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RADIO CONSTRUCTOR

for the Radio and Television Enthusiast

IN THIS ISSUE . . .

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Radio Constructor

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World Upside Down

Did you notice in our last issue that the illustration heading this page was upside down? Purely co-incidental, of course, it was emblematical of the state in which publishers found themselves as a result of the printing trade dispute. Looking on the brighter side, though, it could also represent our endeavours to cater for our hobby by approaching it from all angles.

Editorial

Radio Shows

During this past month, the National Radio Exhibition has been held at Castle Bromwich. Before the war, this show used to be well attended by radio constructors and experimenters, for they could be certain of a fair number of exhibitors who were interested in meeting their requirements. Today, the position is not so satisfactory, and those of us who attend do so mainly in the hope that we might get some ideas which we can develop.

However, the short wave enthusiast is still being catered for by the Amateur Radio Exhibition. Organised by the Radio Society of Great Britain, the show will be held this year at the Royal Hotel, Woburn Place, London, W.C.1., from Wednesday, November 22nd to Saturday, November 25th. We shall be pleased to see you at Stand 4.

CAR QRM.

In his excellent speech opening the Birmingham exhibition, the Lord Mayor of Birmingham laid special stress on the need for suppression of interference from motor vehicles. A good example has been set by Birmingham itself in this respect, as all municipal vehicles have already been fitted with the necessary equipment. There is a saying to the effect that what Birmingham thinks today, the rest of the country thinks tomorrow. Let us hope that this still holds true.

G2ATV.

NOTICES

THE EDITOR invites original contributions on construction of radio subjects. All material used will be paid for. Articles should be clearly written, preferably typewritten, and photographs should be clear and sharp. Diagrams need not be large or perfectly drawn, as our draughtsmen 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.

A Simple

VALVE VOLTMETER

by T. HATTON

THE valve-voltmeter is a rather terrifying affair to the average constructor. A home-built one needs careful construction and high grade components, and the trouble and expense are rarely justified by the results. It is, nevertheless, a very great asset. Consider the case of a high gain amplifier using EF39's, which refuses to work properly. In a proper examination of such an amplifier, it is necessary to know the working screen voltages. If an ordinary voltmeter taking, say, 1 mA for full scale deflection (FSD) is used to measure this voltage, the reading of the meter will be about 20% of the true value or even less, since the increased voltage drop across the decoupling resistor caused by the relatively high consumption of the meter will result in a very low value of HT on the screen grid. The obvious solution to the problem is to reduce the current taken by the meter to read FSD. One of the simplest ways of doing this is to arrange for part of the voltage to be measured to influence the bias of a valve. Then the anode current of the valve will change, and the change may easily be measured on a fairly insensitive meter.

In current practice, it is usual for the meter used in conjunction with the valve to be as sensitive as is practical, so that a very small change in bias may be measured with accuracy, and also so that the valve may be operated on a small, quite linear part of its " Ia — Vg " curve (i.e., its mutual characteristic). For most purposes, however, an ordinary meter is fairly accurate, and the valve voltmeter may be pruned of its expensive luxury fittings, and its cost reduced to a minimum, whilst retaining the advantages of practically negligible current consumption.

This instrument is battery operated, which has the considerable advantage of being ready for use as soon as it is switched on, at the cost of a slight loss of accuracy as the batteries age. These are not expensive, however, as the HT is supplied by two ordinary GB batteries. The valve used is the ex-government type VR21, which is the equivalent of the Cossor 210LF, and is readily obtainable as surplus. The meter is a fairly sensitive one, being 0—500 μA FSD, but these again are easily bought as government surplus for about 7/6, and may clearly be recognised by the appear-

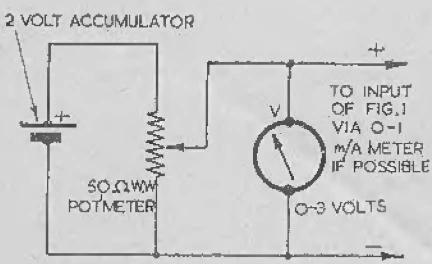

Fig. 3: Showing how to calibrate the valve voltmeter.

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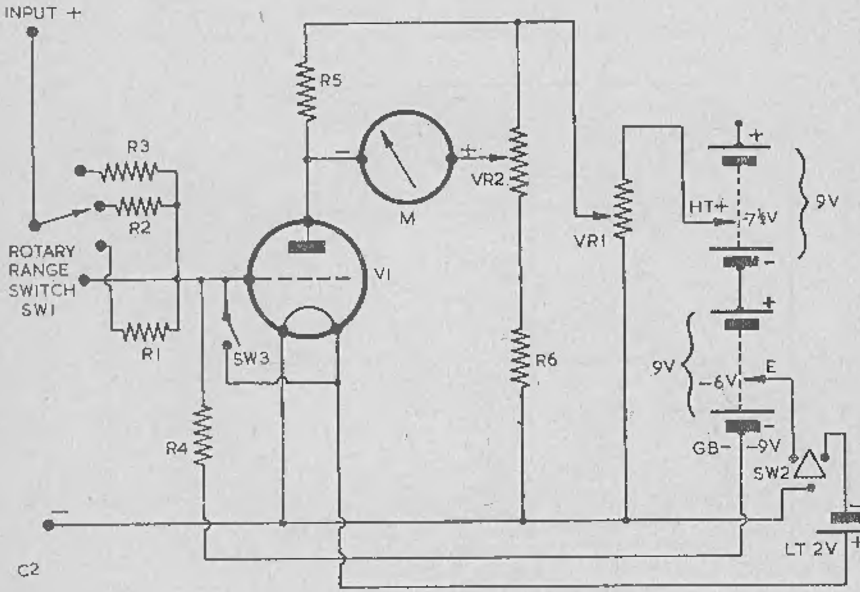


Fig. 1. Circuit of the valve-voltmeter.

COMPONENT VALUES

R1, 1.8 M Ω ¼W ± 10%
R2, 10 M Ω ¼W ± 10%
R3, 10M Ω + 10 M Ω ¼W each, in series, ± 10%
R4, 200 k Ω ¼W ± 10%
R5, 20 k Ω ½W ± 20%
R6, 56 k Ω ¼W ± 20%
VR1, 10 k Ω pot.
VR2, 25k Ω pot.
V1, VR21 (Cossor 210LF)
M, 0—500 μA FSD, 2″ diam.
Sw1, Single pole 6 way Yaxley
Sw2, DPST switch.
Sw3, On/Off toggle
HT, 2× 9v GB batteries
LT, 2V jelly acid accumulator, abt. 15/AH rate.

ance of the dial. This is black, with two scales, 0 — 600 and 0 — 15 volts, in luminous paint. This, of course, means that the calibration will have to be made in white paint, as it is not practical to paint the scale white without first removing all the black background. This is a rather difficult job, so it is best to do the painting, with a fine camel hair brush, leaving the scale plate in position.

The resistors used in the construction of the meter need not be of greater accuracy than ±10%, since a high standard of accuracy has not been aimed at.

The layout and construction are not critical, since the meter is only to be used for DC measurements, but the constructor is advised to use a jelly-acid type of accumulator as a source of LT rather than a dry cell. The accumulator forms a reliable source for checking the calibration (by Sw3) since its own terminal voltage may reasonably be regarded as being from 1.9 to 2.15 volts, and also because it does not give the variations in heater current — and consequently in emission — that the dry cell does. The layout of the original instrument is shown in figure 2, and is perhaps unusual in that all the components are fixed to the back of the panel.

The view shown is of the back of the panel, and may be redrawn full size as a template for drilling and cutting the ebonite. It is preferable to use ebonite rather than aluminium for

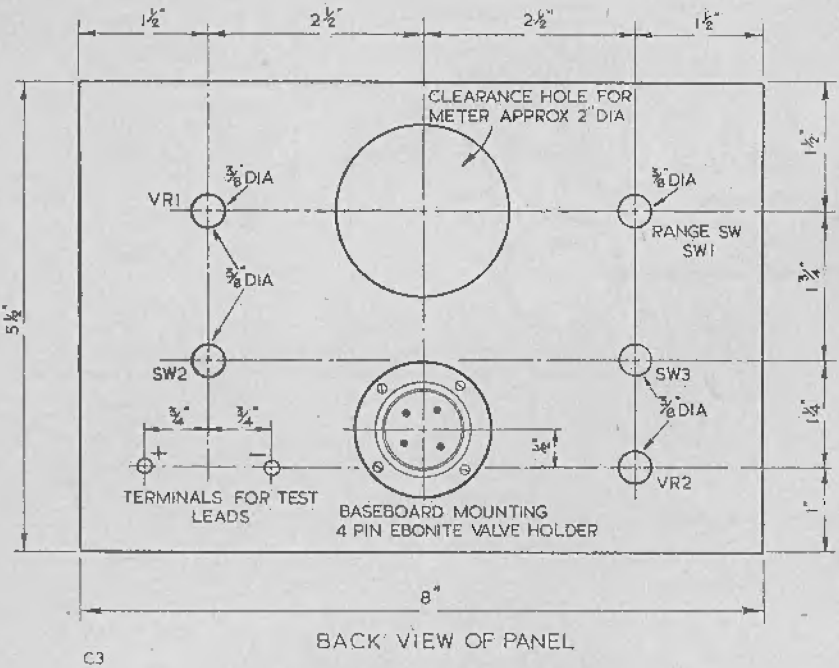


Fig. 2: Layout Arrangement

the panel, since ebonite improves the general insulation of the meter.

