as may be found in any junk box. The writer used one of the ex-AM "5 milliamp" meters such as are advertised in these pages for about 10/-. These are robust little jobs and if the cover is taken off it will be noticed that an internal shunt is incorporated. If the shunt is removed, it will be found that the full-scale deflection is in the neighbourhood of 2.5 mA The scale reads from 0-5 mA.

The first stage in the construction of the meter is to find out the actual full-scale deflection of the movement without its shunt and also its resistance. This is best done with the aid of a 120 volt battery and a 100,000 ohm potentiometer. First make sure that the pot is set for maximum resistance and then wire it across the battery in series with the meter (the shunt being temporarily disconnected) as shown in Fig. 2. Now carefully adjust the resistance until a full scale deflection on the meter is obtained and then temporarily re-connect the shunt. This is of low enough resistance not to make an appreciable difference to the total resistance across the voltage supply, and the new reading obtained will be the current taken by the meter on full scale deflection without the shunt. Repeat the process three or four times and take an average of the results obtained, ignoring any which are very much different from the normal. To find the resistance of the movement, repeat the process outlined above, but replace the shunt by one of 10 ohms resistance. This can be made quite easily with 65.9 inches of eureka wire (30g). Calling the new reading "x" the resistance of the movement is $\frac{10.(5-x)}{x}$

We now have the basic figures required for calculating the other resistances in the circuit, which are obtained from the formulae given in the table. For those interested in the mathematics of Ohm's law, this article concludes with a note showing how the formulae were arrived at.

Having calculated the values of the resistances to be used, the next stage, obviously, is to provide oneself with such values. Resistances up to about 1 ohm are best made from copper wire. A table of wire gauges will give the length per ohm of a given gauge and careful measurement of an appropriate length will give an accurate shunt. Care must be taken not to stretch the wire when measuring or coiling it as the resistance is thereby increased. 18 gauge copper wire will take 5 amps for as long as is necessary to measure such a heavy current, and .00864 ohms (the value used by the writer) can be made from a coil $15\frac{1}{2}''$ long, the "length per ohm" being 53 yards. 30g wire will do for the .5 amp range, the rating being 5.03 yards per ohm. Resistances of 1 to 10 ohms can be made from 30g eureka wire. Larger resistances can be made up from ordinary composition components from the junk box. For the 500 volt range, a 5 watt resistance should be used but $\frac{1}{2}$ or $\frac{1}{4}$ W will serve in the other positions. It should be borne in mind that the resistance of a resistor which is nearly the correct value can be increased by filing a portion of it away, or decreased by putting a larger resistance in parallel with it. For instance a component having 10 times the resistance will drop the given resistance by 10% The best way of making sure your meter is accurate on voltage ranges (other than by winding your own resistances with measured lengths of fine gauge eureka wire) is to borrow a friend's meter putting it in parallel with yours across a suitable voltage and adjusting the resistance until both meters read the same. See Fig. 8. It will be noticed that no formula is given for the AC ranges. The writer found it easier to rely on hit-or-miss methods, as the resistance of the rectifier is not easy to determine and again the best plan is to make use of the friend's meter as a standard.

The theoretical circuit is given in Fig. 1 and one or two points might be mentioned in this connection. It will be noticed that the amps ranges are brought out to separate terminals. This is to avoid the dangers of relatively poor contacts on the switch, and avoids large currents flowing through those contacts. On the 5 amp range, where the shunt is less than one-hundredth of an ohm, what normally passed for a very good contact can play havoc with a reading, besides endangering the movement. The series winding of the shunts, avoids the use of switching for these ranges. Another point of interest is the "doubler switch" which is a simple two-way single pole switch. In its "up" or normal position a resistance R1, equal to the resistance of the movement, is shorted out, while in the "down" or "K = 2" position, R1 comes into circuit and R2 (equal to twice the resistance of the movement) is put across the meter and R1, *i.e.*, A to B. In this position, therefore, we have between A and B, two resistances, R1 plus the movement (=r) and R2 both equal to 2 r, in parallel. The effective resistance is therefore equal to "r" and therefore the proportion of current or voltage absorbed by the circuit A to B is not changed. However, the effect is that when the switch is down, only half the voltage across A to B is dropped by the movement, or looking at it in another way, only half the current flows through the movement. Therefore the deflection of the needle is halved and in order to arrive at the true current or voltage the reading must be doubled. This switch, however, cannot be used in the ohms ranges.

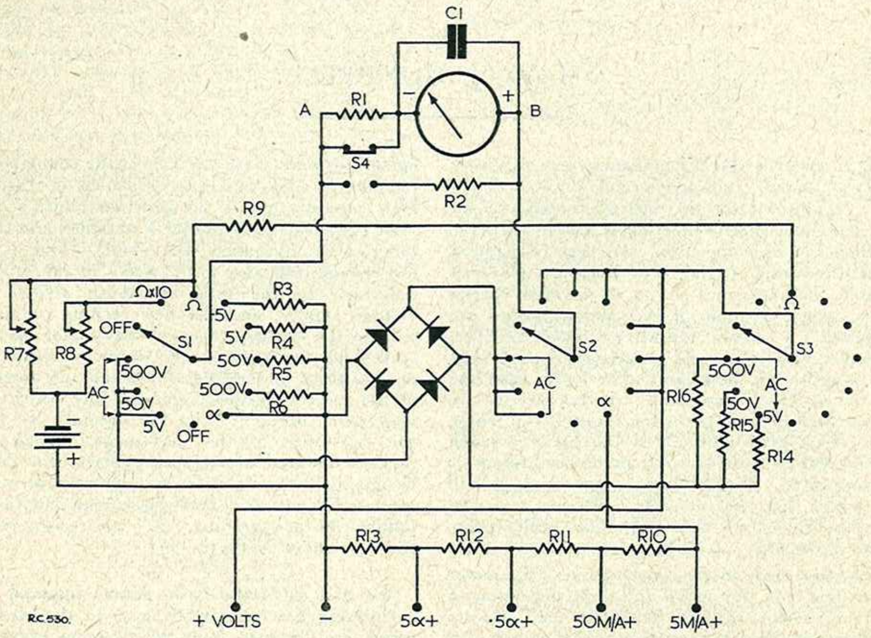


Fig. 1.

