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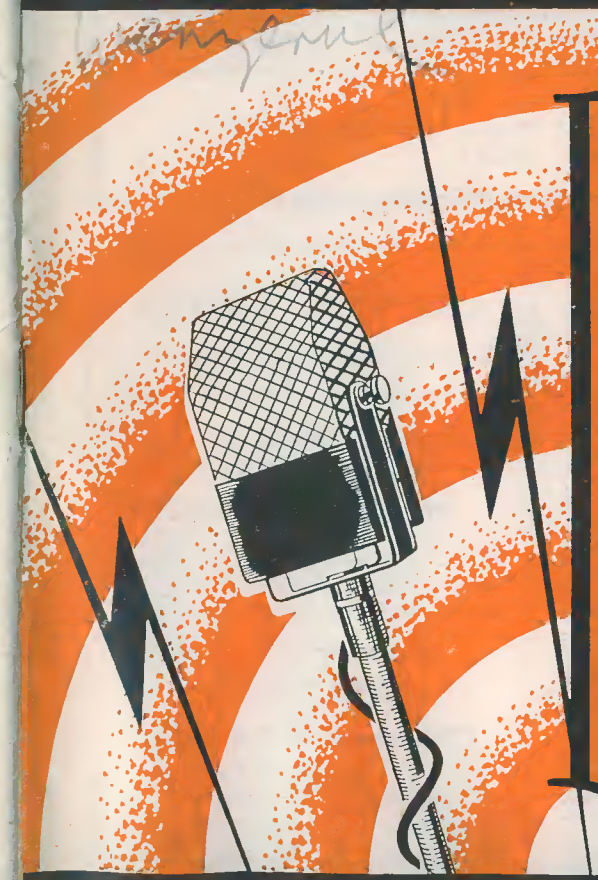
Vol. 3 No. 4
NOVEMBER 1949

RADIO CONSTRUCTOR

For Every Radio Enthusiast



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EDITORIAL

AMATEUR RADIO EXHIBITION

YET another Radiolympia has come and gone. This year the show has again been a success, from the point of view of the manufacturer, at least. The radio constructor derives some satisfaction from it, getting ideas for future plans and enjoyment from the various demonstrations and BBC shows. There is no doubt, however, that these days this exhibition no longer caters for the radio enthusiast in the way that it once did.

Luckily, the radio amateur has not been entirely forgotten, and this month he will be able to go to his own exhibition. We refer, of course, to the Amateur Radio Exhibition organised by the Radio Society of Great Britain, and being held at the Royal Hotel, Woburn Place, London, W.C.1. (The nearest Underground station is Russell Square, and bus routes 68 and 77 pass the door). The exhibition is being opened by Baron Sandhurst, O.B.E., at 2.30 p.m. on Wednesday, November 23rd, and it will remain open until November 26th, from 11 a.m. until 9 p.m. daily. Twenty-five firms have taken space, and there will be a special exhibit by the GPO. Admission is by catalogue, which may be obtained either at the show, or by sending 1/3 to the RSGB, New Ruskin House, Little Russell Street, London, W.C.1.

What's Cooking?

Radio as a hobby consists of many branches—the only other hobby approaching it in this respect which we can think of is model engineering. There is the quality addict, the short wave fans—divided into listeners and transmitters, the former being sub-divided into broadcast and amateur station fans—there is the chap who concentrates on medium and long wave receivers, and the increasing number who are interested in television. Then we have the novelty seekers, the midgeteers, the disc and wire/tape recordists, the radio-control modellers, and other types. Most people, too, at some time or other become interested in test gear.

We try, as far as is possible, to cater for everyone within these pages, according to the amount of interest shown. For this information we rely on letters from our readers, so, if you have not yet seen anything on your favourite branch, drop us a line and we'll do our best to oblige. Meanwhile, we can tell you that in future issues we have arranged for a series on The Design of the Superhet, starting in this number, and another on the Design, Use and Practical Construction of Oscilloscopes, and a short series on a Practical Signal Generator.

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 redraw in most cases, but relevant information should be included. All MSS must be accompanied by a stamped addressed envelope for reply or return. Each item must bear the sender's name and address.

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

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

HOW TO RE-BUILD A SUPER 88

By H. DUDLEY STILTON

IF there's one set I love, it's the old Super 88. Really, I'm not fooling, I think it's a grand old set and what's more, there isn't much which a modern set can do that the old 88 cannot do—and probably better. I love repairing them too, not that many of 'em ever need repairing, but they attract me, like peroxide does a blonde and—well, let's start at the beginning.

I got a Super 88 in for servicing the other day There was nothing wrong with it, really, the customer said, only it didn't play. Well, I mean to say. . . . Still, that's nothing, I had one customer come in some time ago and he calmly told me that *he* wasn't going to pay bills to have his set repaired, *he* was going to mend it himself, and had I such a thing as a resistance that would fit a Dooper set about twelve years old. . . . However—I whipped the old 88 out of its box with the speed of long experience, sorted through the oscillator section and found, as I expected, that—putting it crudely—it was not 'ossing. Now there only ever seems to be one consistent fault with the old Super, and that is that the oscillator coil corrodes, and of course stops oscillating. Knowing this, as I've just said, from past experience, I clipped off the leads, removed the can, and prepared to wind a new coil.

The coil was perfect ! Why can't I learn to check the obvious first ?—the valve was duff. I must admit that I was disappointed, still we can't have everything, can we ?

I put the set back in its cabinet, polished the top, gave it a loving pat and left it playing. I was just having a cup of tea when I noticed there was no sound issuing from the aforesaid 88.

" Hallo," I said to Dave, " looks as though they are having some trouble at the B.B.C., they've gone off the air."

" If they spent as much time drinking tea as you do, they'd never be on the air," he retorted.

That I thought was a very unfair remark, considering that he was drinking my tea and pinching my cakes when he thought I was not looking ! So I made my exit, turning my back on him and grimacing over my shoulder. Unfortunately, my Alsation, Rex, was lying in his accustomed place across the threshold, and I must admit my exit was perhaps more spectacular than dignified.

It was now nearly a quarter-of-an-hour since the old 88 had stopped playing. I came, therefore, to the conclusion that it was the Super that was at fault. You know, at times I amaze even myself at the correctness of my deductions—the *Super* had gone off !

Gleefully I removed the set once more from its cabinet. I discovered that by skilfully manipulating the wavechange switch the set would immediately start playing, but after a short period it would crackle and go off again. This is easy, I thought, a drop of switch cleaner and presto !—off it went again.—Hmmm—find the crackle and you find the cause. I shorted the grid of the oscillator to earth. The set played perfectly, crackled, and went off. I disconnected the decoupling capacitor (posh !). The set played perfectly, crackled, and went off. I disconnected every decoupling capacitor in the set, fixed my meter across the oscillator coil and switched on. The set played perfectly, crackled, and went off ! !

I didn't believe it. I stuck my finger on the rectifier heater to see if I was dreaming—I wasn't ! I shorted out the RF choke, shorted out the AVC line, connected my signal tracer across the coupling capacitor to test for leaks, in fact there was hardly anything in the set that hadn't either been shorted out, cut out, or at least got a meter across it. I switched on the set. The announcer said, very politely, " Have you any problems ? "—I had. I told him so, in fact I described them in detail.—I'm glad he'll never know just what I *did* describe to him ! The set played perfectly, crackled, and went off ! ! !—I changed stations, and the set immediately started motor boating. Why *can't* I learn to check the obvious first ?—Yes, of course it was, you've probably guessed it, the electrolytic was breaking down.

If there's one set I love, it's the old Super 88 ! ! !

Design of the SUPERHET

By R. J. CABORN

WHEN the author was preparing this series of articles on the functioning of the superhet, he remembered an evening he spent recently with a young radio amateur of his acquaintance. This young constructor had for some time been wrestling with the construction of a four valve straight receiver which did little else but bring in the local stations (not entirely free from interference) and then only after a certain amount of fiddling and knob-twiddling had been carried out. Turning with disgust from his set, this youngster switched on a commercial domestic receiver which happened to be in the room and tuning in one station after another with no adjustment but that of the tuning knob and the volume control, he said that he only wished that he could make a set as good as that. On being asked why he did not attempt the construction of a superhet he said it would be too complicated for him.

The author thereupon decided to show this young amateur just what went on inside this particular superhet. Lugging the chassis out of its cabinet he turned it over and displayed the economic simplicity of its components. Firstly, the power supply circuit, which consisted of a simple full-wave rectifier with a choke and two electrolytics for smoothing, exactly the same as he had in his straight receiver. The second electrolytic capacitor decoupled *all* the anode returns of the set. The amateur looked at his forest of resistor and capacitor decoupling circuits and sighed. The audio circuits consisted of a triode followed by a pentode, the detector a simple diode, the IF amplifier an ordinary RF pentode.

What about the frequency-changer ? And all the coils ? Ah, there the complication set in ! But only insofar that, instead of using the two-gang capacitor to tune two separate tuned circuits which must be adequately screened from each other to prevent feedback, this receiver tuned two circuits kept at different frequencies and where the question of feedback did not even occur. The coils did not necessarily have to be screened from each other ; in fact simply placing them with axes at right angles to each other sufficed for an ordinary all-wave receiver. In other words, less care need be spent on their layout than in the case of an ordinary straight receiver. But what about the oscillator ? Well, what is simpler than building an oscillator !

All in all, this commercial receiver, a typical model, had little else under the chassis but the usual connecting wires and an economic minimum of components. And it functioned so well that the manufacturers had sufficient faith in it to put it on the market in vast numbers, knowing that it could hardly help but work ! So much for the complicatedness of the superhet. When I left him the young amateur was busy scanning the postal lists for IF transformers and superhet coils. Good luck to him !

The moral of this little story is obvious. It is simply that the superhet, once its principles are understood, can be an extremely simple and trouble-free type of receiver to build.

The Theory of the Superhet

And now, having absorbed this little Slice of Life, let us become somewhat more academic and consider the actual theory of the superhet.

Fig. 1 shows the block schematic diagram of a simple superhet. It represents the internals of an average four valve superhet (excluding rectifier, if any) each block representing a stage in the amplification of *processing* of the signal received on the aerial to make it sufficiently strong and clear to actuate the loudspeaker. The power supply is the first block of interest. Its function is obvious : it supplies heater and anode or screen-grid currents to each stage as required.

The next block with which we should concern ourselves is that labelled "AF Amplifier and Output." This is nothing more nor less than an AF amplifying circuit which raises the strength of the audio signal obtained from the detector to that level needed for comfortable speaker volume. There is nothing complicated in it and for the time being we need consider it no further.

The audio signal to the AF amplifier is supplied from the RF (or IF) signal by means of the detector or demodulator (as our American friends call it). No hard and fast rule needs to be laid down as to the type of detector used, and, say,

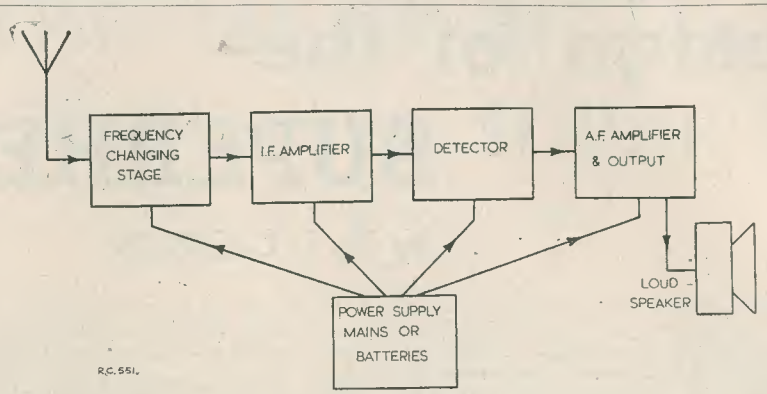


Fig. 1.

Block schematic diagram of a simple superhet.

a leaky-grid or anode-bend detector would function quite efficiently, if so desired. It has been found, however, after the considerable amount of research work which has been carried out by various people, including commercial manufacturers, that the diode detector offers most advantages and this type of detector is used almost always nowadays in the superhet.

The IF Amplifier

The modulated signal fed to the detector comes from the Intermediate Frequency amplifying stage. This IF stage consists simply of a valve or valves which, with their associated tuned circuits, amplify a signal at *one* frequency only. The tuned circuits in the IF stage are used entirely for the acceptance of this one frequency, all others being rejected. The IF amplifier can really be considered as though it were an RF stage tuned to a pre-set signal. If, to choose a typical value, we were to use 465 kcs IF transformers (or tuned circuits) in the IF amplifier, and if the BBC were to transmit a programme on 465 kcs, then, by connecting the aerial to the input of the IF stage, we would receive that signal *exactly as though we were using a straight receiver*.

The Frequency Changer

However, the BBC does not transmit a signal on 465 kcs. But there are many required signals on other frequencies and it is at that point where the frequency changing stage comes into its own.

All that the frequency changing stage does is to *alter* the frequency of the signal we wish to receive to that of the IF amplifier. The signal is then accepted by the IF amplifier, amplified, detected, and fed to the speaker. The frequency changing stage can be considered *pro tem* simply as a unit whose job it is to change the frequency of the required signal picked up on the aerial. Just how it does that will have to be left to next month's article.