When complete, the instrument fits into a wooden box at least 4″ deep (this is the minimum depth to clear the valve.), with a lid about 1½″ deep to accommodate the test leads. The panel does not completely fill the box, leaving a space about 2″ wide above the meter, to house the accumulator and two grid bias batteries. It may be necessary to turn the grid-bias batteries on one side, to clear the jelly-acid accumulator, if this happens to be an exceptionally large one. The box used in the original instrument was the surplus transit case (RAF) of the crystal monitor type 2, but these do not seem to be very plentiful.

Calibration

When the instrument is completed, it is necessary to calibrate it. The scale must first be painted out, as has been described, then the circuit of fig. 3 should be briefly hooked up. The voltmeter involved should be the best obtainable at the time.

First of all, make sure that the battery plugs are all in the correct sockets, and that the range switch is on "2 Volts". Sw3 must be left normally open, unless making the approximate voltage check previously described. Then with Sw2 switched on, and the input voltmeter of fig. 3 reading 2 volts input, adjust VR1 for FSD. Then VR2 is adjusted for zero with 0 volts input, and then VR1 again altered for FSD on 2 volts. The intermediate points may then be calibrated by rotating the potentiometer of fig. 3, and noting the voltmeter readings, marking these off on the valve-voltmeter scale with a pencil. It may be found impossible to reach FSD with only 2 volts input. In this event, the HT positive tap should be moved to the next plug up the "HT" battery.

If possible, a 0 — 1 mA meter should be inserted in series with the positive input terminal of fig. 1. This will then deflect slightly to show about 15 μA. This is a proper value. Any greater grid current will indicate that the valve is slightly "soft", and is consequently not suitable. Grid current may be permitted, however, up to about 30 μA. It is best to try out all the battery valves available and select the one which passes the least grid current.

In the calibration of the original instrument, a graph was made of the readings given by the original meter in the valve-voltmeter, against the true voltage input, to give the constructor a guide as to the linearity of the scale. It will be seen from the graph that this is extremely linear, except at the low voltage end, where it is very open. This is in marked contrast to the normal cheap type of milliammeter, whose scale is cramped at the low-current end. For this reason, it was decided to give each voltage range a liberal overlap onto the next, although such a course was not essential. It has the advantage that readings of extremely low voltages are possible.

In use, the instrument gives reliable, and surprisingly accurate indications of the voltages existent on the screens and anodes of R—C coupled amplifiers, and may be used for all normal voltmeter applications.

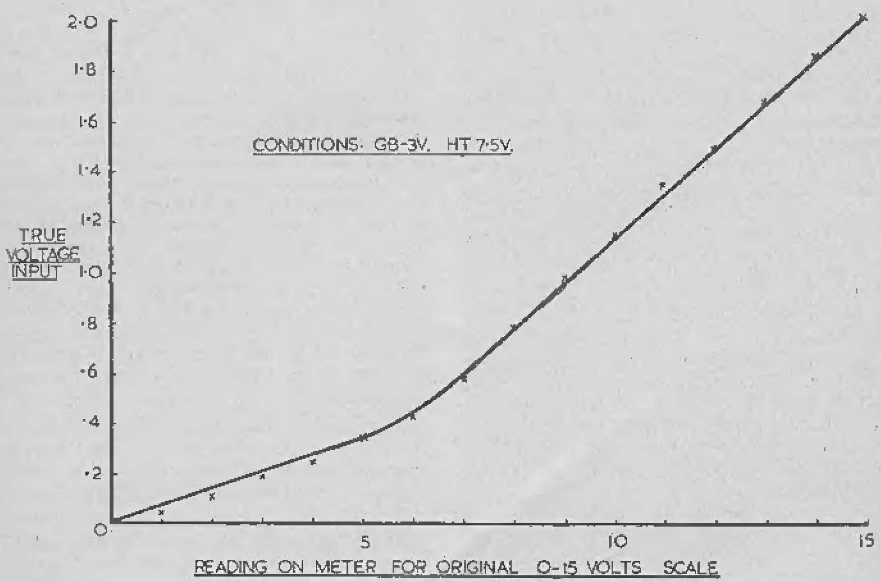
It is practically impossible to damage it electrically. Where an ordinary voltmeter would be burnt out by severe and prolonged overload, the worst damage that the valve voltmeter can sustain is a bent pointer, which may be straightened out with care.

The voltage ranges on the original were found to be sufficient for normal use, but further ranges may be derived as follows: the resistor required to be added in the same way as R1, R2, R3, etc., is Rx = (Vmax x 100,000) —200,000 in ohms, where Vmax is the maximum voltage of the range required.

It was not considered necessary to extend the range of the instrument beyond 200 volts, especially in view of the difficulty of obtaining the rather high values of resistor required.

The Cover Photo

shows the neat and compact appearance of the Valve Voltmeter described in this article, as built by the writer.



Radio Miscellany

"Detector" Vans

I suppose many readers are amused whenever they hear accounts of the drives by the Post Office Engineering staff on "pirate" listeners—those forgetful souls who fail to remember to take out receiving licences.

The solemnity with which the announcers read the item in the news bulletins, when reporting the usual rush on the local Post Offices, always seems to me to conceal a veiled threat of further 'raids'. Perhaps the effect on other districts is salutory.

It is surprising what wonders the lay public attributes to these mysterious detector vans, probably because of a combination of vague memories of the variety of uses to which radar has been put, plus a little imagination. To the guilty, the 'scenting out' of unlicensed receivers probably seems child's play to apparatus which can locate submarines, penetrate darkness and fog, reveal minefields and plot the approach of hostile aircraft. Credibility is heightened by an overdose of "scientific" cartoon strip stories and cheap fiction, so beloved by those who can read only simple words.

It is significant how effective these raids are in the poorer districts. Nothing happens in the street without it being watched by a score of inquisitive eyes, and those who do not actually see the ostentatious display of "detection" are soon warned by bush telegraph rumours which fly over the backyard fences.

I have never discovered what steps, if any, are taken to shake up the better-class areas of suburbia, where rumour would take a fortnight to travel past four houses. Perhaps there are not enough pirates in those areas to make the chase worthwhile.

The Good Old Days

Thinking of piracy brings back memories of the good old days when broadcasting was in its infancy. There were legions of them. At first they were incredulous and later tickled to death because they couldn't get a licence! The amazing part of it was that it went on for many moons while they openly used their receiving apparatus'.

When it was at last decided to issue them with licences, nothing was said about the arrears and, needless to say, they didn't press the subject.

Broadcasting in this country had a slow and tortuous birth. Officialdom dithered and delayed. The higher the official circle, the less it was realised that broadcasting would soon sweep the country by storm and become a part of daily life. The example of America, where they had two years start of us, should have been sufficient to convince even the most obtuse.

When after prolonged negotiations regular broadcasting was commenced, a form of licence was devised which made it a condition that the receiver to be used was one manufactured by a member of the British Broadcasting Company. As more or less every radio manufacturer was a member, this, apart from the royalty payable, seemed a pleasant enough arrangement, the idea being to exclude foreign-made receivers and components.

High officials, with their usual narrow outlook, estimated in their wisdom that the number who would be able to make their own receivers would be very small, and they would be adequately covered by an "experimental" licence. This was to cost the same as a Listeners licence, ten shillings.

Old timers will remember just how simple those home-made sets were. A crystal and a tapped coil and Bobs-your-Uncle!

In a couple of months, it was found that of the first 18,000 licences issued, a third of them were Experimental, and the ratio threatened to grow to alarming proportions. So the issue of Experimental licences was promptly suspended, and it was announced that they would only be granted in cases where the Post Office was reasonably satisfied that the applicant was an experimenter and actually making his own set — not simply hooking up ready made components. This would be about January, 1923, and the home constructor gaily applied for an Experimental licence and within a few days received a postcard acknowledgment. He then merely sat tight while the P.O. made up their minds whether to classify him as an "experimenter" or a "hooker up-per".

I certainly never heard of a case where anyone was classified as one or the other. Things dragged on while the issue of a third form of licence for constructors at a cost of £1 was discussed.

The constructor, as there was no licence to meet his case, was forced to remain a pirate. Needless to mention all his pals, as they too became interested in this new hobby, took good care that they also became pirates!