Theoretical diagram of the meter described in this article.

The physical construction of the meter is quite simple, all the components being mounted on the front panel, a piece of $6'' \times 4\frac{1}{2}''$ ebonite or other good insulator, except the two variable resistances, R7 and R8, which are mounted on a sub-panel, $5'' \times 1''$ supported on pillars $\frac{1}{2}''$ behind the main panel, the relative control spindles just projecting through the front panel and being adjusted for zero on a short with a screwdriver. The shunts are self-supporting a soldering tag being firmly soldered to each end. The tags are tightly held by the nut of the relative terminal. Resistances R3, 4, 5 and 6 are connected at one end direct to the relative tag of the Yaxley type switch and the other common ends to a tag on one of the bolts supporting the sub-panel. Rs 14, 15 and 16, go from the switch to their common connection on the rectifier which is situated just above the terminals and between the meter and the selector switch. The $1\frac{1}{2}$ V cell used for the ohms ranges is half of an Ever Ready No. 8 clipped into a home-made wire holder which can be secured at one end on the nut of the negative input terminal and at the other by one of the bolts holding on the meter or any other bolt which is not connected electrically. Contact to the cell is made at the positive end by means of a valve grid cap and at the negative end by means of a tag tucked in between the paper container and the zinc. It is incidentally, necessary to retain the insulation between the wire clip and the cell. For reading on the ohms ranges, the writer marked the scale of the meter in red ink as follows: 5, 10, 15, 20, 30, 40, 50, 60, 75, 100, 150, 200, 300, 500, 1k. These readings read from the right to the left and their positions can be calculated from the formula; reading =

$$\frac{750}{a\,(Rx+R7+R)}$$

where "a" is the full scale current of the movement, Rx is the resistance to be measured and R the resistance of the movement. For the "ohms x 10" range these figures will simply be multiplied by 10.

Note on the formulae used

R1 and 2 have already been explained.

R3, 4, 5 and 6 are quite easily worked out. Obviously, the resistance of the whole circuit on

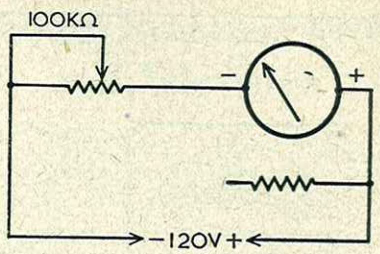


Fig. 2.

Measuring the internal resistance and the current taken.

the voltage ranges is given by dividing the voltage in millivolts by the current taken. The current taken when the full voltage is being measured is the "full-scale deflection current" (=a) and the resistance is the sum of the meter resistance and the external one, *i.e.*, in the case of the .5 V or 500 mV range R3+R=500/a therefore Rs=500/a—R. When we get to the 50 and 500 volt ranges the resistance of the meter is low enough to ignore in practice.

R7 is calculated in the same manner but the voltage to be measured is now that of the cell used in this range, *i.e.*, 1.5 V. The formula gives the mean resistance required; in practice, a somewhat higher maximum resistance will be required, as the voltage of the cell will probably be higher than 1.5 V when first purchased.

R8 is similar, but in this case R9, across the meter is so arranged to absorb 9/10ths of the current so that the current flowing through the external circuit is ten times that when reading "ohms x 10." In order to achieve this with the voltage unchanged, we must decrease the external

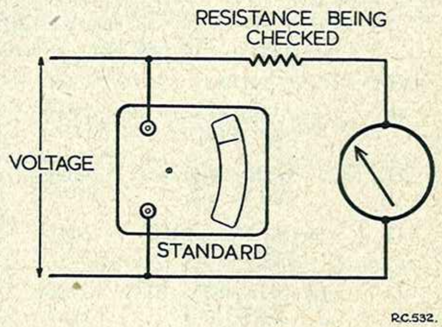


Fig. 3.

Checking the voltage multipliers.

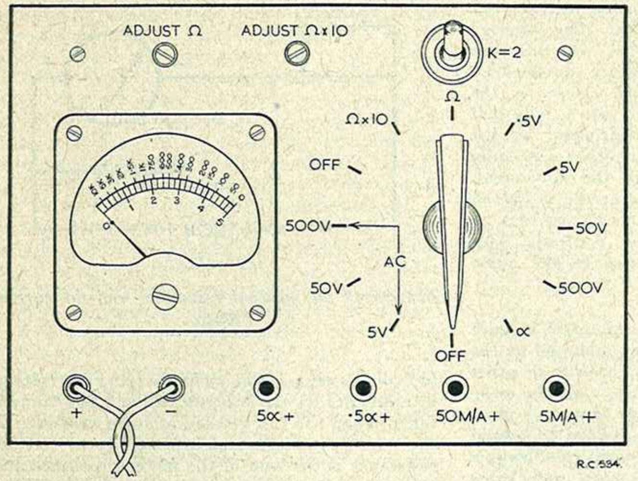


Fig. 4.

Sketch of panel layout as arranged by the writer of this article.