The Job of the IF Amplifier

Now the superior performance of the superhet is owed mainly to the presence of the IF stage or stages. Just how does the IF amplifier give the superhet its peculiar advantages ? This may perhaps be more easily understood if we refer back again to the straight receiver.

Every constructor who has built a straight receiver with a tuned RF stage has come across the difficulty of tracking the two circuits, *i.e.*, of keeping the two tuned circuits accurately trimmed whatever the position of the two-gang capacitor. He has also, of course, noticed the fact that a straight set with two tuned circuits is more selective than a simpler set using one tuned circuit, apart from the obvious extra sensitivity (pre-detector amplification) obtained by the use of the RF stage.

Now, in the superhet, the main burden of the task of giving good selectivity and good sensitivity is borne by the IF amplifier. Fig. 2 shows us the circuit of an extremely simple (but quite practicable) IF amplifier. It consists of two IF transformers and an RF pentode. The output of the frequency changer is fed to the first IF transformer. The signal is then amplified by the pentode, applied to the second IF transformer and thence to the detector. (The IF transformers shown in the diagram each consist merely of two tuned circuits, both tuned to the same frequency and coupled together by means of the mutual inductance of the two coils.)

The first thing we will notice is that, even in this simple amplifier, there are *four* tuned circuits. Now the selectivity afforded by these four tuned circuits is going to be considerably greater than that offered by the straight set with only two tuned circuits. If we tried to emulate the performance of the IF amplifier in a straight receiver we would require a four-gang capacitor and four separate coils to select the required signal before detection took place. The difficulties of tracking such an arrangement would far outweigh any advantages gained. In addition, we would find that our tuned circuits would not offer the same selectivity at different frequencies ; as the tuning capacitor increased in capacitance, the efficiency of the tuned circuits would decrease.

But, in the IF amplifier the tuned circuits operate at *one* frequency only. There is, thus, no question of ganging. In addition, as the IF tuned circuits are only intended to work on this one frequency they can be made as efficient as possible, with no worry over loss of efficiency due to increased tuning capacitance, or from any other similar cause.

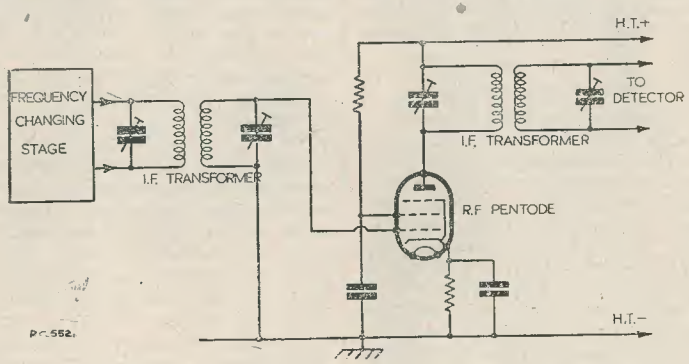


Fig. 2.

A simple IF amplifier.

The IF amplifier therefore will offer us very good selectivity. A further point is that, owing to the use of highly efficient tuned circuits, we will also find that we may obtain a very useful gain in *sensitivity* as well.

Two Advantages of the Superhet

Having considered the functioning of the IF amplifier we may now begin to have some idea of two very important advantages possessed by the superhet over its straight counterpart. These advantages are those of excellent selectivity coupled with good sensitivity and are obtained by carrying out our signal selection at a fixed intermediate frequency instead of at the signal frequency. There are other advantages, and there are quite a few disadvantages as well, but these are better discussed after we have gone into the workings of the superhet in more detail.

The Frequency of the IF Amplifier

To round off this introductory article there is just another little point which should be cleared up. Earlier in the article we used the frequency of 465 kcs to illustrate an example of IF amplification. This particular figure was used only because of the fact that it is typical. *Any* frequency within reason may be used for the IF amplifier but, in something of the same manner that trial and experiment has been the cause of choosing the diode as the best average superhet detector, so, in the passage of years, has the frequency band around 465 kcs (actually 450 to 470 kcs) been chosen as offering the most useful intermediate frequency for the vast majority of domestic receivers as well as for many sets designed for specialist jobs.

Conclusion

So much for the basic theory of the superhet.

Next month we shall begin a more detailed investigation of this type of receiver ; and we shall begin with that little block on the left—the Frequency Changing Stage.

THE EDITORS INVITE . .

● **Constructional articles suitable for publication in this journal. Prospective writers, particularly new writers, are invited to apply for our "Guide to the writing of Constructional Articles" which will be sent on request. This guide will prove of material assistance to those who aspire to journalism and will make article writing a real pleasure !**

A Visit To

RADIOLYMPIA

Described by R.E.H.

IN this short article I am not attempting to give a review on all the items and stands that were to be seen at this year's exhibition, but rather to give an impression of the show from the viewpoint of the constructor or, more accurately, the technically-minded amateur.

Thinking to have the selfish delight of prowling around without the usual crowds, I first went along on Sept. 27th to the preview, armed with a press ticket. Fate decreed that a strike take place, and I was to be found on that day stepping over canvas, ducking under trailing wires, and dodging from the path of those workmen who had decided to work.

Attempts were being made to carry out a rehearsal for the much publicised "Ice Cavalcade" in the TV studios. Performers, male and female, dressed in shiny pseudo-cockney costumes, glided listlessly to and fro awaiting instructions, in front of a backcloth depicting 'Appy 'Ampstead. Carpenters wandered around, painters were carrying steps, and electricians were snaking wire everywhere. The control room was still only a shell, surrounded and covered by still more workmen. The air was filled with noise, thrown against the walls, rebounding again and again, such that it was difficult to imagine. Against all this the valiant performers strained their ears to skate in time to an orchestra that was barely audible. I left in despair!

When I came back a week later, everything was in order. There is no doubt that the emphasis of the show was on TV, and practically the whole of the gallery was taken up by vision demonstration rooms. Around a hundred different televisors were on show, two-thirds of which were designed for the A.P. transmissions, and the remainder for Sutton Coldfield. From the outset my attention was attracted by the new projection large-screen receivers, but the manufacturers of these seemed somewhat chary of exhibiting their new pride and joy to the public. Later I learned that the makers were not yet quite ready to launch these new models and did not wish to attract too many enquiries. I was able, however, to see some in action and found them most pleasing. Most of them appeared to use the Philips' projection system. This employs a conventional looking tube of 2½ins. diameter with a 25kV EHT supply. This small tube is so mounted that its light projects on to a spherical surface-silvered mirror, which in turn reflects back on to a plane mirror from which the light travels through a corrector lens on to the screen. This latter is a ground, or etched, glass panel measuring about 15ins. by 12ins. The tube has some novel features, including a built-in EHT smoothing capacitor having one plate inside the glass, and the earthed plate outside.

One point about the televisors in general annoyed me. On the majority there was a most marked high-pitched whistle from the line time-base oscillator—in some cases an attempt to suppress this had been made by fitting treble cut-off to the sound receiver, resulting in woolly reproduction.

What of the rest of the exhibition? From my point of view the commercial receivers were, for the most part, just so much furniture. The RAF stand drew the crowds, to watch an ingenious panoramic airfield over which "flew" model aircraft. The purpose was to show the working of G.C.A. (Ground Controlled Approach).

For QRP fans, the Royal Corps of Signals were showing their latest battery wonder. This was the 88 set—a "walkie talkie" successor to the old 38—weighing some 15lbs. lighter, including batteries. The set is a 14 valve FM job, with midget valves, operating on four spot frequencies in the 40 Mcs region. On the Ministry of Supply stand this set was shown working whilst completely immersed in water. One thing puzzled me. Why did they revert to an ordinary mike?—the throat mike eliminated "battle noise" at the receiving end.

Throughout my visit the electronic bells were to be heard at intervals. Somebody had conceived the idea of setting up one speaker per note, and fabricating a horn around each to simulate the appearance of a bell. These were hung high up in the gallery and were swung realistically when "pealing." Unfortunately, the lowest pitched bell had a dustbin lid tone which rather marred the effect.

Up in the galleries between the Grand and National Halls was the GPO exhibit, and here I

became interested in their new ship-to-shore Rx/Tx rig. In the past, GPO construction may have tended to look a little antiquated—but this resplendent equipment has nothing wrong in that respect. It is designed to operate on eight predetermined frequencies—three in the long-wave spectrum and five in the medium-high.

Tape recorders seem to have caught on more than ever and several firms were pushing these forward for the home, although I think very few domestic buyers can be expected. The Westinghouse Brake & Signal Co. were showing a new line in their Automatic Train Announcer. This ingenious device has 16 separate channels with pre-recorded messages on tape. The approaching train is arranged to automatically operate its own arrival announcement, which also contains information as to its destination—exit the lady announcer!

For people like us, Judge Industries were offering a wire or tape recorder for £16, or less amplifier for £9. However, with some ingenuity I feel that a recorder along these lines could be made from the gear already to hand in the "junk box," and look forward to seeing articles on this subject in the future.

Again for the QRP merchants, the "Kalium" cells were interesting. It is claimed that they have a life of some 4 to 7 times that of the ordinary cell, but the snag seems to lie in the cost. This is, I was told, around 4/- for a cell of the U2 type. 7 ordinary U2s, at 5d. each, come to 2/11! The only advantage at present, therefore, would seem to be in physical size for a given working period.

Romac Radio have produced a small mains unit which is designed to supply both HT and LT for their personal receiver, which uses 1.4V miniature valves. I understand the smoothing capacitors for the LT supply are two 3,000μF 3V wkg electrolytics.

"RADIO CONSTRUCTOR" QUIZ

Conducted by W. Groome

(1) Mr. Brain, our stooge, was anxious to show off his AC set and took it to a friend's house. On switching on, the mains transformers burnt out. Why? Note that all components and connections were O.K. before the calamity.

(2) Which output valve has the lowest output resistance—triode, beam tetrode or pentode?

(3) Where, in a magnetic Television set, apart from the EHT supply, would you expect to find a very high voltage?

"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.

(*RADIO CONSTRUCTOR QUIZ—cont.*)

(4) How can "hand capacity" effects be avoided in short wave receivers?

(5) The "infinite impedance" detector gives no amplification. Right or wrong?

(6) What is "pre-emphasis?"

(Answers on page 114)

PHILIPS

The Philips Fixed Station Receiver type ET1204 is a medium sensitivity receiver designed to feed a high quality audio signal into either a 600 ohm line or into a power amplifier. Station selection is achieved by the use of easily plugged in RF units. These are supplied separately, pre-set to any single specified frequency in the medium or long wavebands.

The input is from an 80 ohm aerial, which may be either balanced or co-axial, fed into a band-pass aerial circuit and then to the grid of a triode-hexode frequency changer (ECH42). One stage of the IF amplification and detection is provided by a diode-pentode (EAF42). This feeds a double-triode (ECC32) which acts as an AF amplifier and cathode follower output to the 600 ohm line.

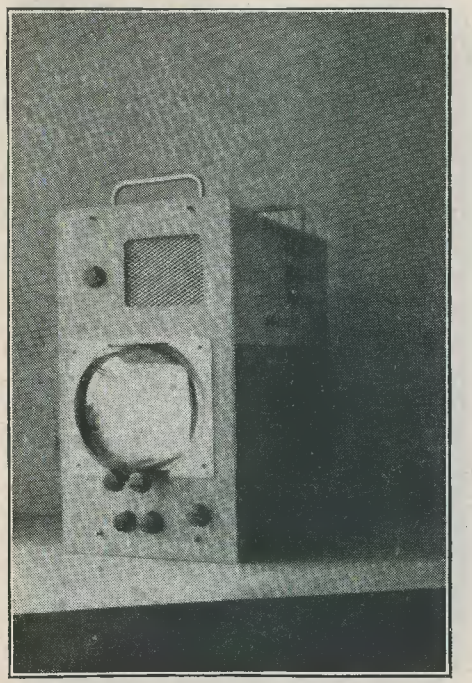
Two bandwidths are provided by varying the coupling of the first IF transformer. The third position of the switch short circuits the "m" derived low pass filter in the anode of the AF valve. This filter is variable in frequency in order to minimise heterodyne whistles in the range of 8 to 10 kcs. It gives an attenuation of about 25 dB.

The receiver is built for rack mounting and is finished in pale grey.

NOEL TA'BOIS TELLS US ABOUT HIS

HOME-BUILT TELEVISOR

I have pleasure in sending you brief details of a Television receiver I have built from War Surplus equipment. The chassis used are those of a type 62 Indicator Unit and a 6A Unit. The tube is mounted in its original chassis which also contains the EHT supplies, DC restorer, phase splitter, sync separator, time bases and amplifiers. The smaller 6A chassis carries the vision and sound receivers, the power pack and speaker. The original cases of these units are retained, to save building a cabinet, but to give a reasonably finished appearance a piece of oak veneered three-ply is fitted to the front.



The complete receiver.