It was reliably estimated that within three months the ranks of the pirates had swollen to 200,000, made up of an unknown proportion of bona fide constructors plus the smart guys who simply evaded payment.

Over eighteen months elapsed while it was being decided at high levels whether the fee for a constructors licence should be 15s. or £1. Eventually a uniform licence at 10s. was started in July, 1924. It was stated afterwards that nearly a quarter of a million " pirates " stepped up to take out licences within ten days, and no charge was made for the past use of their receivers. They were the genuine constructors — the smart guys came along more gradually. Perhaps they even held out until the mysterious "detector" vans descended on their districts!

in Antwerp in 1880. By 1894, the Electrophone Company were operating in London and connecting subscribers to theatres and churches. Similar services were started in other parts of the world, and some of the programmes even included news bulletins.

I believe the first instance of relaying broadcast programmes was in a Hampshire village in 1924, where a radio dealer, who also ran a local cinema, used a self-built receiver for the purpose. Finding that several loud-speakers connected at a distance of a half-a-mile gave satisfactory reproduction with but little loss of power, he connected them up to the houses of a few friends. It panned out well, so he decided to develop the system on a commercial basis.

Over two years later the G.P.O. found out about it, and promptly pointed out that the whole business was clearly 'agin the law'. It was most certainly a contravention of the licence, and a possible infringement of the Telegraph monopoly. The cat would have been among the pigeons and the life of relayed radio might have been brought to a speedy end, but for a strange circumstance. Permission to relay programmes had already been granted by the local main Branch Office!

Finally it was agreed to licence such undertakings, and new Exchanges sprang up all over the place. Bit by bit restrictions were introduced, and since 1939 they have lived under the threat of compulsory purchase.

It is curious to look back on the history of wired programmes and to note that, although it preceded radio broadcasting by so many years, its possibilities were never widely appreciated. The Electrophone Company and similar concerns never appear to have had more than a comparatively tiny number of subscribers. It remained for radio to demonstrate what a large potential audience there really was for a comprehensive form of home entertainment. If we are to look upon radio as being nothing more than entertainment, wired radio may yet prove the solution to the fierce competition of the over-populated broadcast bands. Real radio may then be confined to the propaganda which the various Powers insist on showering upon the rest of the world.

CENTRE TAP *talks about*

DETECTOR VANS – EARLY LICENCES – WIRED BROADCASTING

Wired Broadcasting

Only the statistically minded will have realised the growing importance of wired radio. Its subscribers have grown from a mere handful, until to-day there are over a million. Many advocates have put forward a case for the development of systems using the normal telephone wiring, or even the mains, for programme distribution. B.B.C. officials take more than a passing interest. In fact, they have been known to urge that the Corporation itself should enter the field of Relay Exchanges, and the question always pops up whenever the congestion on the broadcast bands is discussed.

In the early days the B.B.C. vigorously disapproved of relayed radio, particularly as the number of subscribers began to rise. The Relay exchanges sometimes used sponsored programmes, and in doing so threatened that august body's programme monopoly. Of course, they put it a little more diplomatically. The relaying of programmes must be " controlled ", was the cry — they might be disruptive of the spirit and intention of the B.B.C. charter and change the general trend of their programme policy.

Perhaps the first instance of the distribution of programmes by wire was over a distance of a couple of miles, from one cafe to another,

Amplifying Intercom Systems PART 3.

by J. R. DAVIES

LAST month we discussed various means of connection and switching which would enable an intercom system to be used as a master unit with remote stations. We also discussed another type of installation which would allow each station on the system to call another station without the necessity of a master unit at all.

Although, for the second type of installation, we evolved a very satisfactory circuit, there were two inherent disadvantages. Firstly, one could not be certain that one's conversation was not being overheard by another station, and secondly, the installation was not entirely foolproof insofar that incorrect manipulation of a switch could cut off speaker communication between two stations.

Using Relays to Select the Station

In this month's article we intend to discuss a really foolproof system which meets all the requirements of a multi-station amplifying intercom system in every possible way.

The system which we are about to consider uses what may best be described as a small "exchange" to enable one station to contact another. Although at first sight of the somewhat fearsome circuit shown in Fig. 1, it might appear complicated, in actual fact it is quite simple. Closer examination of Fig. 1 will show that all the complication is confined to the wiring in the relay unit, and if this wiring is traced out it may be seen that the somewhat large amount of lines shown are only used in duplicating contacts between the two banks of relays.

It may be remembered that, in the system shown in Fig. 6. of last month's article, it was necessary to use nine interconnecting leads between the various stations and the master unit. There was some advantage insofar that the leads were all in parallel and could be run from one station to the next. However, two of the leads had to be separately screened, thereby increasing the original cost of the installation.

In the circuit shown here, ten leads are used between each station and the relay unit (which should be fitted close to the amplifier). Seven leads, however, are common to all stations and may therefore be run through the whole installation. Unless speaker leads to separate speakers run close together for some way (whereupon they should be screened over that distance) there is no necessity for screening at all, (provided that there is little risk of hum pick-up).

The circuit shown in Fig. 1 will accommodate five separate stations. Stations No. 2 and 5 are shown in the diagram as well, but the interconnecting leads are omitted for simplicity.

The Relay Unit

The relay unit consists of eleven relays. Five relays (1A to 5A) are used to enable contact to be made to the station required. The second five relays (1B to 5B) are used to enable the calling station to have control of the "Talk/Listen" facilities and also to indicate whether the amplifier is "Engaged" or not. These ten relays carry out other duties which will be explained as we reach them. The eleventh relay is the "Talk/Listen" relay.

All the relays are energized from a positive source of supply which is marked in the diagram as a positive sign with a circle around it. The chassis of the relay unit forms the negative return for this supply. The method of obtaining this source of supply will be shown later. Also supplied to the relay unit is 6.3 volts AC, which is used for calling purposes, and which may be obtained from the heater supply in the amplifier itself. All energizing of the relays is carried out by completing the circuit between the negative end of each relay coil and chassis. All the relay coils are permanently connected to the positive source of supply.

An additional lead above the nine interconnecting leads shown in Fig. 6 (last month's article) is used in this system. It is called the Negative Switching Lead and is used to ensure that only one operator may control the circuit at any time.

The Working of the Unit

Looking at Fig. 1, let us now imagine that Station 5 wishes to call Station 2. He first of all switches his "On/Off" switch to "On". This does two things. Firstly, it supplies a chassis connection for the selector switches *via* Negative Switching Lead No. 5, and, secondly, it closes the relay 5B.