Table of Formulae

Resistance No.	*Formula*	*Value on Writer's Set*
1	R	11
2	2R	22
3	$\frac{500}{a} - R$	218
4	$\frac{5{,}000}{a} - R$	2,260
5	$\frac{50{,}000}{a} - R$	22,700
6	$\frac{500{,}000}{a} - R$	227,000
7	$\frac{1{,}500}{a} - R$	1k Ω pot with 3k Ω in parallel.
8	$\frac{1{,}500}{10a} - \frac{R}{10}$	25 ohm pot with 50 ohms in series
9	R/9	1.2
10	$\frac{9Ra}{50 - 10a}$	7.78
11	$\frac{9a\,(R+R10)}{500 - 10a}$	.778
12	$\frac{9a\,(R+R10+R11)}{5{,}000 - 10a}$	.0778
13	$\frac{a\,(R+R10+R11+R12)}{5{,}000 - a}$	.00864

Note: a=full scale deflection current of movement.
R=resistance of movement.

resistance by dividing it by 10. R8, therefore is 1/10th of R7. If R9 is to absorb 9/10ths of the current flowing through it and the meter in parallel, it must obviously be one-ninth of its resistance because the current flowing through two resistances in parallel will be shared in the inverse proportions of their resistance.

The basic circuit used for the current ranges is shown in Fig. 5. For reading 5 mA the current is divided between, Rs 10, 11, 12 and 13 in series providing one path and the meter, resistance R the other. The current through the meter at full scale deflection is a and therefore, that through the shunt will be (5—a).

$$\therefore \frac{R13+R12+R11+R10}{R} = \frac{a}{5-a}$$

$$\therefore R13+R12+R11+R10 = \frac{Ra}{5-a} \quad .. (1)$$

Similarly on the 50 mA range, R13, 12 and 11 in series are in parallel with R and R10 in series, and as above, we get

$$R13+R12+R11 = \frac{(R+R10)\,a}{50-a} \quad .. (2)$$

By subtracting (2) from (1) we get the equation, $R10 = \frac{Ra}{(5-a)} - \frac{(R+R10)\,a}{(50-a)}$: Multiplying out by $(5-a)(50-a)$

$$R10\,(5-a)(50-a) = Ra\,(50-a) - (5-a)(R+R10)\,a$$

$$\therefore 250R10 - 55aR10+R10a^2 = 50Ra - Ra^2 - 5Ra - 5R10a+Ra^2 - R10a^2$$

$$\therefore 250R10 - 50\,R10\,a = 45Ra$$

$$\therefore R10 = \frac{45Ra}{250-50\,a} = \frac{9Ra}{50-10\,a}$$

By considering the 0.5 amp range we get

$$R13+R12 = \frac{(R+R10+R11)\,a}{500-a} \quad .. (3)$$

and from the 5 amp range,

$$R13 = \frac{(R+R10+R11+R12)\,a}{5{,}000-a} \quad .. (4)$$

R11 is obtained by subtracting (3) from (2) and working as is shown above for R10, while R12 can be got by subtracting (4) from (3). (4) by itself gives R13.

A final word regarding the formula given for the determination of the resistance of the meter itself. We know the full scale deflection current (=a) indicated by 5 big divisions on our scale. x divisions therefore represent a current of $\frac{xa}{5}$ mA. The total current remains unchanged at a, and therefore the current through the 10 ohm shunt is $(a - \frac{xa}{5})$ mA.

$$\therefore \frac{R}{10} = \frac{a - \frac{xa}{5}}{\frac{xa}{5}} = \frac{a\,(5-x)}{ax} = \frac{(5-x)}{x}$$

$$\therefore R = 10\,\frac{(5-x)}{x}$$

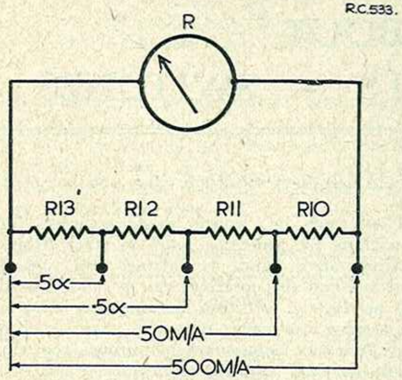


Fig. 5.

Section of circuit showing the arrangement of the current shunts.

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Modern Practical Radio and Television

This work covers every phase of Radio and Television Engineering from many viewpoints and meets a great demand. The author, C. A. Quarrington, A.M.Brit.I.R.E., has been responsible for training Radio and Television Service Engineers and is also well known as a lecturer on Radio and Cathode-ray subjects.

SOME OF THE CONTENTS

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N.1 ....

Radio Miscellany

READERS who have had experience in repairing or servicing their own or their friends' receivers will have noted just how quickly a set will become thickly coated with dust. This is always very much more noticeable in a mains receiver than with a battery set. Probably the dry heat inside the cabinet is the explanation. (Or flow of air through receiver ?—*Ed.*)

A few bright radio servicemen have been known to give this matter some attention, although not with the object of finding a means to eliminate the settlement of dust. They note it as a prospect for a suction-cleaner sale.

When you next have the opportunity to examine the chassis of a receiver which has remained unopened for a while, take a note of the type of dust. If there is as much, or more, fluff than fine dust you can be certain that the house it came from is " brush and pan " cleaned. A chassis from the " suction cleaned " house has practically no fluff, and the enterprising one-man business can put this spot of deduction to advantage, not only in finding the potential market but also as a sales point. It rather shakes a customer if he is told from a perfunctory inspection of his radio chassis, how his house is cleaned.

I can only advise those who think this is a tall story to try it for themselves. The difference is clearly detectable to even an inexperienced eye, although no doubt a real Sherlock Holmes could tell you a whole lot about the household if he got busy with his magnifying glass !

Ideas Dept.

Thinking of clues to judge the character of the user of any personal equipment, I have always found myself instinctively sizing up the quality of a constructor by the way he looks after his tool kit. If it is orderly and well maintained it can be taken as a certain indication that he is a methodical and accurate workman, but I have a feeling that I have laboured this point more than once before. However, thinking of tools and workshops, it recently occurred to me that the " combination tool " has never achieved anything like the popularity it deserves among constructors.

Probably this is due to the lack of suitable advertising by the manufacturers who seem to stress the appeal to the " boy engineer " and model-maker rather than to its more serious use. Or do they think the radio constructor uses nothing less than a lathe ? I refer, of course, to the combination tool for small metalwork such as the Metalmaster, Prestacon, and the Juneero, etc.