The vision receiver is a 45 Mcs strip from a 3585 receiver and consists of five TRF stages (EF50's) diode detector (EA50) and video amplifier (EF50). Contrast is controlled by varying the screen voltages on the first four RF stages. This is easily done since, in the original strip the screens are decoupled and taken to separate terminals. This is simpler than varying the grid bias which would involve considerable modification, and in practice works quite well. I found it necessary to stagger the tuning (single sideband) to get the required bandwidth.

The sound receiver is basically that described in the "Electronic Engineering Televisor." I have modified it to suit components readily available and to reduce it in size to enable it to be fitted into the 6A chassis. The first three stages (2 EF50's and EBC33) are mounted on a chassis 5 x 3 x 2-inch. The speaker is a 7-inch Vitavox wafer speaker.

The time bases originally gave me considerable trouble. I was using Millar integrators without push-pull amplifiers. Trapezium distortion was marked and I was unable to get the raster to fill the screen even with some 500 volts HT. It was at this stage, when I was about to give up in despair, that I came across your booklet and built the time bases described therein. It seemed that my problems were solved; I had a perfectly rectangular raster easily filling the screen. But I was disappointed when I tried to receive a picture. What should have been the left hand half of the picture was perfectly reproduced on the right of the screen, while the right hand half was reproduced across the whole screen back to front and far from linearly. I tried varying the values of various components, and the best results were obtained with the following values (see Fig. 6 of "Inexpensive Television") R6—50 k Ω, R31—10 k Ω, R30—10 k Ω, R29—2 M Ω, R28—1 M Ω, C7 and C8—100 pF. I also had difficulty in getting the frame scan linear. I experimented with different values in V4 stage, and strangely enough the greatest improvement resulted in increasing the value of the decoupling resistor R11 to 100 k Ω.

An annoying fault was the pulling out of individual lines to the right. It appeared that the time base was being fired by interference

superimposed on the sync pulses. Reducing the value of C20 to one pF, completely cured this fault without making the line hold critical.

By far the greatest trouble I have had is loss of interlace. Critical adjustment of the frame hold will produce good interlacing but it is very unstable and frequent adjustment is necessary. Your suggestion (page 24) of checking interlacing by increasing the brilliance until the flyback lines are visible does not help in my case, for it is easy to produce interlacing of the flyback lines, but in spite of the fact that they are properly interlaced the scanning lines are not. An interesting article on this problem appeared in the "Wireless World" for April, 1947.

The EHT supply is from a transformer giving 2000V.RMS, and 5 J50 metal rectifiers in series. All other voltages are supplied from a mains transformer mounted on the top chassis. The HT output is 425-0-425, giving 430V. DC to the time bases, and this is dropped to 250V for the sound and vision receivers by a common dropping resistor.

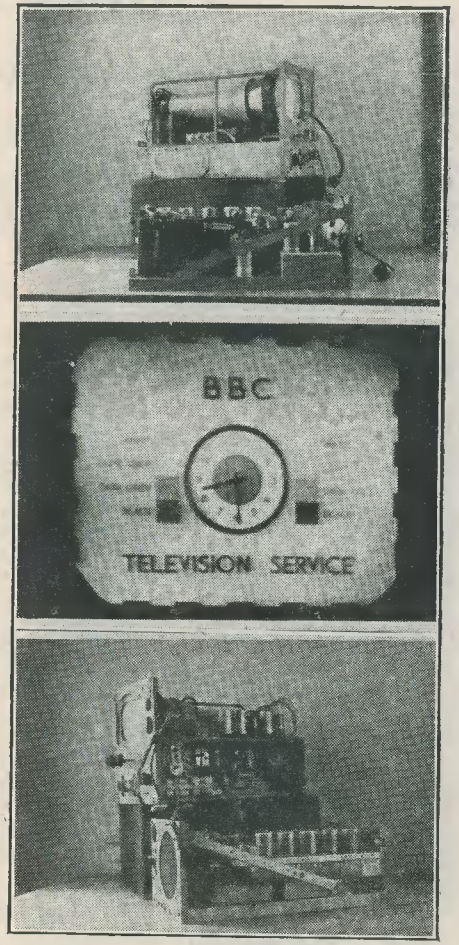
There are two cables connecting the two units. The first is a length of co-axial carrying the VF currents to the DC restorer, and the second is a seven way cable carrying the power supplies. An extra length of cable can be inserted to enable the two units to be run side by side when testing.

The 7-inch Vitavox speaker gives quite good quality but it is somewhat marred by the resonances of the metal case. However this can be largely overcome by plugging in a 10-inch speaker on a substantial baffle. Normally this speaker is always connected but I have included the small speaker inside the receiver to make the latter completely self-contained and semi-portable. The feeder (co-axial) from the aerial is taken to a junction box and thence to two rooms. It is thus quite a simple matter to instal the receiver in either room.

The aerial is a half-wave di-pole without reflector mounted on a chimney stack. I am in a good reception area some 6 to 7 miles from Alexandra Palace. Although the receiver will work with a short length of wire for the aerial an efficient aerial is essential to get a good signal to noise ratio as my house is situated on a main road on the opposite side to Alexandra Palace.

Occasionally difficulties have arisen when one member of the family wants a radio programme and another wants the TV. To overcome this a pair of phones can be plugged into the TV receiver, a process which switches off the speaker so that the radio listener is not distracted by the viewer, whose phones effectively suppress the sound from the radio.

I enclose a few photographs showing the construction of the receiver and also two photographs



Top. General view showing vision strip.

Centre. Photo of tuning signal taken with magnifying lens in place. Exposure 10 secs. at F4.5 on Selochrome.

Bottom. Another view, showing power supply side of vision unit.

of images received on the screen. Owing to the poor light and the long exposure required it is only possible to take still subjects.

I would like to express my appreciation of your excellent little booklet and trust that the foregoing has served to illustrate how that publication has been of great service to yet one more keen amateur.

Yours faithfully,

Noe Ta'Bois

(Essex)

Query Corner

A "Radio Constructor" service for readers

Capacitor Values

"I find that the values of capacitors are marked in different units. For instance, μF, μfd, mfd, μμF, and pF. Will you please explain the connection between these units?"

T. F. Tonkin, Balham.

There has been some confusion in the past as to the preferred method of marking capacitor values. The use of the terms, μfd and mfd is no longer recommended but in their place we have μF, an abbreviation for micro-farads, and μμF or pF, abbreviations for micro-micro-farads or pico-farads. A micro-farad is one-millionth of a farad and is indicated mathematically by 10^{-6} farad, whilst a pico-farad is considerably smaller, being one million-millionth of a farad; a division which is indicated by 10^{-12}. Now it will be clear that it is possible to state the value of a given capacitor in either one of these units, for example, 500pF is equivalent of 0.0005μF. The latter figure is however, rather clumsy and hence the ruling that values of less than 0.001μF should be expressed in μμF or pF is normally observed.

Current Limiting Resistors

"I have noticed particularly in AC/DC receivers that a resistor is included in the anode circuit of the rectifier valve. As the value of this resistor is normally very low it can hardly be for the purpose of reducing the HT voltage. Can you enlighten me on this point?"

M. Howes, Cambridge.

It is not unusual to find a low value resistor in the anode circuit of a power rectifier, the purpose of this resistor being to limit the peak current which the valve is called upon to conduct. It is well known that when a rectifier is fed from an AC supply it will not pass current over the complete cycle of the supply voltage. Because of this the valve must pass sufficient energy during the conducting period to supply the load with DC over the complete cycle. This point will be clarified by considering a half-wave rectifier circuit of the type shown in Fig. 1 when feeding a DC current of 100mA into a load. If the rectifier conducts 100mA during a small part of each cycle then clearly there will be insufficient energy stored in the reservoir capacitor to supply the required 100mA during the remainder of each

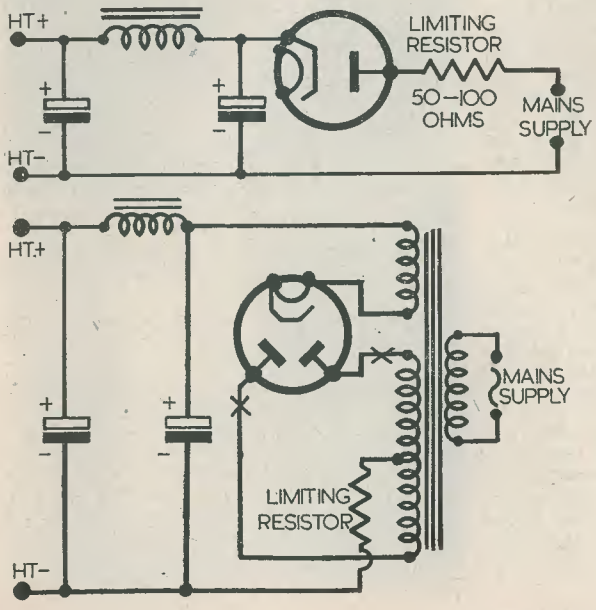


Fig. 1.

Showing the position in the circuit of the current limiting resistor. An alternative arrangement in the full wave circuit is to include one resistor in each anode lead of the rectifier at the points marked "X."

cycle. Hence in order that the direct current may be drawn continuously the rectifier is called upon to deliver sufficient energy during its period of conduction to feed the load with 100mA during this period, and at the same time charge the reservoir capacitor so that it might supply the load current during the non-conducting part of the cycle. This means that without a current limiting resistor in the rectifier circuit the valve may conduct a peak current which is seven or eight times the direct or steady load current. In other words at a load current of 100mA the valve may pass 800mA peak during part of the supply voltage cycle. In a practical case a current of this magnitude might be sufficient to overstress the emitting properties of the cathode in the rectifier with a consequent shorting of its useful life. Fig. 2 shows the wave form of a complete cycle of supply voltage indicating the portion during which the rectifier conducts.

As already stated the excessively high current may be limited by the inclusion of a resistor of about 50 to 100 ohms in the rectifier anode circuit. A resistor of this value normally being sufficient to limit the peak current to five times the load current. This ratio of peak to mean current is normally considered to give a satisfactory rectifier life. The inclusion of the resistor in the circuit has the effect of slightly decreasing the output voltage and thus the rectifier conducts over a slightly longer period in each cycle, but at a reduced peak current. In a full-wave rectifier system the limiting resistor should be connected in the lead which is taken from the centre tap of the mains transformer winding. When connected in this position the resistor is common to both the rectifier anode circuits. The resistor in all cases is in series with part of the resistance presented by the transformer windings and where low current transformers are used it is frequently found that the winding resistance is sufficient to provide adequate current limiting.

Another very important advantage to be gained by the use of limiting resistors is that they assist in reducing the otherwise excessively high current which the rectifier valve is called upon to pass when the mains supply is switched off and then almost immediately switched on again. In these circumstances the reservoir capacitor discharges almost instantaneously into the load whilst the rectifier heater requires some time to cool, so that if the mains switch is closed very quickly after switching off, the rectifier conducts at once but has to recharge the reservoir capacitor. Unless a limiting resistor is employed a number of occurrences of this type may easily ruin the rectifier.

An Electrostatic Screen

"I have read of an electrostatic screen being used in a mains transformer, what is the purpose of such a screen and where is it located?"

A. James, Cardiff.

An electrostatic screen is inserted between the primary winding and the secondary windings of

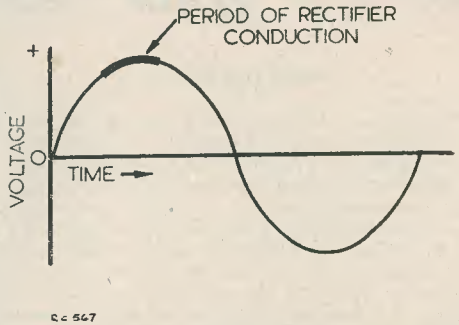


Fig. 2.

Showing the period of rectifier conduction in a half wave circuit. In a full wave circuit, a similar period also occurs on the negative half cycle.

a mains transformer to prevent radio frequency signals from either entering or leaving the receiver via the mains supply lead. Such signals frequently consist of interference caused by electrical apparatus connected to an adjacent supply point.

The shield consists of a strip of non-magnetic material situated between the primary and secondary windings and arranged so as not to form a complete turn on the transformer bobbin. If the shield were to form a complete turn a voltage would be induced in it by the magnetic field of the transformer and the resultant circulating current would result in losses. Such losses reduce the efficiency of the transformer and may cause eventual overheating. The electrostatic screen must always be earthed if it is to be effective.

Bleeder Resistors

"Do you favour the use of bleeder resistors across the output terminals of power supplies?"

D. Grage, Brighton.

The answer to the query is a most emphatic "yes." Many power packs are constructed without bleeder resistors across the output terminals and these sometimes feed into apparatus which contain no HT potentiometers. As a result when the mains supply is switched off an appreciable charge remains on the HT smoothing capacitors for periods of several minutes. To the unwary constructor who has suddenly switched off upon thinking up a new "mod" to make to the gear, such a charge can be quite dangerous as he eagerly gets to work soldering iron in one hand, and solder in the other.

The position is, of course, much worse when dealing with EHT packs as a 0.1μF 5kV capacitor when fully charged can give a fatal shock. A 50 MΩ resistor however, connected across such a capacitor will discharge it to a safe value within a matter of seconds, without at the same time presenting an appreciable load to the power supply when it is operating under normal load conditions.