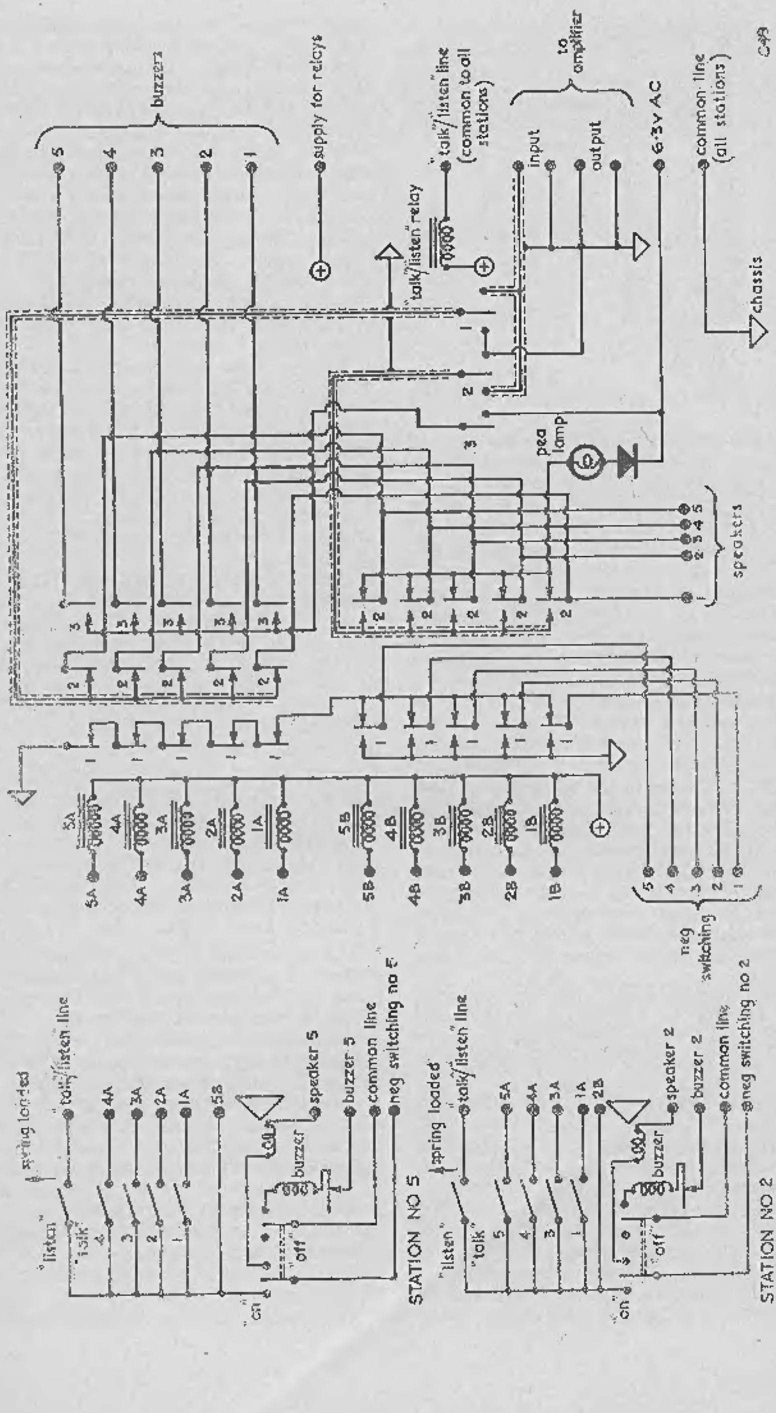


Figure 1 Diagram of the relay unit described in this article. Stations No. 2 and 5 are also shown.

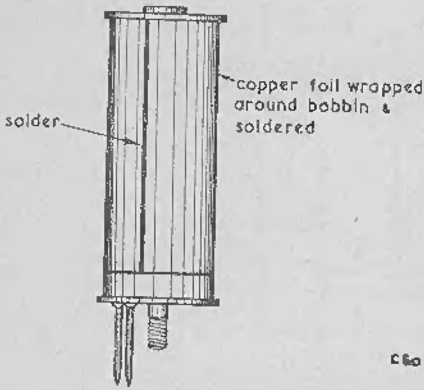


Figure 2: Showing how a relay bobbin may be slugged.

The Negative Switching Lead to Station 5 obtains its chassis connection *via* the appropriate terminal on the Relay Unit, *via* contact 1 (de-energized) of relay 5B, and *via* the contacts 1 of relays 1A to 5A inclusive. As relay 5B closes (owing to the fact that Station 5 has now been switched on) the Negative Switching Lead to Station 5 is then made *via* contact 1 (energized) of relay 5B and is thus independent of the contacts 1 of the "A" bank of relays. (As the chassis connection for the Negative Switching Lead No. 5 is transferred from the de-energized to the energized contact on contact 1 of relay 5B, it is advisable to adjust these contacts so that the energized circuit is made just before the de-energized circuit breaks. Alternatively the relay may be slugged by wrapping a piece of copper foil around the coil bobbin—see Fig. 2—whereupon it should still continue to close even if its energizing current is momentarily broken).

We now have Station 5 switched on and relay 5B energized. Contact 2 of relay 5B also makes, causing speaker No. 5 to be connected to the change-over contact 2 of the "Talk/Listen" relay.

The operator at Station 5 then closes his selector switch No. 2. This connects the negative end of the coil of relay 2A to chassis, thus energizing that relay. When energized, the contacts 1 of relay 2A are then broken. This breaks the chassis connection to all the de-energized contacts 1 on relays 1B to 5B inclusive. Therefore the Negative Switching Leads to Stations 1, 2, 3 and 4 are disconnected from chassis: however, Station 5 still has its Negative Switching Lead in use, owing to the fact that relay 5B is closed, as explained above. Therefore, no-one but Station 5 can now control the Relay Unit, and *no-one can connect their speakers, use the amplifier, or call anyone until he has finished and switched off.* Station 5 now has complete control.

When Relay 2A is energized (as happened when we closed No. 2 switch at Station 5) two more things happened. Firstly, contact 2 of relay 2A closed, connecting speaker No. 2 to the change-over contact 1 of the "Talk/Listen" relay. Secondly, contacts 3 of relay 2A closed, thereby connecting terminal "Buzzer" 2 on the Relay Unit (and thence to the buzzer at Station 2) to contact 3 of the "Talk/Listen" relay.

We now have the speaker in Station 5 connected to contact 2 of the de-energized "Talk/Listen" relay, (and thence to the amplifier output), whilst Speaker No. 2 terminal on the Relay Unit is connected to contact 1 of the same relay, (and thence to the amplifier input). Thus, everything is ready for intercommunication between Stations 5 and 2 except that we now need to call Station 2, so that he may switch on.

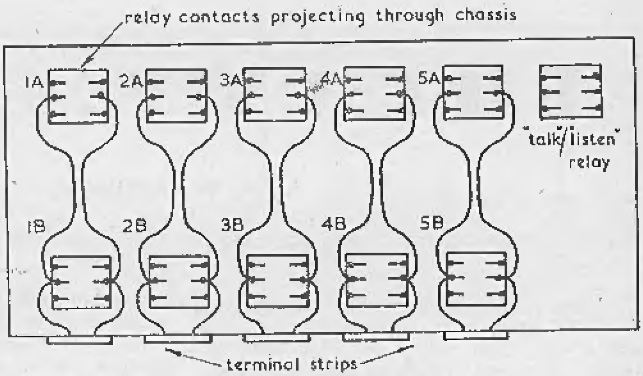
This is done by putting the "Talk/Listen" switch at Station 5 to "Talk" for a second or two. This energizes the "Talk/Listen" relay because the switch then completes the circuit for the negative end of the energizing coil to the Negative Switching Line to Station 5. As the "Talk/Listen" relay energizes, its contacts 3 close, thus connecting the buzzer at Station 2 (*via* energized contacts 3 of relay 2A—see above) to an AC supply of 6.3 volts.

The operator at Station 2 hears the buzzer and switches his station on, thus connecting his speaker to Speaker No. 2 terminal on the Relay Unit, and also disconnecting his buzzer which stops sounding. His "On/Off" switch does not energize relay 2B because his Negative Switching Lead is free from chassis.

The conversation now proceeds normally, Station 5 pressing his "Talk/Listen" switch when he wishes to speak and freeing it when he wishes to listen to Station 2.

Now let us suppose that, while this conversation is in progress, Station 3 switches on. He cannot cause any relays to close as he has no Negative Switching Lead to his "On/Off" switch, but he will still, nevertheless, connect his speaker to terminal Speaker 3 on the Relay Unit. This will cause his speaker to be connected, *via* the de-energized contacts 2 of relay 3B to the limiting pea lamp in series with the 6.3 volt rectified AC supply. The operator at Station 3 will then hear a hum which will tell him that the amplifier is engaged for the time being.

All he needs to do is to leave his switch in the "On" position. As soon as Stations 5 and 2 have finished they will switch off; relay 2A will then become de-energized, and its contacts 1 will allow a chassis connection for the Negative Switching Lead to Station 3. As soon as this occurs, relay 3B will close, allowing Station 3 to be in control, just as happened previously when Station 5 switched on. Station 3 will be informed of the fact that the amplifier is "clear" because the hum in his speaker will then stop.



UNDERSIDE OF RELAY UNIT CHASSIS CS1

Operating

Let us now leave the technical aspect and see how simple it is to operate the system when it is in the hands of a non-technical user.

All the operator has to do is put the "On/Off" switch at his station to "On" and press the switch corresponding to the person he wants to call. If he does not hear the "Engaged" hum tone he knows that the amplifier is not in use. He then pushes his "Talk/Listen" switch to "Talk" several times to operate the required station's buzzer, and waits for a reply. When the conversation is over, he switches off, leaving the equipment ready for anyone else.

It is also possible for the system to be used to talk to more than one person. In this case all that is necessary to do is to press the switches to the various stations and call them in the same manner as above. In this way, one person may speak to all the other stations, and also listen to their replies.

Power Supply for the Relay Unit

It has been mentioned earlier that the various relays in the Relay Unit obtained their power from a "positive source of supply". This description was used to enable the action of the various circuits to be easily explained. What is actually needed, of course, is a source of voltage suitable for the relays used, and one which may be applied between chassis and the points marked with the circled positive sign. Its actual polarity is, of course, immaterial.

Perhaps the best source of relay energizing voltage might be obtained from a metal rectifier connected in a bridge circuit and fed from the mains by a step-down transformer. No smoothing would be needed and the current taken would probably not exceed an ampere if, say, twelve-volt relays were used. The actual voltage applied to the relay circuits will, of course, depend upon the type of relays used.

Some mystification may have been caused by the use of the rectifier in series with the 6.3 volt AC supply which gives the "Engaged" signal. The rectifier is employed because many people find that a pure 50 cycle tone is inaudible. The addition of the rectifier causes a certain amount of 100 cps content to be applied to the speaker, thereby making the "Engaged" signal easier to recognise. A small, low-voltage, metal rectifier will do quite well here. There is, of course, no reason why a separate one-valve tone generator should not be incorporated in the main amplifier if desired, the output of this being connected to the de-energized contacts 2 of relays 1B to 5B inclusive, and thus providing the "Engaged" signal.