I have used one of these tools for some time and as a piece of 'shack' equipment it has seen much good use. Many of us will have an excellent excuse for getting one—for the junior op's birthday. See he looks after it properly so that it is in first-class condition when you borrow it !

These tools, in a sturdy single assembly, form a machine for punching holes in steel strips, a bending anvil, and a slotting and shearing machine, and all operations can be made speedily and accurately. It thus becomes an ideal tool for turning out earth pipe clips, wiring cleats, angle brackets, component mountings, tool clips, small carrying handles, etc., those many little oddments the constructor continually needs and finds so fiddling to do by other means.

There is one little idea I should like to commend to the manufacturers of these tools should this catch their eye. A punch for hollow rivetting ought not to be a costly addition and would greatly add to its usefulness to the radioman. Indeed, its addition to current models by comparatively simple attachments has already come to mind.

CENTRE TAP
TALKS ABOUT
DUST ★ PRESS TOOLS ★ SWITCHES

Before or After

I suppose every constructor passes at some time or the other through the stage where he feels the urge to devise a multi-way switching circuit with a bank of Yaxley type switch wafers. There is certainly a lot of satisfaction gained from feeling that several widely differing circuits, or one of a number of circuits selected, can be switched simultaneously by a single movement.

The old hand will remember the awkward and troublesome switches of the pre-early-thirties. Memories still remain vivid of contacts that soon lost their springiness, or on which formed a film of dirt or oxidisation, and always took up far too much space, while the locator mechanism misled rather than helped.

Newcomers are apt to overlook that the modern multi-way rotary switch is the result of a tortuous evolution. Its smallness not only permits a compact and efficient layout but also keeps circuit paths to a minimum length. Improved design and materials retain the springiness for indefinitely long periods and the self-wiping action cleans the contact surfaces at each movement, while spring-loaded ball selectors give positive location. There is something very satisfying in the feel of a switch which snaps smartly into position.

With the abundance of these switches at knockout prices in the surplus market many readers have no doubt devised ingenious one-movement change-overs. There is, however, one point that constructors must not overlook. That is, the distinction between switches of the make-before-break and the make-after-break types.

Use of the former type in certain circuits might easily lead to damage. For instance in a multi-range meter by turning the switch a shade beyond the locator position while the meter is connected in circuit could easily result in the needle curling up round the back stop ! A switch, even at a gift, isn't much of a bargain, if that happens to be your favourite foundation movement.

WESTINGHOUSE

The new Westinghouse 36EHT miniature high-voltage rectifiers are so small that they can be suspended in the set wiring. They have tag ends and are housed in an insulated tube 7/16in. diameter. These rectifiers will withstand a peak inverse voltage of some 4 times that of a normal selenium rectifier, and are primarily designed for use in voltage multiplier circuits, but may equally well be employed in the normal half-wave circuit.

Four models of the " Westeht " are now available. These provide EHT from the 350-0-350V winding of a standard mains transformer. Positive outputs of 5, 3 and 1.7kV are available, and also 3kV as a negative potential.

ANSWERS TO THE QUIZ

(1) Mr. Brain's method is often effective. Mica capacitors of .001μF, 350V working, are suggested.

(2) In the " see-saw " circuit the anode of the input valve is connected via a pair of resistors to the anode of a second valve, each also having the usual loading resistor. The grid of V2 is fed from the junction of the anode-to-anode resistors. The circuit is self-balancing, requiring no close matching of valves or resistors, and although the grid of V2 is connected to the centre of the anode-to-anode network the circuit provides the correct amplitude automatically. The signal from each anode is fed to the succeeding PP stages via the usual capacitors. This interesting and useful circuit deserves more complete description, and it is hoped to discuss it in these pages in the future.

(3) Directly heated rectifiers supply current almost immediately after switching on, but as the other valves do not draw current until their heaters have warmed up, high voltages are set up in several parts of the circuit, and may cause breakdown, particularly in capacitors. With an indirectly heated rectifier the delivery of current is delayed for approximately the same time as the delay in " demand " by the other valves, and no excessive voltages occur.

(4) The arrangement is to hold the heater at the same potential as the cathode, and prevents the transfer of hum from heater to cathode.

(5) Cores at a right-angle. Some slight deviation from 90 degrees may be effective, but as the two components approach 180 degrees hum will increase.

(6) With cathode loading, both anode and power grid are connected to HT —. This is the same as " strapping " them together, and causes the valve to function as a triode.

(7) Slight movements of the electrodes caused by external sound or vibration can result in the valve functioning as a microphone. If considerable amplification follows, the slightest touch can cause a loud "ringing" sound. If the valve picks up sound from the speaker it may oscillate.

LITERATURE RECEIVED

Marconi Instruments, Ltd., St. Albans, Herts. Illustrated leaflet describing communications Test Gear in current production. Among the models described are the Portable Receiver Tester TF888, which enables actual measurements to be made of the sensitivity, selectivity, second channel suppression, AVC operation, signal-to-noise ratio, hum level and power handling capacity of receivers—plus the resolution and linearity—line and frame—of television sets.

Other instruments described are the TF887 Valve Voltmeter, the TF899 Valve Millivoltmeter, and the TF894 Audio Tester. All these instruments are available on hire purchase terms.

Crystal Oscillators

BY O. J. RUSSELL, B.Sc., A.Inst.P, G3BHJ

It is difficult to decide whether the major fascination of amateur radio is the actual "on-the-air" operating, or the intermittent rebuilding operations aimed at improving performance. Certainly the two factors are generally interlinked, and the satisfaction of an improvement to the transmitter is heightened when this is confirmed by improved performance on the air. It is indeed often the case that after the first hasty construction to get on the air has resulted in the satisfaction of actual contacts, that thought and energy is expended in the direction of transmitter improvements. This alternate process of improvement, testing the improvement and further improvements, operating as it does in conjunction with variables such as propagation conditions which are outside the operator's control, has therefore the element of chance as a further attraction.