. . . *from our mailbag* . . .

BIRMINGHAM TV

Dear Sir,

Some time ago I purchased a copy of your very excellent booklet "Inexpensive Television." Considering the distance from Alexandra Palace, the results obtained here are remarkable. The TV set as it stands did a very good job, under ideal propaganda conditions, e.g., ducting and Sporadic "E." These conditions appear for the most part to prevail about the last quarter moon phase. Working the TV at this extreme range makes it easier to assess the value of any modifications carried out. The following is a brief survey of modifications to date, which have made large improvements. In preparation for the Birmingham TV frequencies a type 26 Unit was purchased. As this employs EF54's it was reasonable to assume that a greater signal to noise ratio may be obtained. By adding 2½ turns to the RF and mixer stage coils, and 3½ to the oscillator coil, the 45 Mcs signal was tuned in. The 10k Ω anode load to the RF stage was replaced by a VHF choke, and the screen resistor replaced with a 1 k Ω. The cathode bias resistor was reduced to 33 Ω. The HF coupling coil was removed (this leaves the control grid of V1 in the air, so it is grounded across the top trimmer with a 100 k Ω in keeping with the mixer stage). A 2-element Fixed Beam is coupled to the aerial coil with a single turn loop. The results from the modified 26 Unit gave worthwhile signals when the 25 failed to do so.

The next thing which required attention was lack of picture quality and definition, also inability to hold line sync. The next modification gave picture quality which compares with any commercial TV receiver. The cathode follower was fed via a 0.1 μF capacitor directly from the anode of the video amplifier. Interposed between the video amp. anode load, and the decoupling resistor, was placed a choke to offset the HF feedback. The cathode resistor is reduced to 47 Ω and bypassed with 0.01 μF. The screen is directly coupled to the point between the RF choke and anode decoupling resistor.

For sound I am using a similar receiver, fed into a 50 watt amplifier! Hoping this gen will be of use to anyone contemplating operation on TV at extreme range. Generally speaking, I can always receive something, and on an average three good evenings a week for complete entertainment.

C. G. Turner, A.I.P.R.E. (Birmingham)

LINCOLNSHIRE TV

Dear Sir,

I thought you would be interested to hear of "Long Distance" reception of the Birmingham test signal on the Inexpensive Televisor. I live approximately 100 miles away. On Tuesday, August 22nd, I had been lining up an RF26 Unit ready for Birmingham. I then connected up the aerial to see what local interference there might be on this wavelength and was very surprised to find the test pattern signal coming through with more power than I have ever had from AP. The signal held solidly from 10.15 a.m. until 1 p.m. This performance was repeated on the afternoon of August 29th. At other times some sort of a signal has always peaked up within 10 minutes, usually rather faint and of short duration. As I understand that the signal is of low power it gives us great hopes of the 1355's possibilities when Birmingham gets going. Incidentally, many amateurs would, I am sure, agree that a medal should be struck to the "inventors" of the "Inexpensive Televisor." What a journalistic scoop! I am at present experimenting with a 3-inch tube, a magic lantern lens (to cover 4¼-inch x 4¼-inch slides) and back projection through ground glass. If successful, more anon.

R. A. Ilett (Cleethorpes, Lincs.)

COVENTRY TV

Dear Sirs,

I must say that your TV set is working very well on the Birmingham test transmissions. It comes in so strong on the 1 kW of power which is being used, that I think that when they start pumping 35 kW out I shall use it (instead of a 100W bulb) to light the dining room! More power to your elbow!

W. S. Handy (Coventry)

INDICATOR UNIT 74

Dear Sirs,

I enjoy reading your magazine and find the articles on conversion of surplus gear particularly interesting. I am wondering if any of your readers has used the Indicator Unit type 74 for Television purposes. I have built several Television receivers using the VCR97 tube with considerable success, but should like to use the type 74 Unit which I have with its VCR516 9-inch magnetic tube and 4kV RF EHT Unit, but have been unable to obtain the circuit of same, so that quite a lot of work would be entailed to trace this out.

K. C. Buteux (Maidenhead, Berks)

INDUCTANCE TESTING

Dear Sir,

If any of your readers intend constructing the Inductance Testing Apparatus described in Query Corner of the August issue, its use can be greatly simplified and the AC voltmeter dispensed with, if a scale and pointer is fitted to R2 and the scale calibrated as follows:—When L=1 Hy. R2=314 Ω. When L=2 Hy. R2=628 Ω, and so on. By means of an ohmeter set R2 to 314 Ω and mark the scale 1 Hy. Then set R2 to 628 Ω and mark the scale 2 Hy, and so on all along the scale. This will give a direct reading instrument. Fractions of henries between the main divisions can be easily assessed or can be marked in on the original calibration.

J. C. Dixon (Penwortham, Lancs.)

A 4-VALVE SUPERHET MIDGET

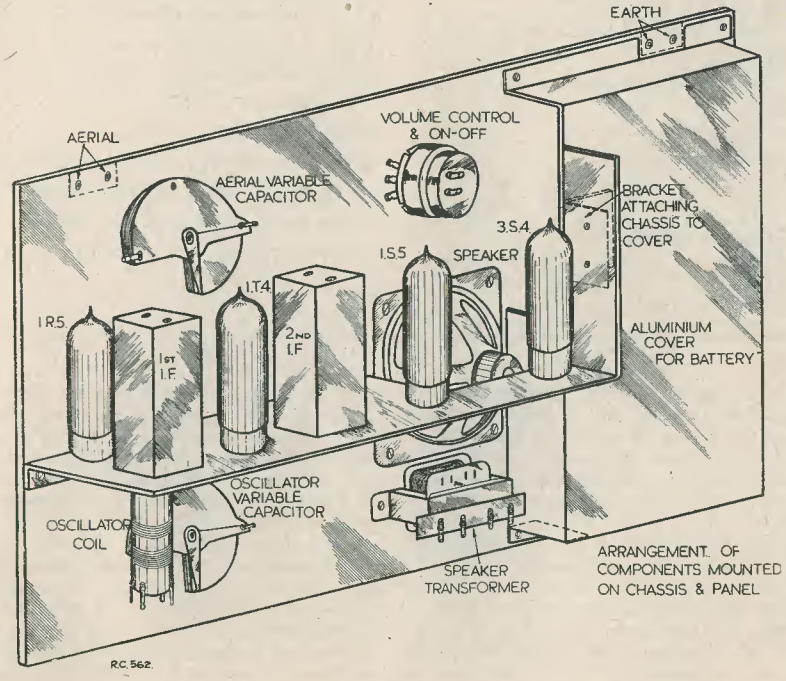
PERSONAL PORTABLE

by *VINCENT HILL*

UTILISING BUTTON BASE VALVES

THE set about to be described is a 4-valve superhet using 1.4 volt valves and is built around the B-114 type layer-built dry battery. The overall size is 9¾-in. by 5¾-in. by 3½-in. deep, and it weighs complete just over 3½ lb. It is thus somewhat larger than a commercial type of personal receiver, but this is inevitable, since the amateur cannot obtain the ultra-small components necessary. The circuit calls for no comment, and it is simplified as much as is possible. The oscillator is tuned separately; thus there are four controls. No ultra-small 2 gang capacitor was obtainable when the set was first made, but, in any case, the difficulties of tracking a home made frame aerial with an oscillator coil are too great. The use of separate tuning capacitors makes it no more difficult to construct than a TRF set; there is no ganging and the IFT's are simply adjusted for greatest signal strength.

Basically the construction is as follows: The panel carries a small chassis, the 2½-in. midget speaker and the battery case; the panel is dropped into a lightweight containing box; the aerial is wound on a narrow frame and hinged to the panel, and over this frame is slipped a lightweight containing lid. This somewhat elaborate construc-



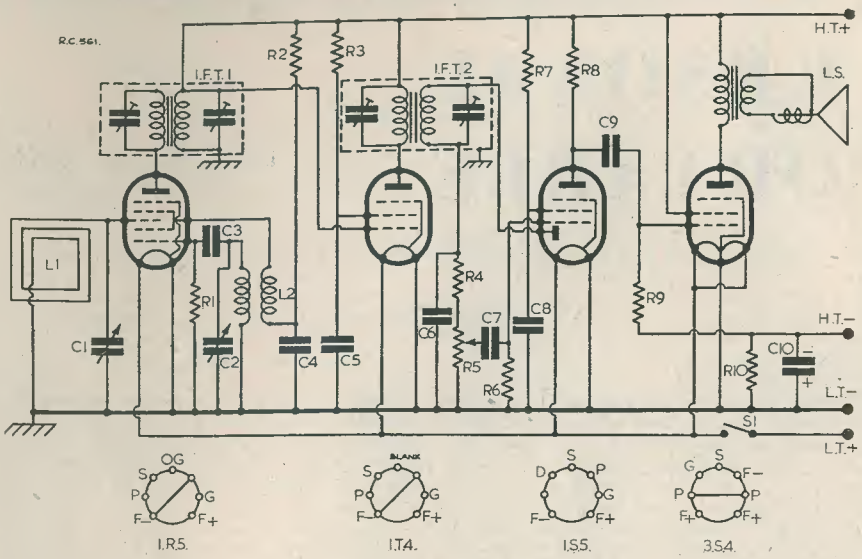


Fig. 1.

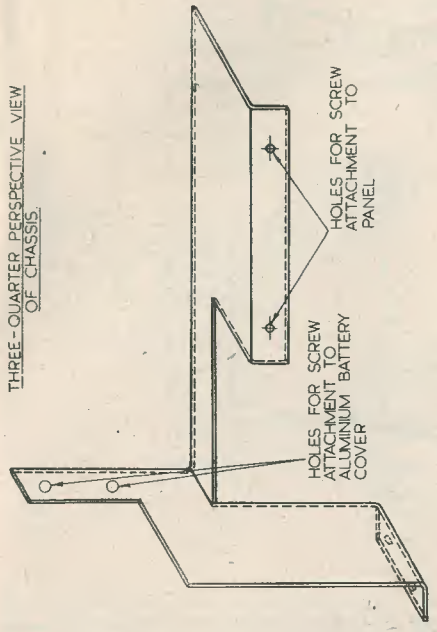
CIRCUIT AND COMPONENT LIST

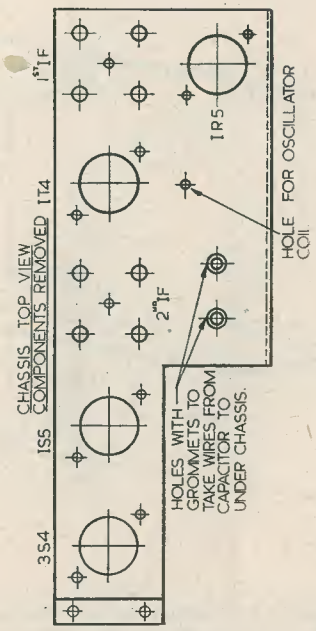
L1—Frame: 20 turns 24DCC.
L2—Oscillator Coil: Wearite PO2.
C1, 2—300pF Variable Mica Dielectric.
C3—100pF.
C4, 5, 8—0.01μF Non-inductive.
C6—500pF.
C7, 9—0.002μF.
C10—25.0μF electrolytic.
R1—100k Ω *R2—5k Ω*
R3—10k Ω *R4—47k Ω*
R5—1M Ω pot with switch (S2).
R6—5M Ω *R7, 9—3M Ω*
R8—1M Ω *R10—850 Ω*

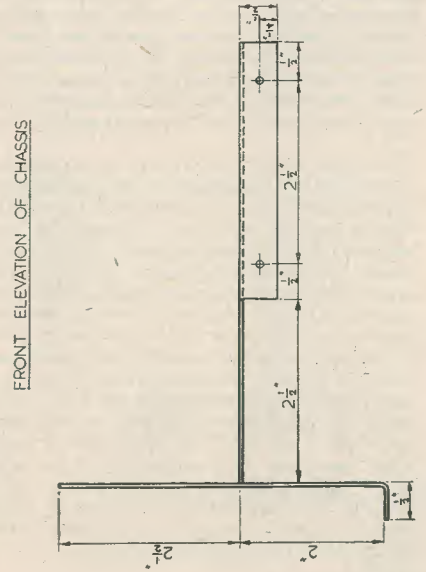
LS Transformer: to suit.
IFT1, 2—Wearite Midget 465 kcs.
B.114 Battery—Ever-Ready or equiv.
Speaker—Celestion 2½in. midget.
Valveholders: 4 x B7G.
Battery Plug: Belling Lee.
Dials: Celluloid Protractors backed with white card.
2×3ft. lengths, 3in. x ⅛in. Balsa wood.
1×3ft. length, 3in. x $\frac{1}{16}$in. Balsa wood.
Bakelite panel, wire, nuts, bolts, etc.