The Layout of the Relay Unit

Fig. 3 shows a suggested layout for the Relay Unit. There is nothing very remarkable in this diagram, but some attention should be given to the placing of the wiring.

It may be seen that the connections from the relays to the terminals for each station unit are kept separate in individual harnesses or groups. The purpose behind this method of wiring is to ensure that there is little feed back between individual speaker leads. Also, in order to reduce undue couplings, the leads to the "Talk/Listen" relay in the Relay Unit are screened (as shown in Fig. 1). In addition, the lead from the Relay Unit to the input of the amplifier should also be screened. (There is no necessity to screen the output lead).

Contd. on P.108.

EHT UNIT . . . for 7/6

by H. W. ARUNDEL

I have yet to find a method of supplying EHT which is so simple and cheap as the one I have been using for the past two years. This unit, which is described below, contains a spare EHT transformer, and is, of course, suitable only for AC mains. I have employed it in six "Inexpensive Televisors" which were built for friends, all of whom are satisfied.

The Unit

First of all, the ex-W.D. power unit Type 225 was purchased. This was advertised at a local shop, with the notice "It's your birthday —all this for 5/-!" The unit was sold complete, but less valves, and has a box large enough to contain the EHT power pack, and the time-base, vision and sound receiver power packs.

Amongst an assortment of useful "swag" there were two 0.023 µF 8kV capacitors, an 0.4 µF 4kV capacitor, and two transformers marked 10KB/794 and 10KB/795. These transformers will provide EHT at 4.2 kV and 3.8kV respectively, after rectification and smoothing (electrostatic meter reading). An input of about 30V 50cps is required, and by raising or lowering this voltage the required output voltage can be obtained.

First Method

I first proceeded to use the unit by employing the tappings on the primary side of the time-base transformer to supply the necessary input as shown in Fig. 1. This method has the disadvantage of slightly raising the temperature of the time-base transformer and, if followed, it is advisable to use a generously rated and well proportioned component for this. Otherwise a small transformer will eventually "cook".

Second Method

The method finally adopted, which has proved very satisfactory, is shown in Fig. 2. By using an 8 µF paper or oil-filled capacitor in series with the mains to the input of the 10KB/794 transformer I can obtain 4.2 kV; with the 10KB/795 and a 4 µF capacitor the output is 2.8 kV. By varying the value of the capacitor the EHT voltage can be regulated as required.

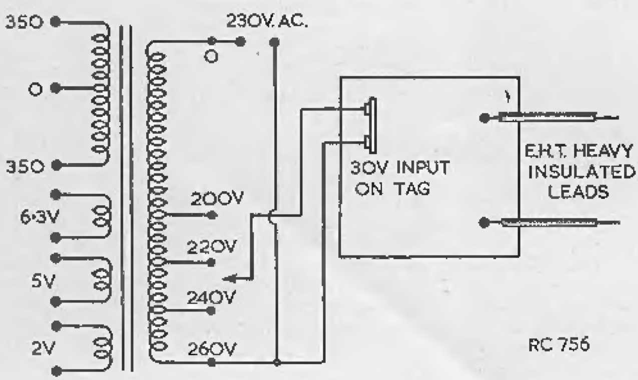


Fig. 1: The method first tried out.

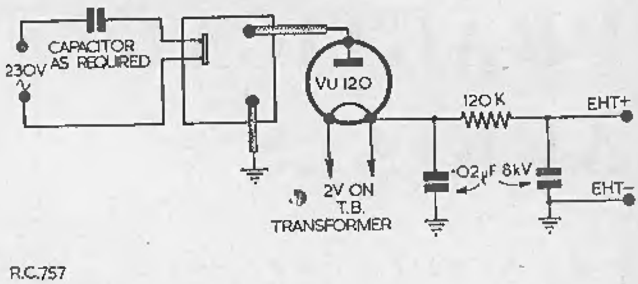


Fig. 2: Circuit of the final arrangement.

The cost of this capacitor was 2/6, so that for a total cost of 7/6 I have a complete EHT power pack plus a spare EHT transformer. The VU120 rectifier is taken from the R1355 receiver, and, using either method, the heater winding was wound on top of the original windings of the time-base transformer. In my case, I required six turns for this, and I found that ordinary 1/044 cable, as used for electrical installations, gave perfect insulation with the outer covering removed and the inner rubber sheathing left intact.

The connections of the EHT transformers are easily found. The EHT windings have heavy insulated wires, and the 10KB/795 is already fitted with a top cap for the VU120 rectifier. The input connections are to be found on a small bakelite panel fitted with soldering tags. Incidentally, there is no necessity to purchase a complete 225 Unit, as the transformers are obtainable separately for about 2/- each.

"RADIO CONSTRUCTOR" QUIZ

Conducted by W. Groome

(1) Whilst experimenting with a four-valve push-pull amplifier, Mr. Brain was astonished to find that it continued to function when one of the "see-saw" phase-splitter valves was removed. The line-up was:—V1 received the input and with V2 formed a "see-saw" pair, each valve delivering a signal to one of the output valves—in opposite phase, of course. Heavy negative feedback from the "low" side of the output transformer was fed to the cathode of V1. With V2 removed, the amplifier worked and no loss of gain was apparent, but overloading was evident at rather less than half the normal full output. Explanation, please !

(2) Suppose you needed a resistor of 5 k Ω, which must be of 2W rating, but only had two 2.5 k Ω 1W and two 10 k Ω 1W. Which pair would you use ?

(3) 10% harmonic distortion is serious—painfully serious to many—in sound reproduction, but is not likely to have an equally undesirable effect on TV. Right or wrong ?

(4) The writer thanks Mr. C. C. James of Sutton Coldfield for submitting this interesting teaser. Two flat pieces of steel, say 5 ins. long, lie on a table. They are identical in appearance, but one is a magnet and the other is just plain steel. How would you decide which was which, without the use of compass, string, metal or any other aid ?

(5) Probably the simplest contrast expansion arrangement is that using a small light bulb across the secondary of the output transformer. How does it work ?

(6) Why is a choke used in series with the anode resistor in the video stage of some TV receivers ? *Answers on P.98.*

DESPITE THE FACT

that we are now printing and distributing many more copies of this magazine, we are still receiving letters from readers informing us that they have difficulty in obtaining regular copies. If details are sent to us, then we can take up the matter with the people concerned. Should this prove ineffective, then we shall be glad to supply copies direct, on either 6 or 12 month subscriptions.

PRACTICAL AERIALS

by "AETHERIUM"

Multi-Band Aerials

Notes on Feeders

Directional Aerials

Part 2

The Multi Band Aerial

The "long wire" aerial previously referred to is often used as the main aerial for operation on 3 or 4 of the Amateur Bands. There are several ways of accomplishing this, and the system employed usually depends upon the amount of space available. The more common type of aerial used for this purpose is the "End Fed Hertz". This aerial with its associated coupling circuit is shown in Fig. 1.

The length of 138 ft. need not be a deterring factor, even for the Amateur with limited space, because this length is measured from the actual transmitter (or receiver) to the far end, and the average house and garden can accommodate this quite easily. This aerial may be "bent" if necessary, but not at any haphazard point. If the available space prevents the erection of this aerial in one straight length, the bend must be made at a point midway between a current loop and a voltage loop of the frequency most used. Therefore, if the main operating frequency is going to be 28 Mcs the bend should be approx. 12 ft. or 20 ft. from the far end (Fig. 2). If the main operating frequency is 14 Mcs. the bend should be made approx. 8 or 24 ft. from the far end.

When making right-angle bends in any aerial such as this, the total length should be increased by approx. 3 per cent., in this particular case by 4 ft., making a total length of 142 ft. The Polar Diagram, although modified slightly, is not adversely affected, in fact in some cases this bending sometimes improves the performance, especially with regard to reception of signals from stations using vertical polarisation.

In general this aerial performs well, the only drawback being that a part of the radiating system has to be brought into the operating room. If this room happens to be at the "wrong end" of the house, some difficulty will be experienced in keeping the wire clear of walls, etc. This type of aerial is also prone to produce interference by shock excitation on BC receivers in the house.