It is hoped that the discussion of a number of the technical factors in transmitter construction will be of some guidance as to the possible variations and circuit arrangements in various stages of the transmitter. It is logical therefore to consider first of all the initial generation of radio-frequency energy. In addition, with the present widespread use of variable frequency oscillators, any extra care and attention to this section will be well worth while.

Despite the widespread use (and abuse !) of the variable frequency oscillator, the crystal controlled oscillator is by no means extinct. For those starting operation it is in fact advisable to commence with crystal control, progressing to a variable frequency oscillator (VFO) when experience has been gained. It should be stressed that while it is often taken for granted that crystal control is an infallible guarantee of frequency and stability, this is by no means necessarily so. This fact should make the ultimate approach to the VFO more cautious than it usually is.

The vast majority of crystal oscillator circuits employed in amateur practice employ parallel resonance of the crystal, and are in fact derived from normal oscillator circuits by replacing a tuned circuit by a crystal. The employment of the series resonant condition is seldom encountered, but the possibility of its occurrence when trying trick regenerative circuit arrangements should be remembered.

In Fig. 1 is shown what is now known as the grid-plate crystal oscillator, derived from the once popular tuned-anode tuned-grid (TATG) oscillator, by replacing the grid tuned circuit by a crystal. The oscillator tube may be a small triode, such as a 6J5, but it is preferable to use a small pentode or tetrode type such as the 6V6, KT66, 6L6, 807, 6F6, etc. Such tubes have a lower grid-anode capacitance and higher sensitivity than triodes.

This is of assistance in two ways. Firstly the increased sensitivity results in greater output for the same degree of crystal heating, or alternatively for the same output as with a triode, crystal heating is greatly reduced. This factor is of some importance for operation on the higher frequency bands, as the popular X cut crystals have a temperature coefficient of some 20 cycles per megacycle per degree centigrade.

Under amateur conditions a shift of some six to twelve kcs. on warming up when operating on the ten and five metre bands is by no means uncommon. The AT cut type have a temperature coefficient nearly one-eighth as small, and where the crystal oscillator is run at high ratings, the possible frequency shift due to crystal heating should be considered. An annoying slight drift of about a kilocycle at ten metres even when the crystal has become warm, is often attributable to alternate crystal heating and cooling between transmissions. It should be noted also that the air gap between the crystal plates, especially if the plates are not accurately polished and clean, may accentuate the frequency shift with temperature and indeed usually introduces the more insidious phenomenon of an actual frequency jump without warming. In such cases the shift may be several kilocycles even at 7 Mcs., and is an intolerable condition, especially as it often happens that the occurrence of a frequency jump

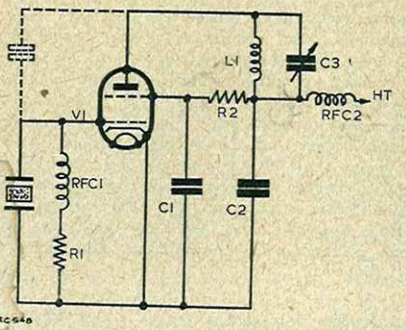

Fig. 1.

L1/C3 should resonate on the desired band.

RFC1/2 may be small SW receiving type chokes.

If R1 is $100k\Omega$, *RFC1 may be omitted.*

C1, 2$=0.001\mu F$. *R2 to suit valve and HT voltage.*

HT volts should not exceed 400 and 350 is usually adequate.

V1=6V6, 6L6, KT66, 807, 6F6, QV04/7, etc.

is irregular and may or may not repeat over similar conditions. Having suffered from this effect in the past, the writer feels that this phenomenon is worth some stressing. It is to be avoided by selecting crystals of reputable manufacture, preferably with low temperature coefficients, and mounted in well designed holders. The AT and BT cut plates, with holders employing accurately lapped stainless steel plates, can be recommended with confidence, as stable low drift units of high performance.

In the adjustment of the crystal oscillator of Fig. 1, it will be found that the setting of the tuning of the anode circuit will slightly affect the frequency of operation. With a triode this effect is often quite marked. The second advantage conferred by using a tetrode or pentode in this circuit, is that the lower anode-grid capacitance greatly reduces this slight shift of frequency with tuning. With a pentode or tetrode, a high grid-leak of say 100,000 ohms is perfectly satisfactory when directly shunted across the crystal, and accordingly the choke often shown in series with the gridleak may be omitted. In some cases it will be found that a small amount of cathode bias is of value in operation. This can be added as a resistor of about 300 ohms bypassed by a $0.1 \mu F$ capacitor.

In view of the widespread use of the circuit of Fig. 1, the adjustment of the tuning capacitor will no doubt be familiar. This capacitor, which may be of say 160pF for the 1.7, 3.5 and 7 Mcs bands, is arranged to resonate the coil at the crystal frequency. As the capacitor is tuned from the minimum capacitance position, oscillation occurs as the crystal frequency is approached, and these oscillations increase rapidly in strength as the capacitance is increased, until a point is reached at which a further increase causes the oscillations abruptly to cease. For maximum stability, it is necessary to tune the capacitor to a position somewhat below that giving maximum output. For chirp-free keying at high frequencies when multiplying from the oscillator output frequency, it may be necessary to readjust the anode tuning still further. A jack inserted in the cathode lead, and bypassed directly to earth by a small capacitor of $.01\mu F$ or so will be found a convenient method of direct keying for break-in operation.