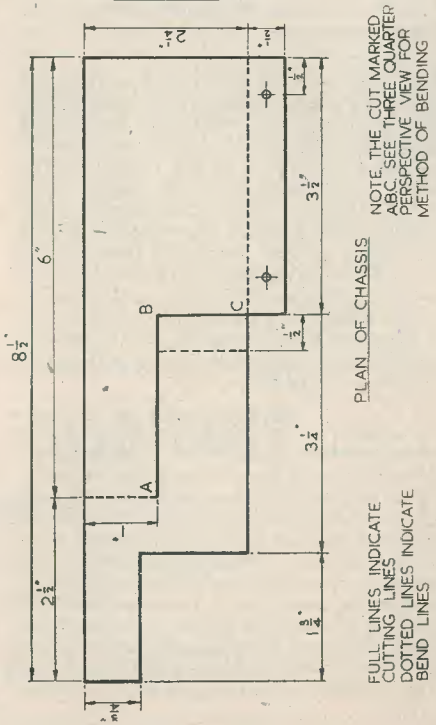
tion is necessary in order to give facilities for changing the batteries, and to allow the frame aerial greater pick-up properties by being able to swing well away from the receiver. In a set of this nature it is the mechanical parts which require the greatest labour and exactitude.

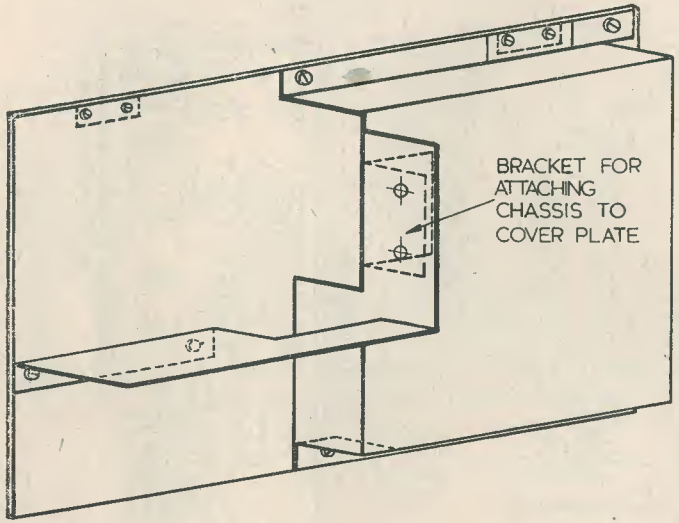
The panel is best made of ebonite or bakelite, of ⅛-in. material. The loudspeaker is centrally placed; this allows 3½-in. on either side and 1½-in. top and bottom. The receiver part of the chassis is 2½-in. deep, 3½-in. long with an extension of 2½-in. and 1-in. depth which goes behind the loudspeaker; a further extension is bent at right angles and acts as a stop for the battery. The chassis is made of aluminium and the measurements are given in the plan. Particular attention should be given to the way it is cut, to get the angling for the further extension and so allow room for the loudspeaker. The aluminium is easily cut with a fretsaw using a metal cutting blade. It is best bent in a vice. On the other side of the loudspeaker is the metal cover for the battery, which is so made that the battery is a nice sliding fit. Four nuts and bolts fix this cover to the panel. One end of the chassis is bent and screwed to this cover, and the top of the cover is also used to anchor, by means of a











THREE QUARTER PERSPECTIVE BACK VIEW OF PANEL, CHASSIS & COVER PLATE.

RC 565

right-angled piece of aluminium, the other end of the chassis extension. Reference to the diagram should make this clear.

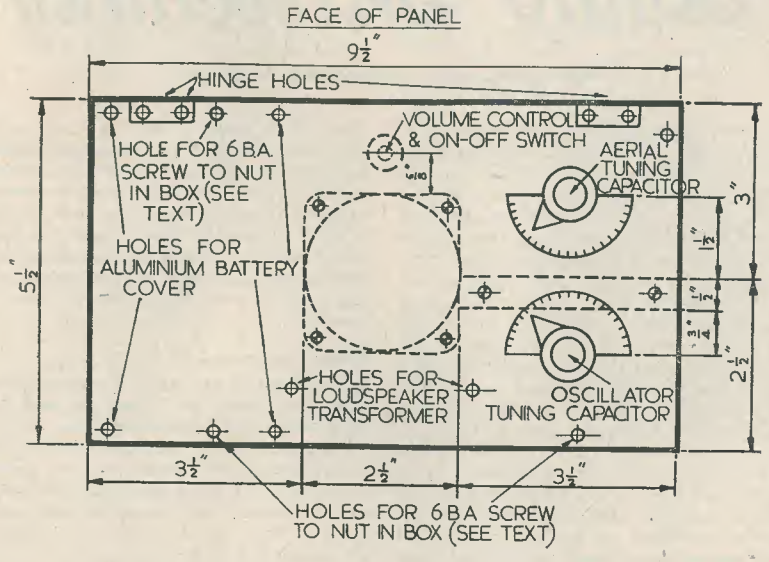
Above the loudspeaker and fixed to the panel is the volume control combined with on-off switch. Below the loudspeaker is bolted the loudspeaker transformer. The aerial variable capacitor is fixed above the chassis to the panel, and the oscillator capacitor is below the chassis. Two bolts only secure the front of the chassis to the panel, but this is enough as the chassis is secured in two other places. There are thus quite a number of bolts on the panel and a decision has to be taken whether to leave them to show, or to cover the panel with a leather cloth; if the latter, then allowance must be made for the thickness of the leather when cutting the rebates in the panel for the frame aerial hinges.

With regard to the components, the smallest possible should be chosen. The variable capacitors are of the mica type; the oscillator coil is the Wearite OP2 and the IF transformers are Wearite midgets; the resistors can be $\frac{1}{2}$ or $\frac{1}{4}$ watt, with the exception of the bias resistor, which should be of 1 or 2 watts rating. When drilling the panel, it is essential to remember that the aerial frame folds down on top of it, and therefore the actual panel space is shorter by roughly $\frac{1}{2}$-in. all round; the only component likely to cause trouble in this respect is the volume control, but even the knobs for the variable capacitors must be watched for size.

All the drilling of holes in the panel and chassis is done before assembly. All the panel components are put in place on the panel, and the valve holders bolted to the chassis, and then the two can be bolted together, the other components being fixed to the chassis afterwards. The aluminium cover for the battery is put in place, and the extension end of the chassis anchored to it.

Wiring is quite straightforward, though it is desirable to use a pencil bit on the soldering iron. The leads are all quite short, and those to the volume control are taken through the space between the loudspeaker and the cut-out part of chassis. Even here the resistor has sufficient of its own wire to stretch from the IFT to the volume control. The grid bias resistor and its associated capacitor are anchored to the bracket by means of an insulated strip, and lie above the battery cover. Particular attention should be given to the wiring of the filament of the last valve, as this valve has a double filament, the minus being taken from pin 5 and the plus from pins 1 and 7. When mounting the components it is helpful to put soldering tags under the majority of the nuts, as this facilitates all the earth wiring. Similarly, a small insulated strip bolted in front of the IFT tags will give anchorage for the HT leads.

The aerial frame is best made of hardwood of $\frac{3}{8}$-in. or $\frac{1}{2}$-in. thickness. Its dimensions are $\frac{1}{8}$-in. less than those of the panel; it is $\frac{3}{4}$-in. wide. Thin beading—1/16-in. Balsa wood can be used—is glued to the inner and outer sides of the frame



RC 563

in such a manner as to bring the dimensions of the frame up to those of the panel. There is thus formed a wide groove $\frac{3}{4}$-in. wide in which to wind the aerial wire. The beading can be omitted where the two hinges occur, and this will make a natural rebate for the thickness of the hinge. Actually, it can be omitted altogether from the outer surface, since the lid will act as a cover, but, if it is made, then the lid will be easier to fit.

The hinges are used to connect the aerial and earth leads from the frame aerial to the receiver. This may not be the best sort of electrical conductor, but it works. They are screwed to the frame, and bolted with countersunk bolts and nuts to the panel. Two pieces of copper foil or thin copper are placed underneath the hinge before screwing to the frame, and these two copper pieces are bent round the frame to act as anchorages for the beginning and end of the wire. Do not take any of the copper underneath the windings as this will affect the inductance; for the earth end of the winding, solder a piece of connecting wire to the copper and connect that to the end of the winding; this will form a slight bump, but it will help to keep the winding taut. It might be advisable to screw the hinges tightly to the frame before drilling the holes in the panel, as then the panel holes can be so drilled as to allow the frame to fall square on the panel; it is surprising how even the smallest variation of drilling can throw the hinges out of true.

——To Be Concluded in next issue.——

Radio Miscellany

THE home construction of televisors is now well and truly in its stride, not merely the ex-WD conversion—popular as it is—but the pukka job home-assembled down to the last screw. Despite the head-shaking of those who should have known better, I was always confident that TV home construction would have a wide appeal. Strange as it may seem, one at least of the popular amateur journals even went so far as to say that it considered home-built superhet sound receivers to be beyond the amateur's ability. And that was since the war !

Indeed, I had to read it twice to make sure that I was not seeing things, and then passed it to our Bill (2ATV, who has both feet on the ground if anybody has) to read it aloud before I could believe it. I can't repeat exactly what he said, at least not with his forcefulness, but we agreed that to know anything of the enthusiast's capabilities one needed to get around amongst them instead of simply to air uninformed opinions from the remoteness of an office desk. The chief qualification for informed and successful popular radio journalism is a real enthusiasm for all, or most, branches of amateur activity outside ordinary working hours. This may be why most radio journals are repeatedly inviting contributions — unless it's because technical writers choke themselves to death with radio !

Who knows when my turn will come, although (touch wood) there is no apparent indication that the enthusiasm is on the wane, even after quite a long innings. I still manage to find quite a lot of pleasure in keeping a close contact with the experimenter, and by that I do not mean simply those in the London area.

While I cannot claim many distinctions, my knowledge of the shortest distance between any two junks shops in many provincial towns is quite unique. If anyone is uncertain just what the enthusiast is capable of doing on his own initiative, and not by simply following published designs, he cannot find a better place to become enlightened.

Maybe I will be jostling elbows with you for a front row view of the window at your favourite bargain centre next Saturday afternoon.

Further Outlook

There is to-day a very high number of constructors who have built, or are capable of building, 100% successful superhet receivers—admittedly a more difficult feat than a transmitter. If it were not for the vast number of ex-WD sets which have been available at low prices, this fact would be even more obvious.

Experimenters, too, have made many ingenious modifications and additions to the popular Service types—it sometimes seems that most of them have been " hotted-up " or modified by their purchasers. The general standard of technical knowledge is higher than ever before, thanks to Service training and the ever-widening range of technical books and test equipment.

My little weather glass is quite as dependable as the astrologer's crystal, and it foresees a future having a still larger number with knowledge equal to, or exceeding, that of " Radio-Mech " standard.

Home Constructed TV's

To return to the original subject, the cheapest televisor I have yet heard of used a VCR97 with home-made chassis and coils, and, of course, " bargain " valves. This neat and successful job cost £12 (without cabinet) and the power supply ran away with more than half this amount. It is not claimed as a record ; other readers by keen buying might easily have done as well or better.

Another set using a Mullard MW22-7 tube cost £25.10.0. In both these instances construction occupied three months of nearly all the builder's spare time.

Another constructor (unlike the other two, he had no Service training) bought a widely advertised kit. To give a better idea of his radio knowledge it should be mentioned that he had built no radio gear for over ten years but had kept in touch by occasional reading of radio periodicals. In his case, the most interesting part is in the time taken. As he was building from a kit no time was wasted in " recovering " parts or sorting out his junk box and adapting, and naturally the chassis were already drilled and punched.

The construction took him nearly seven weeks, occupying most evenings and most of the week-ends. I thought he would be a fair example of the " time factor " so I asked his opinion and permission to pass it on to our readers. After some consideration he said : " If they know no more about radio than I do, I don't expect they will get it finished much quicker."

At this juncture I should in fairness point out that he is a natural handyman and able to make clean and reliable soldered joints.

He continued : "A lot of my time was spent in checking over what I had done the previous time I had spent on it. I have not had enough experience to work to a system, and I could never be sure just where I had left off. In any case I was a little bit nervous of circuit reading and at first it does seem complicated. Many of the components were so small that I had to hold them in position with tweezers when soldering, and I found it extremely awkward to get the last few bits in when most of the wiring was completed. I should say the time taken was something over 140 hours, but an experienced man working systematically might knock a lot off that. It would have taken me even longer if the valve pins, etc., in the circuit had not been numbered."

Questions

Most readers will agree that seems an interesting and reasonable account, but I thought a few more details would prove helpful, so I asked the following questions.

"*Did you buy any special tools ?* "

" Yes, I had to get a pencil bit for my soldering iron, a pair of sidecutters, and the tweezers."

"*Did you make any mistakes in wiring, and did you get it working straightaway ?* "

" Yes, I went wrong several times on the time base chassis owing to the strange arrangement of the valves, and they do not appear in the circuit in numerical order. They were quickly spotted as I came to wire the next part, and everything worked the first time I put the power on."

"*Can you suggest any way by which the construction might be made easier ?* "

" The long job is the wiring. Extra pages with each circuit duplicated in dotted outline, so you could mark in each wire as you complete it, would be a big help."

The latter seems a very sound suggestion, and might well be used in technical journals for complicated circuits, or alternatively a piece of interleaved tracing paper might be bound in.