The Centre-Fed Zepp

A more efficient multi-band aerial is the Centre-Fed Zepp (shown in Fig. 3). This may also be bent at the ends as described above. The length of 136 ft. enables this aerial to be used on 4 bands, but it must be remembered that the 300 ohm feeder length is important, and this must at all times be of the length specified. The tables give details of several

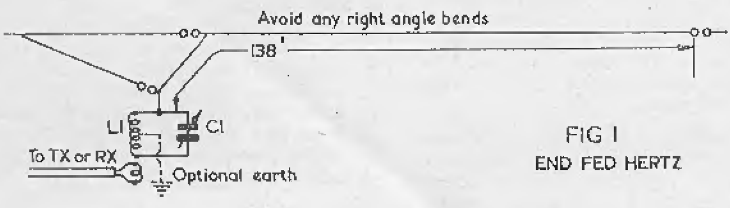


FIG 1
END FED HERTZ

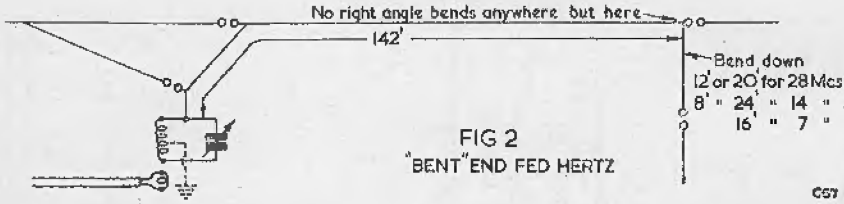


FIG 2
"BENT" END FED HERTZ

aerial and feeder lengths suitable for multi-band working, and indicate whether series or parallel tuning should be used for L1. The coupling coil (L.1) should, of course, always be designed to resonate at the particular frequency in use. It is normally designed as a plug-in unit to facilitate a quick change over from band to band. For a C1 value of approx. 100pF, the coil sizes are approx. as follows:—

28 Mcs.—5 turns No. 10 swg spaced ¼″ between turns.

14 Mcs.—9 turns No. 10 swg spaced ¼″ between turns.

7 Mcs.—14 turns No. 10 swg spaced ¼″ between turns.

3.5 Mcs.—23 turns No 16 swg enamelled close wound.

All on 1¾″ diameter former.

These coil dimensions also apply to the end-fed Hertz (Fig. 1).

Polar Diagrams

To obtain a better idea of the performance to be expected from the two aerials just described, the Polar Diagrams shown in part 1 should be studied. The 136 ft. aerial is 4 wavelengths long on 28 Mcs. and the Polar Diagram is basically as for the 2 wavelength aerial, excepting that the main lobes are a few degrees more inclined towards the ends of the aerial and more minor lobes appear at right-angles to the wire (NOTE: A 4 wave-length aerial has a gain in each of the 4 main lobes of approx. 3.5dB, or over twice the power of a di-pole).

On 14 Mcs it is exactly as for the 2 wave aerial, on 7 Mcs as for the full wavelength and on 3.5 Mcs. as for the ½ wave di-pole.

There are many variations of the single-wire aerial, the main differences being the method of feed and the number of bands upon which efficient operation is claimed.

Some of these types depend upon a critical connecting point for the feeder, and some give optimum performance at a certain height above ground.

Three of these types are depicted in Figs. 3a, 3b, and 3c. Where the aerial coupling method is not shown, it will be as for the end-fed Hertz, Fig. 1.

The beginner is strongly advised to become acquainted with the simpler aerials before attempting to use any of the specialised types.

Methods of coupling aerials such as these to the transmitter (or receiver) will be discussed in a later chapter, but it must be stressed that it is very bad practice to attempt to couple the aerial tuning unit direct to the transmitter. A low impedance link should always be used, which not only greatly reduces harmonic radiation but renders the installation much safer, with no risk of high voltage being present on the aerial.

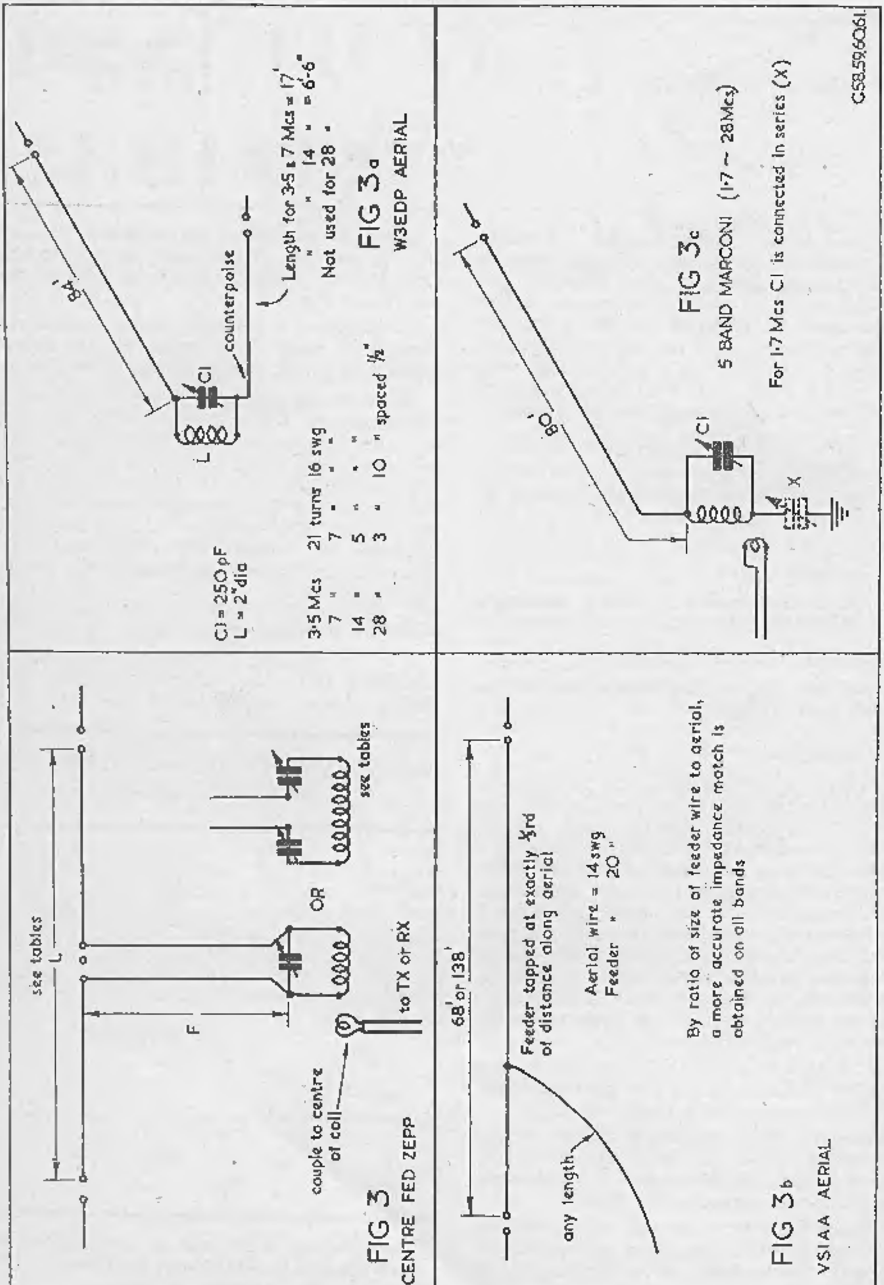
Notes on Feeders

It will be noticed that for the aerials so far described 100 ohm balanced or 300 ohm ribbon feeders have been specified. This

AERIAL AND FEEDER LENGTHS FOR CENTRE-FED ZEPP

Band Mcs.	Aerial Length Ft.	Feeder Length Ft.	C1 Series or Parallel
3.5 7 14 28	136	68	P P P P
7 (*) 14 28	65	67	S P P
7 14 28	65	100	P P P

The average impedance at the transmitter end of the line is 1400 ohms, excepting at (*), when it is approximately 80 ohms.


see tables
L
F
couple to centre of coil
OR
see tables
to TX or RX
FIG 3
CENTRE FED ZEPP
68' or 138'
Feeder tapped at exactly 1/3rd of distance along aerial
any length
Aerial wire = 14 swg
Feeder " 20 "
By ratio of size of feeder wire to aerial, a more accurate impedance match is obtained on all bands
FIG 3b
VS1AA AERIAL
84'
C1
L
counterpoise
C1 = 250pF
L = 2" dia
3·5 Mcs 21 turns 16 swg
7 " 7 " " "
14 " 5 " " "
28 " 3 " 10 " spaced 1/2"
Length for 3·5 & 7 Mcs = 17'
" " 14 " = 6'-6"
Not used for 28 "
FIG 3a
W3EDP AERIAL
80'
C1
X
FIG 3c
5 BAND MARCONI (1·7 – 28Mcs)
For 1·7 Mcs C1 is connected in series (X)
CS8.59.6Q61.