The above discussion of the grid-anode crystal oscillator serves to also mention points that should be remembered as applicable to many other types of crystal oscillator. The ultra-simple crystal oscillator of Fig. 2 is of some interest as it dispenses with a tuned circuit, and will be found to give ample output to drive a small tetrode PA or buffer/doubler to thirty watts input for a simple transmitter design with only one tuning adjustment. This oscillator is often referred to as a Pierce oscillator. In point of fact both the circuits of Fig. 1 and Fig. 2 are due to Pierce, and some authorities give the Fig. 1 circuit as the Pierce oscillator. The circuit, basically, is a form of Colpitts, and the capacitor shown from grid to earth is essential for providing the correct degree of excitation to the grid. The value of 100pF will be found satisfactory for a small tube such as the 6V6. The anode potential should be restricted to 300 volts in this circuit, as the full RF voltage is developed across the crystal. A small triode can also be employed in this circuit. For the circuit

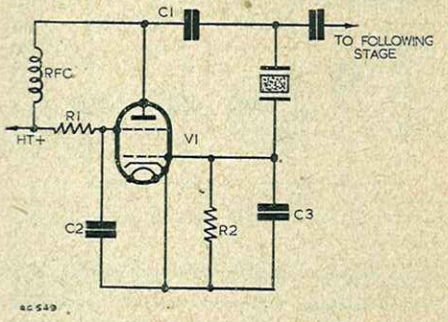

Fig. 2.

C1$=0.01\mu F$. *C2*$=0.001\mu F$. *C3*$=0.0001\mu F$.

R1, R2 and RFC as for Fig. 1.

V1=6V6 or similar. Anode volts 300 max.

of Fig. 1, with a triode the HT should be limited to 300 volts, while for a tetrode or pentode the voltage may be increased to 400 volts if desired. These voltages apply to most of the other circuits mentioned, and it is a good plan to include in all crystal circuits a low consumption bulb in series with the crystal as an indication of crystal current, at any rate during initial adjustments. It might also be mentioned that in the circuit of Fig. 1, if a very low capacity tube, such as the 807, be employed, a few picofarads of capacity may need to be connected between anode and grid to ensure oscillation. This is shown in dotted line in Fig. 1.

A more elaborate form of oscillator is the Tritet Oscillator of Fig. 3, and an alternative version is shown in Fig. 4. This is extremely popular for obtaining harmonic output with a crystal. Using a small tetrode or pentode, the circuit will provide 3 to 4 watts of RF output on the second harmonic, while by shorting the cathode coil it can be operated on the fundamental as a grid-anode CO with slightly greater output. A reasonable amount of fourth harmonic output can be obtained directly from the anode circuit, although if appreciable fourth harmonic is obtained it is often at the risk of excessive crystal heating. However it should be noted that there is a good chance of the 21 Mcs band being granted for amateur operation in the near future, and the third harmonic output is certainly only slightly less than the second harmonic output. In this circuit, the anode should not be tuned to the crystal frequency, unless the cathode coil is shorted to earth. With this circuit a permanent indicator of crystal current is very desirable, and can consist of a low consumption (100 mA) bulb wired in series with the crystal. The cathode coil should be arranged to resonate at a frequency slightly higher than the second harmonic. It will be found that crystal current and stability are greatly affected by the cathode capacitor setting, which should be adjusted, preferably with reduced voltage applied to the oscillator, until the optimum performance, particularly when keyed, is obtained.

A further interesting circuit which falls into the trick category is that of Fig. 5. It permits of obtaining a crystal controlled output upon half the crystal frequency, and has some use in obtaining operation on a lower band with crystals having fundamentals in the next higher band. This is often useful, not only because it obviates the purchase of crystals, but crystals that have limited use on their fundamentals will provide useful frequencies on their half-frequencies. Crystals lying between 7,200 kcs and 7,300 kcs are for example virtually useless under the heavy interference of the Broadcast transmitters now using these frequencies, and have very limited uses on ten metres. They will however give useful extra frequencies in the eighty metre band. Crystals purchased for use on the present five metre band will also give additional frequencies in the eighty metre band. Eighty metre crystals can similarly be given extra use by providing operation in the top-band. It should be noted that this circuit is capable of self-excited operation if incorrectly adjusted.

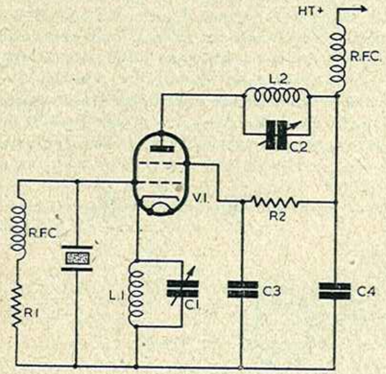

Fig. 4.

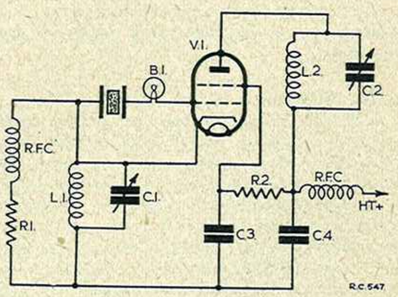

Fig. 3.

Circuit diagrams showing alternative versions of tritet crystal oscillator.

With pentodes the suppressor grid may conveniently be connected to the screen grid.

L1/C1 resonate to a frequency somewhat higher than the crystal frequency. Settings too near the crystal frequency should be avoided.

B1—100mA bulb as indicator of crystal current.

L2/C2—Tune to required harmonic.

C3, C4—0.001μF. Other values as before, but a variable R2 is convenient.

The writer has found the following procedure of value in setting up the circuit in a troublefree manner. It will be noted that the circuit is identical with the Pierce oscillator of Fig. 2, but with the addition of the tuned circuit, which should be arranged so as to resonate in the next lower frequency band to the crystal fundamental. That is, for a forty metre crystal the circuit should tune to the eighty metre band. If this circuit is shorted out, the circuit will oscillate normally as a Pierce oscillator on the crystal fundamental. The crystal fundamental is located on the receiver, and with the BFO running is heterodyned to a convenient beat note. If the short is removed from the tuned circuit, the crystal note will cease until the tuned circuit is tuned to the crystal half frequency, when the crystal note suddenly picks up again, and, it will be found that it holds the tuned circuit in oscillation at the crystal half frequency over a slight range of the oscillator capacitor tuning. Check by keying the oscillator that the crystal fundamental picks up cleanly and follows the keying, adjusting the capacitor tuning slightly if it does not. When adjusted, tune to the half frequency, when the oscillator note will be found to be pure crystal. Cathode keying is recommended for this oscillator, and again the anode volts should not exceed 300v. A 6V6 has been found very suitable in this circuit.