CRT's

The large majority of home built TV's use the electrostatic VCR97 or 5CP1 cathode ray tubes. Proportionally very few amateurs feel justified in going to the expense (£11.5.6 plus cost of deflector coils) of the 9-inch size magnetic CRT.

What is the position going to be when the present stocks of ex-WD tubes run dry ?

I cannot imagine any manufacturer making them, and in any case they would not be cheap. When the amateur HAS NO alternative he will have to change over to the electromagnetic type—so we can only hope that prices will fall, but how that will be managed it is not easy to foresee, unless purchase tax is removed and increased production makes economies possible.

In any case, for televiewing the magnetic type of tube has all the advantages. They can be much shorter for a given picture size, require less EHT voltage for an equivalent brilliance, and as there are no complicated deflector plates to add to the cost are simpler and quicker to produce.

The manufacture of electrostatic tubes of a size suitable for direct viewing can scarcely be regarded as an economic commercial proposition, so we can hope for no replacements for the VCR97, etc. The only answer must be, conversion to the magnetic tube unless the back-room boys devise an inexpensive projection system.

Recently considerable experiment with methods employing lenses and mirrors to magnify the picture from small CRT's has been made (Examples were seen at Radiolympia.—*Ed.*) and that seems to be the next logical step in TV progress, especially in view of the BBC's commitment to their present transmitting system. It is, perhaps, the most logical outlet for research energy.

Blessing ?

That is where the home constructor will score He will be able to keep his receiver in step with each advance.

Or will he ? When all the VCR97's have gone, most of the other ex-WD stuff will have gone also. Just imagine the cost of building a set if you have to buy all the EF50's and SP61's at list prices ! At first glance it would seem to be a pretty grim outlook, but then I am a confirmed optimist. Remember, back in 1939 there was no ex-war surplus, but there was always plenty of " Manufacturers' surplus." And the prices ! ! ! Well, if your memory does not extend that far back, just turn out a few of those pre-war advertisements !

CENTRE TAP TALKS ABOUT THE HOME CONSTRUCTION OF TELEVISORS

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.)

3—Distortion Caused By Near-Instability

DISTORTION caused by near-instability is occasionally rather difficult to clear. In the case of home-constructed receivers, and providing that they were not working efficiently before the fault occurred, the cause will probably lie in a mistake in circuit design, and we shall deal with this point later on in the article when we discuss those repairs that necessitate a change in the receiver circuit. In the case of a commercial receiver, or successful home-made set that has only recently given trouble, we know, before we search for the fault, that the set has been working satisfactorily; and also, as the set is presumably giving reasonable volume, that the fault is only of a small nature, being most probably the gradual deterioration of some component. Sometimes, however, the very fact that the snag is only of a small nature makes it the harder to locate!

The effect of distortion due to near-instability is usually quite easy to recognise. Nearly always, a certain volume of sound or a certain note (assuming that the speaker or AF circuits are resonant at that note) causes the AF section to burst into damped oscillations, dying away quickly until the next note or sound triggers them off again. (May 1949 R.C., page 584, para. 4).

The effect is very similar to that obtained from a faulty loudspeaker and can sometimes be mistakenly blamed on that component. The volume control (particularly in the case of the superhet in which this control is almost invariably found in the grid circuit of the first AF valve) helps considerably in diagnosis. The trouble usually occurs after the control has passed a certain setting. Occasionally, distortion occurs at that setting whether the actual volume of sound is low or high. It may also occur when the control is in the middle of its travel, disappearing again when the full-volume position is approached.

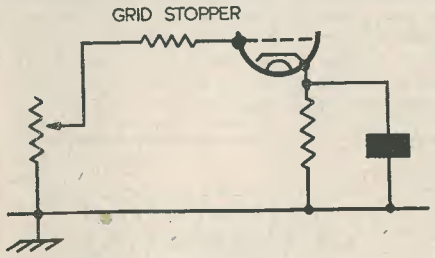


Fig. 34.

Connecting a grid stopper to a valve. The resistor should be mounted as close as possible to the valve connection.

However, we shall now deal with the first case, in which the trouble sets in above a certain volume level. The first and most likely component to suspect is the main decoupling capacitor between HT positive and chassis. This may be checked by connecting another similar capacitor across it, *using short test leads*. If, as occasionally happens, the capacitor is mounted on the cabinet away from the chassis, the test capacitor should be connected to an HT point on the chassis itself. If a battery set is causing the trouble, and if it isn't fitted with a capacitor across the HT supply, the internal resistance of the battery should be checked.*

If the main decoupling capacitor is not at fault we must check any other decoupling capacitors that are used in the AF circuit. A quick method of checking decoupling capacitors is referred to in May, 1949 R.C., page 585, col. 2.

There will be few, if any, of these capacitors in the AF circuit so the process should not take long.

If it is decided that the decoupling is above suspicion, the next probable path of feedback is that via capacitive route. Loudspeaker leads running close to grid leads, valves with faulty screening, badly shielded grid leads, these all lend themselves to capacitive feedback. AF feedback via a capacitive link has already been treated under the heading of "Instability," which chapter should be referred to for further information.

Finally, in the case of battery sets, the GB battery should be checked for high internal resistance.

*The performance of many battery receivers is often improved by the addition of a capacitor of at least 4μF connected across the HT supply, assuming that one isn't fitted already. If an electrolytic capacitor is used, it should be switched out of circuit when the set is switched off, otherwise there will be a continuous current drain from the HT battery.

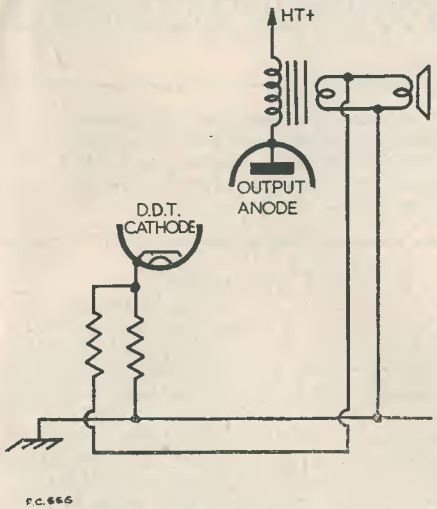


Fig. 36.

A simple negative feedback circuit.

If the trouble occurs when the volume control is in the middle of its travel, assuming that the volume control has the correct value, then the fault is due to capacitive pick-up by the grid to which the volume control is connected. The reason for distortion occurring only at this position is because, at either end of the track, the grid and its wiring has a sufficiently good path down to earth to by-pass any random voltages impressed on it. The volume control itself may be the culprit, but, if its travel is smooth and it causes no crackles, it may be considered serviceable. If the volume control is working correctly, then the shielding of the lead from its slider to the grid of the valve should be inspected, and, if necessary, screening should be fitted to this wire and/or the valve itself. As the trouble may be caused by reason of the grid leak picking up an RF or IF voltage, a decoupling circuit as shown in June, 1949 R.C., page 606, fig. 12 (*c*) may assist in clearing the fault. Alternatively, a grid stopper (connected as close to the valve's grid as possible) can be used. See Fig. 34. The value of the stopper should be kept as low as possible, and should not be higher than 100K Ω.

4—Distortion Caused By Components Not Directly Connected With Valve Supplies

Under this heading may be grouped those components which are concerned with feeding the loudspeaker from the anode of the output valve (or valves), and those which are used in the negative feedback circuit, if any are fitted.

Firstly, let us consider those components between the output anode and the voice coil of the speaker. These do not consist only of the speaker transformer and its tone correction capacitor, both of which may be checked quite easily by substitution: they include also the leads from the transformer secondary to the speaker as well as any silencing arrangement that may be fitted. Fig 35 (*a*) shows how a silencing switch for use when an extension speaker is installed is fitted to the output circuit, and Fig. 35 (*b*) a plug and socket arrangement mounted at the rear of the chassis. Both these circuits are commonly encountered and both may give rise to distortion. If there is a poor connection between the transformer secondary and the speech coil (even if it is introducing a resistance of only a few ohms), then distortion will almost certainly result. The amount of distortion depends on the latitude given by the output valve in so far as mismatching is concerned.

Negative feedback circuits may cause distortion should they break down. These circuits, as far as the average commercial receiver is concerned, are usually fairly simple in design. Fig. 36 gives a typical example, in which a small amount of feedback is applied from the speech coil to the cathode of the first AF valve. As these circuits do not use many components they may be checked very quickly. Alternatively, the circuit may be temporarily removed, whereupon there should be an increase in volume and probably in distortion as well.

To be continued

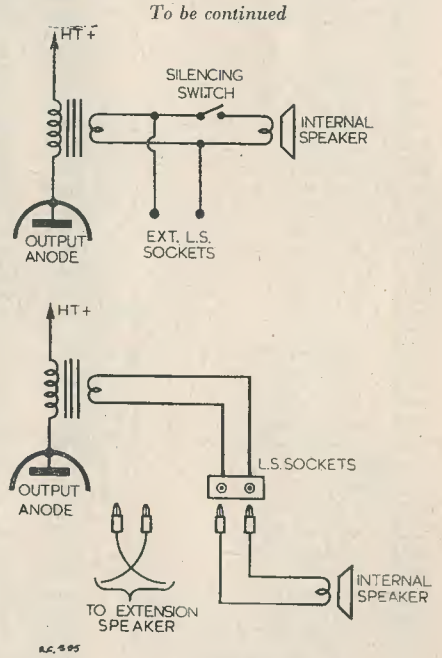


Fig. 35—a & b.

Fig. 35a (above). How a silencing switch may be connected in the speech coil circuit of the internal speaker so that an extension speaker may be used by itself.

Fig. 35b (below). An alternative system using plugs and sockets. The internal speaker may be silenced by removing one or both of the plugs.

Ex-R.A.F. COMPONENTS

In our August issue we gave a list of ex-RAF components, with the reference numbers and values. We now print a further list, compiled from details kindly sent in by readers H. G. Higgins (Birmingham), D. Warren (Weymouth), B. Carter (Reading) and G3XT (Saxmundham). As before, all the numbers given below are preceded by the reference 10/C, except where otherwise stated.

Capacitors

84	40 pF 2 Gang
90	65 pF Vari.
148	8μF
288	2.0 μF
437	0.5 μF
651	0.001μF
786	20 pF 2.25kV
787	40 pF
789	100 pF
794	0.006μF sil/mica
795	0.01 μF
797	0.1 μF
798	0.1 μF 1kV
800	0.1 μF
801	1.0 μF
802	0.001 μF
938	0.1 μF
965	0.001 μF
1090	1.5 μF
2010	200 pF
2018	10 pF
2038	200 pF
2039	50 pF
2040	0.25 μF
2041	200 pF
2042	0.004 μF
2043	0.004 μF
2044	0.005 μF
2045	300 pF
2053	0.25 & 0.5 μF
2086	6 pF
2090	6.0 μF 600V
2091	4.0 μF 600V
2123	5 pF
2157	0.02 μF
2162	4.0 μF
2165	0.01 μF 1kV
2174	0.25 μF 4kV
2220	2 pF
2223	0.1 μF 5kV
2368	0.01 μF 5kV
2374	4.0 μF 1kV
2634	0.25 & 1.8 & 1.0 & 1.0 μF 500V
2635	0.5 μF 500V
2922	1.0 μF 1kV
3084	5-40 pF disc trimmer
3101	300 pF
3102	0.004 μF
3103	0.01 μF
3105	0.004 μF
3299	25 pF trimmer
3320	0.25 μF
3339	400 pF
3381	0.001 μF
3383	40 pF
3404	2 pF
3415	600 pF
3431	0.03 μF
3464	2.0 μF
3580	0.001 μF
3850	40 pF Vari.
3851	28 pF Vari.
3855	40 pF Vari.
4032	3.0 μF 6kV
4236	200 pF
4321	100 pF Vari.
4323	300 pF 350V
4330	1.0 μF 500V
4429	0.015 μF
4474	0.15 μF
4479	25 pF
4763	200 pF
4807	5/15 pF Vari.
5215	0.5 μF
5328	1.0 & 1.0 μF 500V
5466	8.0 μF
5547	0.005 μF
5549	0.001 μF
5787	150 pF
5814	0.005 μF
5871	300 pF
7902	10 pF preset
8143	0.1 μF 2kV
10A/8496	0.01 μF
9180	2.0 μF
10A/9197	70 pF 3 Gang
10A/9198	200 pF Vari.
9630	1.0 μF 25V
10343	2.0 μF
10509	2.0 μF 450V
10546	2.0 μF 1kV
10553	100 pF
10824	4.0 μF 600V
10825	4.0 μF
10920	1.5 μF 4kV
11120	0.001 μF 1kV
11129	0.25 μF 500V
11138	0.01 μF 375V
10A/11192	0.1 μF 250V
10A/11394	0.25 μF 350V
10A/11486	100 pF
11540	0.05 μF 9kV & 100VAC
11576	2.25 μF 2kV
11973	1.0 μF 2kV
12101	0.005 μF 350V
12493	0.02 μF
12499	0.05 μF
12502	0.1 μF
12508	0.5 μF
12569	500 pF 2 Gang
12570	8.0 μF 125V
12634	1.0 μF 600V
12635	0.5 μF 800V
12655	2.0 μF 700V
12946	4.0 μF 250V
13210	10.0 μF 25V
13223	0.25 μF 500V
13271	8.0 μF 600V
14002	330 pF
14003	27 pF
14048	8.0 μF 275V
14302	25.0 μF 25V
14708	8.0 μF 400V
14904	0.008μF sil/mica
14905	900 pF sil/mica
15086	1.0 μF 350V
16968	0.1 μF 2.5kV

Resistors

56	20 K Ω
677	510 Ω
851	51 Ω
877	5.1 K Ω
1042	51 K Ω
1043	50 K Ω
1044	20 K Ω
1045	75 K Ω
1046	12 K Ω
1047	5 K Ω
1048	350 Ω
1049	15 K Ω
1050	20 K Ω
1051	7.5 K Ω

(*Continued on page* 114.)