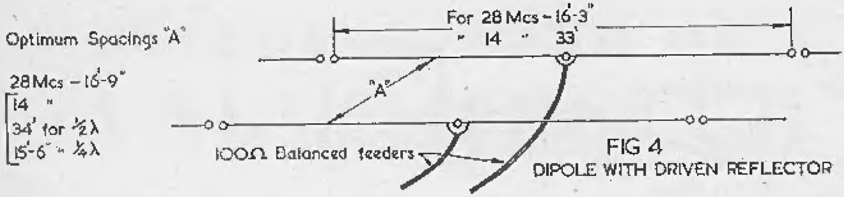


FIG 4
DIPOLE WITH DRIVEN REFLECTOR

has been done deliberately as, firstly, these types of feeders are easily obtainable in this country, they have the lowest loss factors (excepting air spaced types), and are most easily matched into any type of aerial. The co-axial feeder, although widely used by Amateurs, is—because of its unbalance—usually far more difficult to match, and its loss factor higher, unless one uses the special low loss type which by virtue of its cross section (½" or over) is often unmanageable and inconvenient.

Secondly, air spaced feeder lines are not easy to construct, especially for the beginner. The weight of such lines is usually excessive and they are difficult to bring through the house. Further, unless enamelled wire is used, corrosion sets in and the efficiency becomes rapidly impaired. So for the maximum input power allowed in this country (150 W) it is recommended that wherever possible either 100 ohm balanced feeder (Telcon BA.3) or 300 ohm ribbon (Telcon K.25) be used.

The Directional Aerial

The directional aerial, as its name implies, is the type which radiates a signal in one direction, and operates at maximum sensitivity in receiving signals from that same direction A reflector placed at the correct distance from a di-pole or a director placed in front, will, of course, produce the directional effect due to the change in the phasing. These so called "parasitic" elements are extremely useful in turning the ordinary di-pole into a "one way" aerial, but unless we rotate this aerial, we are now limited to working in one direction only. So before going into the question of rotary beams, let us see what other alternatives there are in obtaining this directional effect. The most easily constructed aerial with firm directional properties is the di-pole, with driven reflector (Fig. 4). This is usually spaced ½ wavelength with the resultant Polar Diagram as shown in Fig. 5. The two equal-length feeders are brought into the house and switched to produce the change in phasing necessary to obtain the directional effects (Fig. 5A). A forward gain of approx. 4 dB (more than twice the power) is obtainable with this arrangement and at the same time the vertical directivity is at a much lower angle, thus producing more effective gain than the 4 dB quoted. As can be seen, this aerial is suitable for two directions only, and for 28 Mcs operation, two such aerials should be erected at right angles. The beam width of

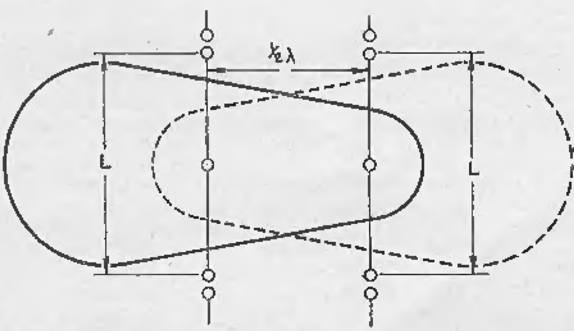


FIG 5
HORIZONTAL DIRECTIVITY OF DIPOLE WITH DRIVEN REFLECTOR
(½λ spacing)
C63

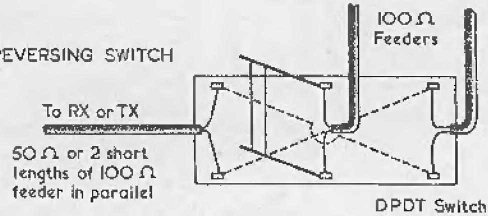


FIG 5A
FEEDER REVERSING SWITCH

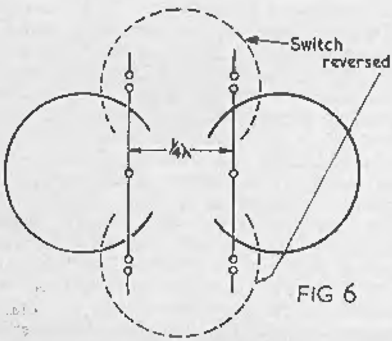


FIG 6

HORIZONTAL DIRECTIVITY (BI-DIRECTIONAL)
Dipole with driven reflector (¼λ spacing), lengths as for FIG 4

this type of aerial is approx. 60% for 3dB down.

At first sight, it may appear that to feed each of these di-poles with 100 ohm feeder is incorrect. In actual fact the impedance is not lowered as it would be by the presence of a parasitic reflector, and the standing wave ratio has been measured at approximately 1.25 : 1, which is quite a reasonable working value.

In practice, this aerial is capable of surprisingly good results, and for 28 Mcs operation can easily be installed in the average roof space. For 14 Mcs operation, only 33 ft. of garden length is necessary, but it may be difficult to attain the necessary width of 33 ft. for ½ wave spacing. In this case it will be better to use ¼ wave spacing, and so obtain bi-directional operation in both the in-phase and out-of-phase conditions (Fig. 6). It is again stressed that for this type of aerial, each feeder must be of exactly the same length.

(to be continued)

Useful Signal Generator

In response to many enquiries from readers concerning details of home-wound coils for the Signal Generator described in the August issue, Mr. A. R. Tungate, G3ELB, has sent us the following data.

All coils are wound on 1½" diameter formers, such as the 4-pin plug-in type, and all turns are close spaced.

Coil	Approx. Frequency Coverage	Wire Gauge	Turns
A	360 kcs.—660 kcs.	36 swg	80+40
B	650 kcs.—1.3 Mcs.	36 swg	38+18
C	1.2 Mcs.—2.5 Mcs.	30 swg	28+14
D	2.4 Mcs.—4.8 Mcs.	24 swg	12+5
E	4.7 Mcs.—9.5 Mcs.	22 swg	5+2½

Some readers have also experienced difficulty in getting the AF Oscillator to function. Reduction in the value of C9 will often help here.

BUILDING YOUR OWN VALVE TESTER

By W. G. MORLEY

Part V

Using the Tester

Let us now carry on to the use of the tester and show how we may utilize it to test typical valves.

The method used in this tester to read the mutual conductance of a valve is as follows:

The valve is plugged into the appropriate socket and its electrodes connected, *via* the electrode switches, to the appropriate voltage and services required. The anode of the valve is switched through to the meter, the other side of which is then connected to the various voltages required.

It might help if we take a few examples. Let us therefore first measure the mutual conductance of a simple triode such as the Cossor 41 MLF (British 5 pin).

The connections to this valve are as follows:

Anode 1, grid 2, heater 3 and 4, and cathode 5. Now the heater pins will already be connected to the heater voltage switch, so switches S3 and S4 may be put to "Chassis" as they will be out of circuit in this particular case. All that remains to do is to connect the anode to the meter, the grid to the grid bias switch, and the cathode to HT negative (chassis). We therefore set the electrode switches as follows:—S1 to "Meter", S2 to "Grid", and S5 to "Chassis". All the other switches (from S1 to S10) may remain at "Chassis".

We now proceed to S11. The recommended grid bias for the 41 MLF is 4.5 volts, so we set S11 to "4", which is one of the two nearest available voltages. The required heater voltage is 4 volts, so S12 is also set to "4". S13 is switched off since we shall not be needing the 90 and 45 volt HT supplies. As the anode current will be around 8.5 mA, S14 is set to 10 mA (therefore making the meter read 10 mA full scale deflection). The anode voltage for the valve should be 200, so setting S15 to "+210" will connect the anode, *via* the meter, to 210 volts, which will be sufficiently near the recommended voltage for our purposes. S16 is left at "Normal" as we do not intend carrying out any insulation tests for the time being.

The tester is set up and should now be switched on (S18, mains on-off). When the valve has warmed up the press button, S17, should be pressed, whereupon the meter will show the anode current of the valve under the above conditions. The reading should be about 8.5 mA, and if it is below this figure, will indicate low emission in the valve.

This procedure has already allowed us to test the emission of the valve. We now proceed to find the mutual conductance by changing the standing grid bias. For instance, if we turn the grid bias switch, S11, to "5", we will be changing the grid voltage by one volt. The anode current should then alter. As, under these conditions, the mutual conductance of the 41 MLF is 1.9 mA per volt, the change in anode current reading should be 1.9 mA. If it is below, say, 1.5 mA, then the valve may be considered faulty. It should be mentioned that it is possible to obtain a very accurate reading of mutual conductance by using this process.

There is, incidentally, no necessity to disconnect the meter whilst the grid bias voltage is being adjusted. As mentioned in a previous article, when the arm of S11 is between two contacts and is therefore "free", the grid of the valve is taken to the full negative voltage *via* the 10 Meg Ω resistor (R29 of Fig. 7), so no damage may be caused to the meter by excessive anode current.