In connection with crystal oscillators, it has been stressed that the oscillation frequency is somewhat dependent upon circuit conditions and adjustments. It will be noted that the circuit employed when the crystal was calibrated is invariably included in the calibration certificate. Various devices are employed for slight variation of the crystal frequency. Thus small trimmers of 30pF max. capacitance may be wired across the crystal to permit of adjustment. This is a useful feature if band edge crystals are available, as they may be set either dead on the band edges, or slightly inside. The use of a parallel capacitance in this manner produces a slight lowering of the crystal frequency. By increasing the air-gap in the crystal holder, it is possible to increase the frequency. By such means as the insertion of a cigarette paper between one plate and the crystal, or by coating the crystal with indian ink, appreciable shifts in frequency are often obtained by amateurs. Such practices are somewhat liable to erratic operation, but by the use of a correctly designed variable airgap crystal holder a smooth control of frequency can be obtained. A popular American holder, available before the war, permitted of no less than 12 kilocycles variation on 7 Mcs. It is believed that such holders are no longer available in this country, and the suggestion is offered to any enterprising crystal manufacturer, as a means of clearing the ether of the somewhat unstable variable frequency oscillators so often heard to-day. It should be mentioned that crystals of 14 Mcs fundamental frequency are now available from British manufacturers, and are useful in

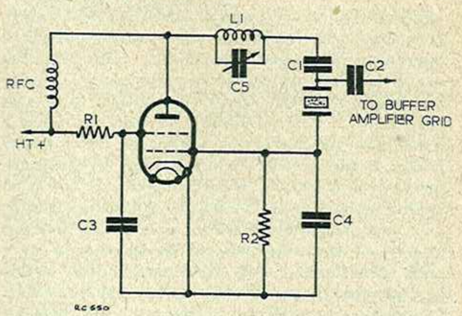

Fig. 5.

Frequency Halving Oscillator. L1/C5 should resonate at half the crystal frequency. C1—0.01μF, C2—0.0001μF, C3—0.001μF, C4—0.0001μF, R1—50k Ω, R2—100k Ω, RFC—Small SW choke, receiving type. Valve—A 6V6 is recommended.

reducing the number of stages required to reach a high operating frequency. Such crystals should be treated with respect however, as they are in general considerably more fragile than crystals of lower frequency.

It will of course be realised by readers that a simple absorption wavemeter or similar frequency checking device is of the utmost value when adjusting oscillators, especially those of the frequency multiplying type. The absorption wavemeter is in fact to be preferred, not only for its simplicity, but also for the fact that confusion with or apparent response to other frequencies is impossible. The use of a receiver for checking output frequency is satisfactory for an accurate check, but for the purpose of harmonic identification is usually misleading, as the harmonics present, even when the output is substantially on one frequency can be heard at a strength sufficient to cause confusion. If a superhet is employed, additional beat frequency effects may also cause confusion. The absorption wavemeter, by virtue of its response to one frequency, is, therefore, a most useful device for identifying harmonic output frequency.

However, if a receiver is used for harmonic checking, the greatest care should be exercised to see that no confusion is caused by spurious beats between high harmonics of the crystal oscillator beating with harmonics of the superhet oscillator. Very often these false beats will produce a very strong response upon a sensitive communication receiver, producing signals apparently at a number of frequencies having no obvious relation to the crystal harmonics. When the oscillator is adjusted to any given harmonic, the strength will peak sharply in the receiver, while the others will remain unaltered in strength. It is thus quite feasible to use a receiver to check operation, if caution is exercised. However, the use of an absorption type of wavemeter is highly advisable, as in this respect it is better to be safe than sorry. The possibility of emission upon a harmonic frequency not falling in an amateur band, should be sufficient deterrent to slap-dash methods of harmonic identification. It has been stressed that a crystal is not an infallible guarantee of a pure stable note, and it is essential that the quality of the note emitted be monitored after each adjustment. Any slight shift will of course be magnified by monitoring upon a high harmonic. It will come as a shock perhaps, to hear the ten metre harmonic of a 7 Mcs crystal producing a " char-chip " note reminiscent of a wobbly VFO, yet this can happen readily with some circuits. In general, the CO should be finally checked under typical operating conditions, that is loaded into an aerial, buffer, doubler or PA stage as it will be in the operation intended. A fairly light loading, and a carefully adjusted cathode circuit (for tritets) will produce a really " rock "-steady note, and eliminate chirp. A little time spent in experimenting will provide some illuminating experience, and also—we hope—render the question of VFOs to be approached with due and judicious caution. Finally, this brief treatment of the crystal oscillator makes no claim to completeness, and for obvious reasons, special crystals and advanced circuits such as those for obtaining high order harmonic output directly, have been omitted.

RECEIVER CONTEST

Closing Date December 30th 1949

See September issue "Radio Constructor" for full details

ANYONE CAN ENTER

BULGIN INCREASE RANGE

The range of Bulgin standard and miniature products has been augmented by many new items. Among these, new types of Signal Lamp Fittings have been introduced to cater for popular and easy-to-obtain bulbs, low voltage a well as mains voltage, together with new pilot lampholders of the all-insulated and shrouded types.

The large range of Bulgin radio fuses is being increased, with holders, with many new ratings. There are new types of Plug/Socket Connectors, including models for in-flex-running, and U.S.A. types of flat pin plugs. There is a new Ignition Suppressor with a constant value wire-wound element for stability and constancy of performance.

The already very comprehensive range of toggle and miniature switches is being increased by over 100 new models, and there are variants to the existing range with coloured plastic dollies and fixing nuts. Extra long bushes for thick mounting surfaces, available on many switches, is a welcome asset. New types of switches include nearby-current selectors as well as on/off, and jack or press-key types.