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 first category* (*a*).

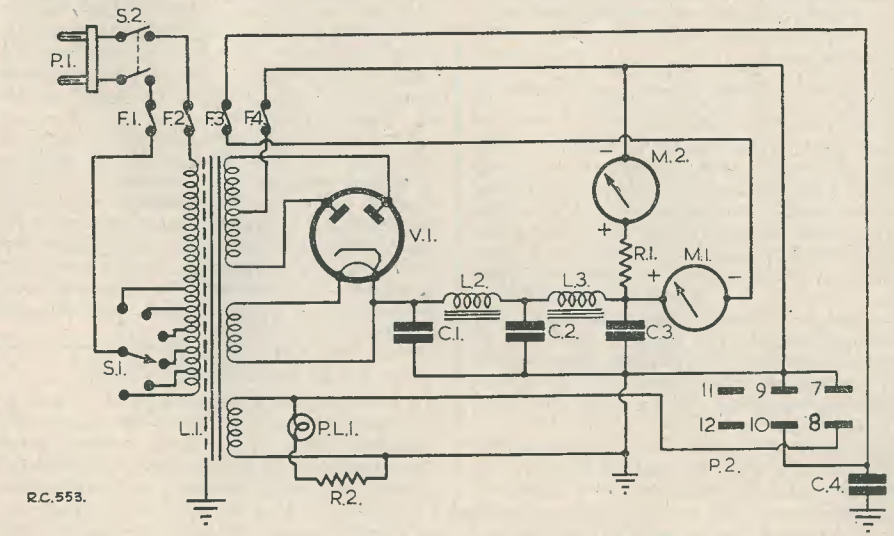
Power Unit Type 3 (10K/11517)

This power unit is built for 19-inch rack mounting. The front panel is 7 inches deep and enamelled grey, with chrome handles, and the dust cover is 10½-11 inches deep.

It was used with the R1132-R1481 style of receivers. No modification is required if suitable connectors are available, as the input is 200-250 volts in 10 volt steps at 50 cycles through a 2-pin plug (an electric iron socket is an ideal connector).

The output is 230 volts at 80mA DC and 6.3 volts at 4 Amps AC via a Jones socket (holes 7-12 type). All connections are at the rear of the unit. A study of the circuit diagram will show that a normal full wave valve rectifier is employed with two stages of filtering, the correct voltage being applied to the primary winding of the mains transformer by means of the "Mains Voltage

Continued overleaf.



COMPONENTS AND VALUES

1 Voltmeter, 300 Volts, 10A/11818, M2.
1 Resistor, External Voltmeter, 10A/11851, R1.
1 Ammeter, 150mA, 10A/8514, M1.
1 Mains Transformer, 10K/11850, L1.
2 Smoothing Chokes, 10K/42, L3, L2.
2 Fuses, 1 Ampere (input), 10H/96, F1, F2.
2 Fuses, 150mA (output), 10H/95, F3, F4.
1 Rectifier Valve, VU39, 10E/9600, V1.
1 Valveholder, British 4-pin.
1 Resistor, Wirewound, 3 Ω, 10C/1488, R2.
1 Electric Lamp, 6.5 Volts, 0.3 Amps, 5A/2130, PL1.
1 Pilot Lamp Holder, red, 10A/11846.
2 Capacitors, 6.0μF, 600VDC, paper, 10C/2090, C1, C3.
1 Capacitor, 4.0μF, 600VDC, paper, 10C/2091, C2.
1 Capacitor, 0.001μF, mica, 10C/470, C4.
1 Switch, toggle DPDT, 10F/11, S2
1 Switch, rotary, 1 pole, 6-way, 10F/10, S1.
1 Knob, black bar, for S1.
1 Plug, 2-pin, 10 Amp (input), 10H/530, P1.
1 Socket, Jones 6-way (output), 10H/98, P2.
1 Fuse Panel with 4 fuse-holders, 10K/11848.

BOOK REVIEW

" Television To-day."

By Roy C. Norris, Technical Editor of *Electrical and Radio Trading*. Publishers, Rockliff Publishing Corporation, Ltd., 1, Dorset Buildings, Salisbury Square, Fleet Street, London, E.C.4. With 278 line diagrams and 11 half-tones. Price **21s.** nett.

To the many televiewers, this book will be found to give a very clear analysis of the workings of television. Written primarily for the non-technical viewer, it is, however, ideal also for the person who makes television construction a hobby. 15 chapters, commencing with the earliest form of television apparatus (illustrated) such as the disc systems perfected by Nipkow and Baird. How television tricks the eye, scanning and synchronisation, time bases for electrostatic and electromagnetic tubes, and a host of secrets relating to television are explained in a very easy-to-absorb manner. British and American systems of television are explained, also large screen (projection) systems, and colour and stereoscopy. A final chapter on adjustments and fault diagnosis should prove very helpful, as there is very little information published on this subject. Altogether a very interesting book. L.E.H.

(SURPLUS RADIO EQUIPMENT—contd.)

Control " switch (S1) situated on the front panel. Some units were not fitted with the voltmeter but had a paxolin mask fitted, with a socket for use with an external meter, while others were fitted with an extra filter stage built on a chassis behind the fuse panel. Both the input and output circuits are fused, access to the fuses being gained by first SWITCHING OFF then removing the butterfly nuts and pulling the horizontal handle. The cartridge fuses will be found on the back of the plate. The rectifier valve, VU39, has direct replacements in CV1039, NU17 (R.N.), AU3A (Army), and (civilians) MU14, IW4, R3.

One word of warning—when removing the grime and dust from the front panel do not use the same vigour on the surfaces of the meter glasses that one would use on window panes, as the glass is stuck to the inside of the face, and age and adverse storing conditions may have rendered the adhesive ineffective, resulting in damaged movements.

ANSWERS TO QUIZ

(1) The most likely explanation is that his friend's mains supply was DC, to which a mains transformer presents a short circuit instead of a load. A fuse would have saved it, but many constructors omit this vital little component.

(2) The triode—or alternatively, the tetrode or pentode strapped as a triode.

(3) A high voltage is developed across the line output transformer during the very rapid line fly-back. It is possible to use this voltage for EHT by the use of a voltage multiplier type of rectifier circuit.

(4) Modern methods of construction have done much to eliminate this once troublesome effect. Metal front panels (earthed) with variable capacitors spaced away and connected to the controls by extension shafts of insulating material are effective. Coils, grid and aerial leads must, of course, be arranged where they are screened from the hand's effect. Incidentally, a carelessly arranged grid lead in a high-gain audio stage can pick up hum when the hand approaches it. That, however, is not due to a change in capacity as in the case of the fading caused in RF circuits.

(5) Wrong. It has quite a useful gain at radio frequencies, but some slight attenuation at audio frequencies. The by-pass capacitor prevents attenuation of RF, but the rectified signal is subject to 100% negative feed-back and the AF " gain " is about 0.9.

(6) In frequency modulation it has been found that by accentuating the high audio frequencies an improvement in " signal-to-noise " ratio is obtained. The " pre-emphasised " signal from the transmitter is passed through a circuit in the receiver which reduces the high AF to normal, and in so doing also reduces the " noise " which may be picked up. Pre-emphasis, therefore, may very simply be compared with treble-lift, and de-emphasis with treble-cut.

CLUBS PLEASE NOTE

We have received a sample copy of " Electrons in Triodes " from the Edison Swan Electric Co., Ltd., 155, Charing Cross Road, London, W.C.2. This most interesting publication is the second in a series now being produced, and explains the history and working principles of the triode in a very lucid manner. Other valves will be dealt with in later booklets. Copies are available free, as published, to Education Authorities, Radio Societies and other bona fide bodies.

(Ex-R.A.F. COMPONENTS—contd. from page 112.)

1052	820 Ω	1903	100 Ω	8228	0.1 Ω
1053	68 Ω	1916	15 K Ω	*Potentiometers*	
1054	16 Ω Tapped at 10 Ω	6119	24 K Ω	1800	200 K Ω
1055	10, 2.9, 5.3, 12.6 & 69.2 Ω	6833	16 Ω Tapped at 10 Ω	8026	2 K Ω
1056	10, 19.5 & 19.5 Ω	6835	1 M Ω	9205	55 K Ω
		7908	1.5 Ω	*Westectors*	
		8208	5 K Ω	10D/22	WX12
				11080	WX6

THE CONSTRUCTION OF WAVEMETERS

By P. F. T. Redman, ISWL/G186, BRS15383

Foreword

IN every ham-shack a wavemeter of reliable stability is a necessity. I wonder how many of the VFO's outside the band are due to wavemeters which have gone off frequency without the operator knowing it! Most wavemeters consist of a variable frequency oscillator working in conjunction with a crystal oscillator for check purposes. It is desirable that both the oscillators should be capable of being modulated with a 400 or 1,000 cycles audio note. An extra refinement is to have a variable attenuator, since a local signal could easily block a receiver sufficiently to make calibration impossible. Also, in the wavemeter it is usual to incorporate a detector with headphone output, with if possible a tuned circuit in the grid input. It can then be used as a phone or CW monitor, which will save space and enable a constant check to be kept on the signal radiated. It will now be obvious that it is necessary to be able to switch the oscillators on and off, since otherwise blocking will result. The accuracy of the finished instrument will depend upon mechanical rigidity, stability of the power pack and the Q of the tuned circuit. For really accurate work it is advisable not to use a VFO for check purposes above the fourth harmonic, hence it would be best to have several, one on 1.7 Mcs, one on 14.0 Mcs and one fixed oscillator on 112.0 Mcs. for checks on VHF frequencies.

Far too many hams take the construction of a wavemeter too casually. In reality it requires considerable forethought, planning and care in construction—if any part of the work is hurried, an unreliable wavemeter will result without any doubt! One of the main troubles is the famous dry joint—at all costs it is advisable to make absolutely certain that all joints are OK. Another important item is the maximum tolerance of the components. If possible they should be ±1% in the tuned circuits and ±10% elsewhere, likewise the rating should be 2 Watts or (preferably) 5 Watts for all resistors, and the voltage working of the capacitors at least 350VDC. The above remarks apply equally well to any test equipment.

Circuit

The Block Schematic of a wavemeter can be seen in Fig. 1. It will be noted that it incorporates all the above features, namely, 1.7 Mcs oscillator, 14.0 Mcs oscillator, 112.0 Mcs oscillator, Xtal check oscillator and detector. At first it might be thought that there is a lot of work involved in building this wavemeter, but if the blocks are constructed one at a time you will soon get it built up and working. As with any radio apparatus, exact dial readings for the equipment cannot be given, due to different layouts, etc.

It will be seen from Fig. 2 that both the variable oscillators use the now famous Clapp oscillator circuit. This type is very stable and also easy to get perking. The output is taken via a 50pF variable to the aerials, which can be short brass rods ¼" dia. and about 8" long. In this circuit I have omitted a switched attenuator, but the 50pF variables are quite effective. The HT supply can be either 120V or 240V stabilised;

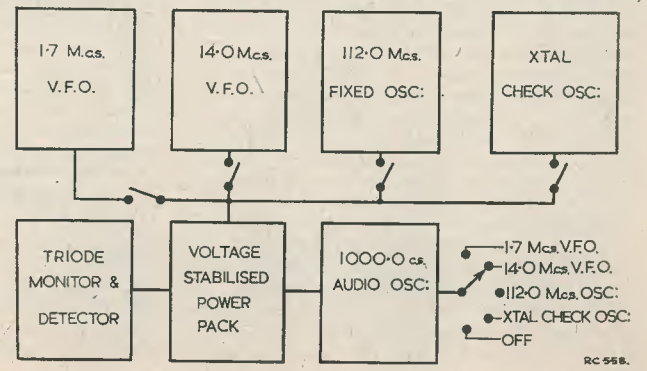


Fig. 1.

Block schematic of a comprehensive wavemeter.

the mains transformer for 120V should give 250V and for 240V should give 350V, both types rated at about 50-60 mA, with LT windings of 6.3V-3A and 5V-2A. If possible the transformer should have an earthed screen between primary and secondary windings. If necessary, an AC/DC pack could be used, but the series dropping resistor should be kept well away from the oscillators.