There are also many new control knobs, in attractive shapes, and in various colours.

Continued from page 89.

Continuing with the Television theme if a NC14 is available I would like to hear what the picture looks like, this tube is the same size as a VCR97 and has the same connections as far as can be ascertained, however, it has a blue trace which may possibly give a better picture. Personally I do not favour blue traces on the grounds of eye strain and certainly find a green trace more pleasant for Oscilliographic work over long periods. Although TV is a long way from Scotland I am working on a receiver (off and on) with which I hope to get sound if not picture. I am using a 3132 (with altered coils), and intend preceding it with a 45 Mcs. TRF strip, ref. page 11 of your August issue.

Finally I would be glad if you would send me your " Guide to the Writing of Constructional Articles " I have in mind a Modulator Unit giving sufficient to modulate a 150 Watt phone station and would be grateful if you would let me know whether this would be of interest to you.

Thank you for a really excellent and useful magazine.

Yours faithfully,
John A. Hardy
(Glasgow)

. . . *from our mailbag* . . .

Dear Sirs,

Being a subscriber to your " Radio Constructor " I now realise I am missing a lot by not having " Short Wave News " as well.

I should like to have this as well and hope you will be able to accept my subscription

Whilst writing to you I thought I would make mention of your " Inexpensive Televisor." Here I am about 120 miles from A.P. and am using a ½ Wave Spaced Dipole 40ft. high on wood pole at side of house. Aerial made by myself with 50ft. of Co-ax lead in.

I get a picture on most days and some times the picture is so bright that it can easily be seen in daylight or room light at night.

The picture is always synchronised before modulation is visible and it only slips with severe motor interference and just occasionally. The result I get is much better than that I have seen in London in shops showing the VCR97 in use.

People who see mine say how steady the picture is when compared with commercial sets seen in use in London and round about.

Actually I have modified the 1355 Receiver by " *Removing* " completely the 3rd and 4th IF valves and feeding the second direct to the grid of the 5th and giving it normal working voltages. I find that I can get better stagger tuning on the IF with only 3 valves and they give all the gain I can use without a lot of noise (white spots).

I also get a vast improvement by replacing the input coil in the No. 25 RF unit with one wound on a bakelite former with brass slug for adjustment and a 0-30pF capacitor across it variable from outside, setting the slug so that 45 mcs. is at mid setting and then when signal is good off set the tuning one way or the other which ever gives the best definition. The improvement is considerable.

My results on the " C " test signal is much clearer and one can see more than I did on a Baird £150 outfit at Maidenhead during the August holiday and this was over days of viewing.

Altogether the hook up is good and not just another stunt as so many people think. I use 3,000V EHT *on the tube* and can just scan both ways.

Please excuse me writing at length but I felt I must thank you for issuing the 1/6 booklet which really works.

What about an article on suitable Aerials and their construction. A matter left undone by most periodicals.

Have just acquired a BC624C (not A) Receiver with 12A6 output and note you gave conversion details of this unit—" Short Wave " May—Sept. or Oct. last. Are copies available?

Yours faithfully,
H. G. Rogers
56 Stonebridge Park,
(Upper) Eastville, Bristol 5)

Dear Sir,

I am writing to you with regard to your Data Booklet No. 2 (Inexpensive Television).

Lately I have had the opportunity to build the time bases and divider network into a Cathode Ray Tube tester. As this tester has been made primarily to test VCR97 I am taking this opportunity to write to you concerning it.

As you will know the VCR97 is most extensively used for " Inexpensive Television " and it was with this fact in view that I used the networks and time bases described in your Data Booklet No. 2. Testing a sample lot of twenty VCR97's the following results were obtained :—

No. of Tubes which work with " I.T." network	4
No. of Tubes for which network was modified	15
No. of Tubes faulty	1

This then suggests that something is wrong. On examination of the circuit it was found that the grid of the VCR97 was returned directly to earth instead of to the point Z, however it would seem that the point Z cannot be more than about 20 volts positive to earth with the applied voltage, hence the standing or minimum bias on the VCR97 cannot at any time be less than —30 volts. With this in view the resistance R9 was replaced by a 5,000 ohms 1 watt resistor and all the tubes were tried once more. The four tubes that worked originally still gave a bright and clear raster. However, the other 15 would only give a suitable spot but no visible raster. The next step was to remove R9 from circuit altogether and to ground R8 directly. On testing the tubes once more they were all found to work satisfactorily.

If I may suggest a slight modification in the circuit, R9 is changed from its present value of 82K Ω to a 100K Ω pre-set wire wound resistor which can be set for the particular tube in question to give a satisfactory minimum bias

As I have not had the opportunity of seeing " Inexpensive Television " in action I cannot say what the effects of the following observations would be on the picture but I don't think they could be very great. On checking the Line time base with an Oscillioscope I find it to be Non Linear, however this does not show on the raster to any marked extent, the frame time base is also inclined to be non linear at maximum gain. Secondly the outputs from either side of V5 are not the same (180 out of phase) however the proof of the pudding is in the eating and the wide demand for your No. 2 Booklet answers any criticism (such as has been levelled in some quarters and ably answered by you).

I would appreciate your observations on the above phenomena for which purpose a stamped and addressed envelope is enclosed.

(Continued at foot of previous page.)

SMALL ADVERTISEMENTS

Readers' small advertisements will be accepted at 2d. per word, minimum charge 2/-. Trade advertisements will be accepted at 6d. per word, minimum charge 6/-. If a Box Number is required, an additional charge of 1/- will be made. Terms: Cash with order. All copy must be in hand by the 10th of the month for insertion in the following month's issue.

PRIVATE

HAMBANDER COMMUNICATIONS RECEIVER COMPLETE with built-in power pack and matching L/S. Full details.—D. Young, 92, Alverstone Road, Milton, Portsmouth, Hants.

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