It will be seen that the oscillators are separately switched, and that the audio oscillator also can be switched to the different oscillators at will, thus enabling location of the marker points easily without mixing them up with other stray signals. The detector does not need to be at all elaborate, since it will be used only for monitoring transmitters in the shack and to check their frequency in conjunction with the check oscillators. As in both cases the signal strength will be fairly high I have used a simple leaky grid detector circuit. This gives ample output for normal use, with Tx's working from upwards of 1 Watt. The 100pF variable capacitor between the aerial and the tuned circuit again acts as an attenuator.

Construction

The valve and component layout is straightforward. The chassis and screening compartment should be of 16 swg aluminium, whilst inter-stage screens can be of 22 swg brass, which will make cutting easier. All holes in the chassis through which wires pass should have rubber grommets in them. All components should be anchored to tag boards or else screwed to the chassis, since the movement of components will cause instability in the accuracy of the frequency checks. Wiring-up where possible should be done with 16 swg wire, in order to ensure rigidity. The coils should be wound on 1" dia. formers for 1.7 and 14.0 Mcs with the wire stretched as tight as possible on the formers, while the 112.0 Mcs coil is an air-spaced coil of 16 swg silver plated copper wire.

Components

The components used in the oscillator circuits should be of the best quality obtainable, with ceramic capacitors and 2 Watt carbon resistors. The tuning capacitors should be air-spaced, and as rigid as possible, with ceramic insulation. The rest of the circuit can use $\pm 10\%$ accuracy components in the Xtal check oscillator and audio oscillator stages. The individual stages should be well spaced out with screens between each one. The slow motion drive used on the VFO's should preferably be of the Muirhead 50 : 1 reduction types for fineness of tuning. The neon stabilisers can be the usual 4-pin types and R11 adjusted so that they always strike irrespective of whether all the stages are switched on or not. R11 will vary with the valves used, but it should not be less than 1,000 ohms in any event, otherwise the stabilisation will suffer. It will be found that the neons will add a lot to the smoothing of the power supply. Tag boards should be mounted $\frac{1}{2}$" from the chassis to reduce capacity to earth, likewise screened leads should be reduced to a minimum. The valves used can be either triodes as shown or, for larger output, pentodes can be employed, a suitable type being the EBC33. In particular, if it is found that the 14.0 Mcs oscillator will not give sufficient harmonic output for requirements, it will be found advantageous to use an SP61 RF pentode, the screen grid of which should have a 10K resistor to HT+ and a 0.1μF capacitor to earth. As will be seen in Fig. 2, the outputs for the 1.7, 112.0 Mcs and 100 kcs oscillators are all taken from the cathode, this position giving sufficient output for wavemeter purposes. In the case of a VFO for a Tx, the output is higher at the anode, in which case a pentode should be used. (I will later be writing several articles on VFO construction for transmitter drive units, but in this article we will stick to wavemeter applications.) The switches S1, 2, 3 and 5 are all single pole on/off switches. S6 is a single pole 5-way rotary switch, and need not be ceramic. T1 is an inter-valve transformer (any ratio between 2 : 1 and 5 : 1 will do), T2 is another inter-valve transformer, with a ratio of 5 : 1 to match high impedance headphones to the triode output. In the case of T2 a ratio of 15 : 1 would be better, but one of 5 : 1 works quite satisfactorily. The neon stabilisers can be standard four-pin types working at 120 volts, two of them giving a stabilised output of 240 volts, which is sufficient to run the wavemeter.

The 100 kcs. crystal should be mounted on top of the chassis in a clear position away from any hot components, in order to improve stability, since this will be the main sub-standard for frequency checks. The mains transformer should be run well under its ratings in order to help the regulation of the power pack, the heater windings should have minimum ratings of 5V-2A for the rectifier and 6.3V-3A for the oscillators, and the HT winding should be rated at 350-0-350V at 50-60mA.

Conclusion

In conclusion, the wavemeter just described is not claimed to be perfect, but it does embody several interesting features, such as three check oscillators, a 100 kcs crystal in a Clapp oscillator circuit improving stability, separate switching of each valve, etc. It will be found that if the unit is built with care it will prove very reliable and accurate, and will cause a minimum of trouble in checking the frequency of the transmitter. Another feature is the signal strength meter in the detector stage, which enables final touching-up of the transmitter to be made.

DUODECAL BASE CR TUBES

The first Mullard Television Tubes in the new Duodecal Base are now coming off the lines. Production is limited at present, and it will be some time before a complete change over to the new base will be accomplished. The principal feature is a large diameter spigot which accommodates the exhaust stem of the tube.

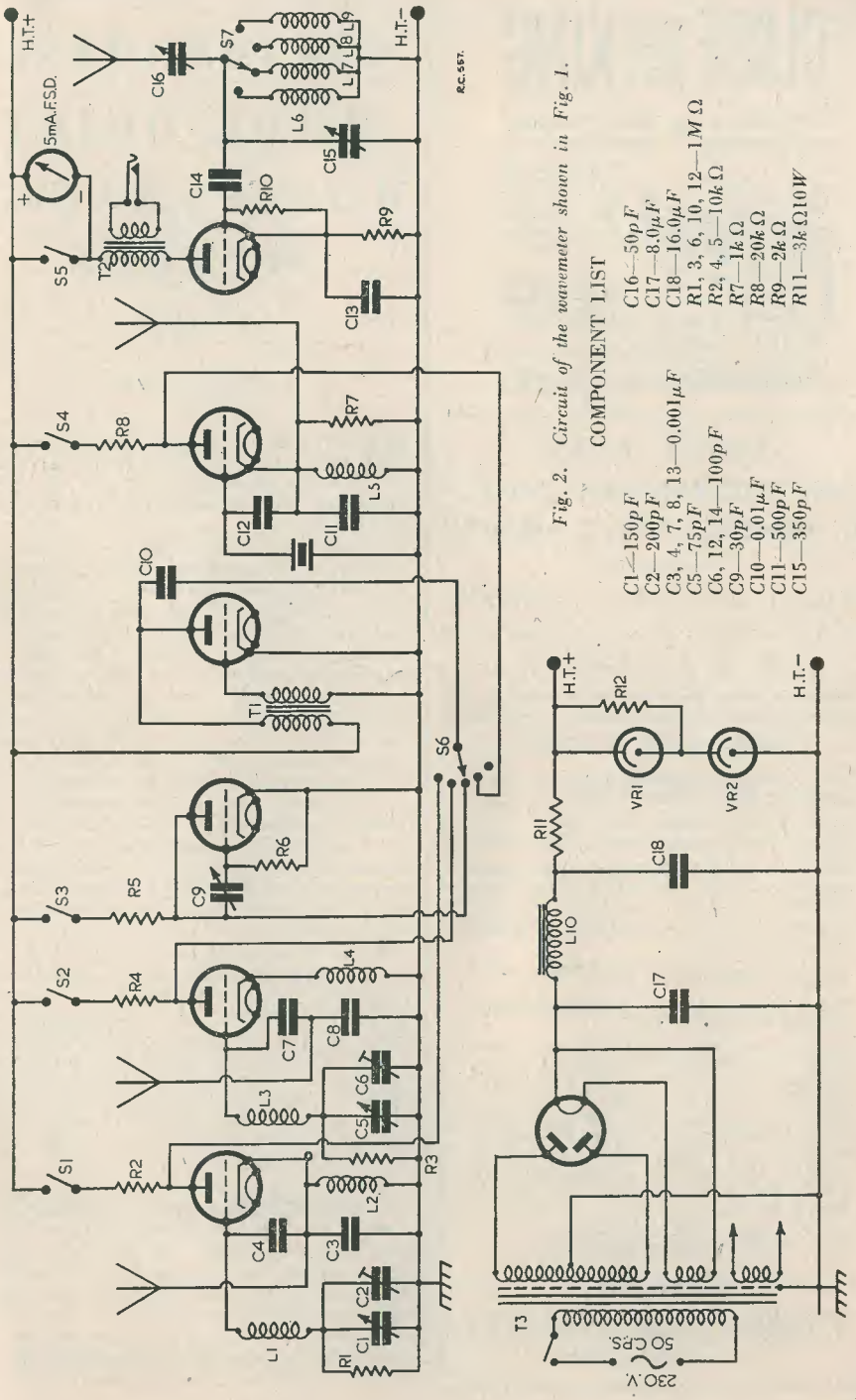


Fig. 2. Circuit of the wavemeter shown in Fig. 1.

COMPONENT LIST

C1—150pF
C2—200pF
C3, 4, 7, 8, 13—0.001μF
C5—75pF
C6, 12, 14—100pF
C9—30pF
C10—0.01μF
C11—500pF
C15—350pF
C16—50pF
C17—8.0μF
C18—16.0μF
R1, 3, 6, 10, 12—1MΩ
R2, 4, 5—10kΩ
R7—1kΩ
R8—20kΩ
R9—2kΩ
R11—3kΩ10W

CALIBRATING HOME-BUILT MULTI-RANGE METERS

by

PETER DAW

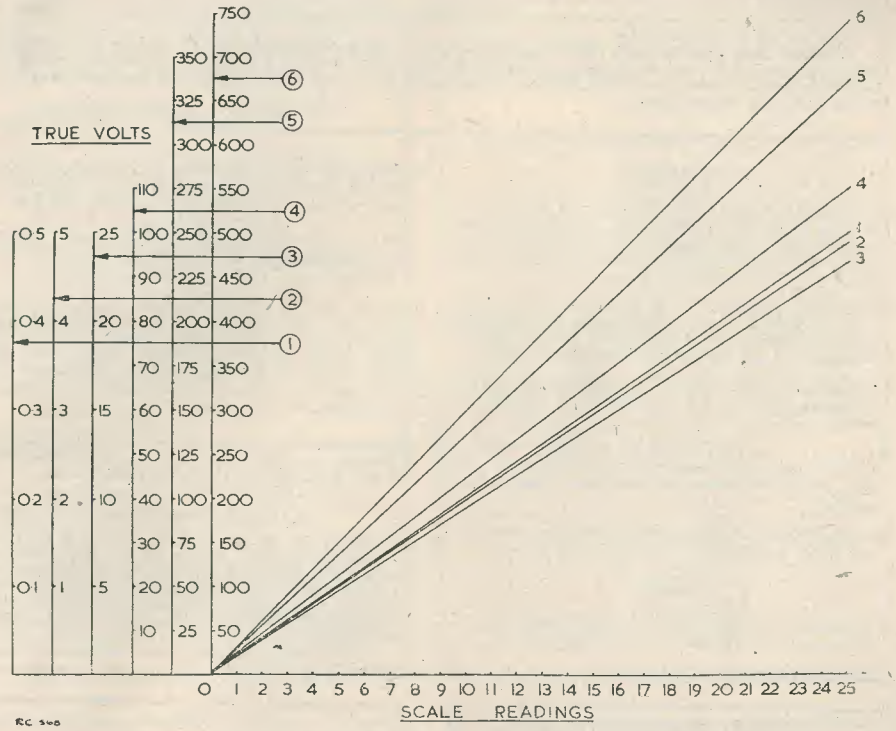
MANY amateurs of limited means have constructed multi-range test meters around surplus milliammeters, only to find a deplorable lack of accuracy in the finished instrument.

For this there are two main reasons; firstly, the resistance of the meter may not be exactly that marked on the dial—my own 0.5 mA moving-coil instrument is marked "less than 500 ohms" and has an actual resistance of 472 ohms, as measured on a good bridge. Secondly, the theoretical ranges of the test meter may be upset by resistor tolerances, and by errors in winding current shunts; few people can afford ½% or 1% resistors, and in any case many of the odd values needed are not obtainable, and would have to be made up of two or more resistors at 1/6 each.

The simplest solution is to select the nearest values of ordinary 10% resistors; but remember to choose suitable wattage ratings—for a 0.5 mA instrument, ¼ watt is suitable for voltage readings up to 400 volts, and ½ watt up to 750 volts; beyond that, the amateur should consider the valve voltmeter.

When wiring is complete, borrow an accurate multi-range meter for a few hours—one advantage of "club" membership, maybe. Now measure as many voltages as you can, on the borrowed meter in volts, and on your own *in scale-divisions*. Get readings for each voltage on as many ranges as possible. Low ranges can be covered by using torch cells and a grid bias battery; higher ranges can be covered from receiver HT lines (the actual voltages are immaterial so long as they can be read on both meters).

Now plot the results on a sheet of graph-paper; set all the *true* voltage scales side by side on the vertical axis, and your instruments scale divisions on the horizontal axis. Plot the readings for the first range and draw a straight line through the mean path of the points; this should pass through the origin (the readings nearest the origin are the most likely to be inaccurate, and may be disregarded if sufficient higher readings have been taken). Label the line, and repeat for the other



ranges. True voltages can now be read on the appropriate range line.

Coloured inks for the various ranges are helpful; the card may be mounted and varnished.

The full scale true voltage readings for each range may be used to find the actual value of the series resistor *plus* meter resistance, by Ohm's Law, $R+r=\frac{E}{I}$. Thus, for a full scale reading of 700 volts and a 0.5 mA instrument, $R+r=\frac{700}{0.0005}$ =1.4 megohms.

Similar methods can be used to calibrate for DC current, AC volts, and ohms.

Does it sound a tedious business? It took me 40 minutes to calibrate 6 ranges.

Have you entered

★ for our ★

Receiver Contest?

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