Let us now follow the same procedure, using another valve: the Mullard EF39. The connections to this valve are as follows:—Shielding 1, heater 2, anode 3, screen-grid 4, suppressor 5, heater 7, cathode 8, and control-grid to the top-cap. (Pin 6 is blank). As the heater is connected to pins 2 and 7, the valve may be plugged into the socket marked "INT. OCT. 1". The top-cap is connected to fly-lead No. 9 and the electrode switches are set up as follows:—

S1—"Chassis", S2—"Chassis", S3—"Meter", S4—"+210", S5 to S8—"Chassis", S9—"Grid", and S10—"Chassis". S11 is set for a grid bias of 2, S12 to a heater voltage of 6.3, S13 "off", S14 to "10mA" and S15 to "+210". The tester is switched on and the valve allowed to warm up. When the press-button S17 is pushed, the meter should read at least 6 mA. The mutual conductance of the valve under these conditions is 2.2 mA per volt, so switching S11 to "3" should cause a change in anode current of 2.2 mA.

It may be seen that the switching procedure is really very straightforward. The various switch positions are obtained simply by referring to the appropriate literature for each valve. It will also be noticed that, at the low grid bias voltages which we have used up to now, we were able to change the grid bias in steps of 1 volt. However, with such a valve as, say, the American 2A3, which needs a grid voltage of -45, changes of 1 volt will not cause much deflection in the anode current meter. It is therefore advisable to check a valve such as this by switching the grid voltage from 40 to 50 and dividing the change in anode current by 10 to obtain the mutual conductance in mA per volt.

Checking Frequency Changers, etc.

When two valves are fitted in one envelope they may be checked individually. For instance, the 6SN7, which consists of two triodes, can be tested by checking each triode separately.

The same holds true for such valves as the 6K8, in which, to take an example, the triode may be checked separately from the hexode. If, when checking frequency changers, it is desired to test the mutual conductance using, say, the signal grid, the oscillator grid should be connected to chassis; or vice versa.

Checking Output Valves

Owing to the fact that some output valves, (6L6, etc.,) take more than 30 mA anode and screen-grid current, it is not always possible to obtain reliable results at their recommended voltages since the HT stabilizer circuits only regulate up to about 30 mA. For this reason, large output valves are tested at reduced HT voltages. This may be done by connecting the anode and screen-grid of the valves to, say, the "+105" volt supply and using a lower value of grid-bias.

In this case, it will be found that the readings of mutual conductance obtained from these valves will be somewhat lower than those given in the appropriate tables. It will therefore be necessary to calibrate the tester originally by checking a few output valves which are known to be good. Any unfamiliar valve which may be met and for which no calibration has been made may then be compared with the known figures for a good valve.

Rectifier and Diode Test

If it is desired to test the emission of a rectifier valve, this may be carried out by setting the electrode switch connected to the particular anode under test to "Meter". All other electrode switches (S1 to S10) should be at "Chassis". The meter switch, S15, is then set to "Rectifier Test", whereupon a current, limited to 30 mA, will flow through the rectifier. The meter should give a reading of at least 25 mA if the emission of the rectifier is adequate. It is advisable, in the first place, to obtain a maximum performance figure for rectifiers by observing the figure obtained with a heavy-current rectifier such as the 5U4. There will be little discrepancy between the readings obtained with different types of rectifier if they are in good condition. If a full-wave rectifier is being checked it will, of course, be necessary to check each anode separately.

It may be remembered that, should the rectifier under test have a filament only, this will be automatically connected to HT negative by the heater wiring. If it has a separate cathode, this may be connected to chassis by the appropriate electrode switch.

The same procedure is followed when diodes are tested; only, in this case, the meter switch S15 is set to "Diode Test", limiting the current to 1 mA. Again it is advisable to originally calibrate the meter against a diode which is known to be good, and, once more, there will be little change in indication for different types of valve, so long as they are serviceable.

Cathode Insulation and "Short" Tests

To check the insulation between cathode and heater, all electrode switches except that connected to the cathode should be set to "Chassis". The appropriate cathode switch is then set to "Meter", S15 set to "Insulation Test", and S16 to "Insulation". (The meter should be connected to read 1 mA full scale deflection).

The meter will then measure the insulation between cathode and heater up to a figure of 4 Meg Ω whilst the heater is hot. The various meter readings for different values of resistance were given in an earlier part of these articles.

If it is required to check the insulation of any other electrode, all the electrode switches should be set to "Chassis" except that corresponding to the appropriate electrode, which is set to "Meter". The same procedure is then followed as for the cathode test. This method of testing checks the suspected electrode for insulation from every other electrode in the valve.

All insulation tests are, of course, carried out at a pressure of 105 volts.

VALVE TYPE 6Q7
BASE No Int. Oct. 2
TOP CAP CONNECTION No 10
PURPOSE Double Diode Triode

ELECTRODE CONNECTIONS

1	2	3	4	5	6	7	8	9	10
Shield	Heater	Anode	Diode	Diode	Blank	Heater	Cathode	Blank	Grid

MUTUAL CONDUCTANCE TEST
SWITCH CONNECTIONS

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Chassis	Chassis	Meter	Chassis	Chassis	Chassis	Chassis	Chassis	Chassis	Grid	-3	6·3	off	10mA	+210

MINIMUM ANODE CURRENT PERMISSIBLE 0·9mA

CHANGE S_{11} TO -2

MINIMUM CHANGE PERMISSIBLE 1mA

OTHER TESTS:

DIODE CHECKS:- S_4 TO METER } "METER TO
S_5 TO METER } DIODE CHECK"

CBO

Fig. 10: *One of the cards in the card index.* (*Shown filled in for a valve type* 6Q7)

Testing Tuning Indicators

In addition to the other facilities offered by the tester, it is possible to check tuning indicators under working conditions. It may prove simpler to explain the testing procedure if we take a typical example such as is offered by the American 2G5. To check this valve, the target should be connected to "+210", the anode to "Magic Eye Anode", and the grid to "Grid", (and then to the grid bias switch, S11). When the tester has been switched on for some moments the "Magic Eye" should light up. The sensitivity may be checked by varying the voltage on the grid by adjusting S11, and observing by how much the tuning indicator "opens" or "closes". The 2G5 for instance, should have zero degrees shadow angle at —22 volts on the grid: this point may very easily be checked.

Making a Card Index

It is obvious that interpreting the necessary switch positions from valve tables may take some time, so a quicker method for, at least, the more popular valves would be a desirable asset.

For this reason, it will prove very advantageous to make up a card index, one card being used for each type of valve. The cards may be numbered, the numbers being referenced in a separate index, or, alternatively, they may be arranged in a combination of numerical and alphabetical order. This second method, however, has some disadvantages owing to the different methods of referencing used by different makers.

A proposed layout for each card is shown in Fig. 10. It will be seen that the various switch positions for testing each valve may very quickly be found simply by glancing at the legend on the card.

Cards may be made up from time to time as different types of valve are tested and the electrode switch positions worked out from the valve tables. In addition, as stated above, it is possible to make up cards for the more common types of valve entirely from the valve tables published. A good foundation for the card index may be made in this way.

Working Out the Mutual Conductance

Before finishing this series of articles there are one or two outstanding points which should be cleared up.

For instance, it may be found that, with

*Contd. on P.*108

TELEVISION

Picture Faults

Part seven of a series, illustrated by photographs from a Televisor screen by courtesy of

Mr. John Cura.

Part 7 – Power Supplies

FAULTS in the power supply circuits of television receivers are often spectacular, and frequently show instantly the section most affected, if not the actual seat of the trouble. The power available from the mains transformer during short periods when a fault occurs can be very great, and a serious amount of damage may be caused. It is advisable, therefore, to take special precautions if the receiver is being tested for the first time, and also if some modification has been carried out. This is well justified, if only on economic grounds.

The faults most likely to occur on initial test are short or open circuits, incorrect heater supplies, faulty components and insufficient insulation. Short circuits may occur as wiring errors, short ends of wire left in the chassis during construction, or an unnoticed drop of solder. The latter can be almost invisible, the thin wafer of solder wrapping around tag strips and valve pins so that it appears as part of the component on which it drops. This type of fault can be avoided if very careful inspection is carried out before testing. A simple check with a continuity meter or ohm-meter will generally show serious short circuits, and voltage tests when the receiver is operating will show shorts which affect small portions of the circuit.

Open circuits will show as an absence of HT in the receiver circuits, with high voltages at the cathode or heater of the power rectifier. The important point, here, is to see that the voltage does not rise to a value where damage may be caused to reservoir capacitors. It is advisable to fit surge resisting capacitors of sufficient rating to withstand the peak voltage provided by the power rectifier off-load, if the rectifier is of the directly heated type. An alternative to this is to use an indirectly heated rectifier, which will give an adequate time lag before the HT voltage builds up.

Incorrect heater supply voltages can be avoided only by careful inspection before testing. They may be checked by taking voltage readings across the valve pins, with all valves removed. This is particularly important with cathode ray tubes, which have a wide variety of heater ratings. Frequently, CRT heaters are catered for by taps on a 6.3V winding.

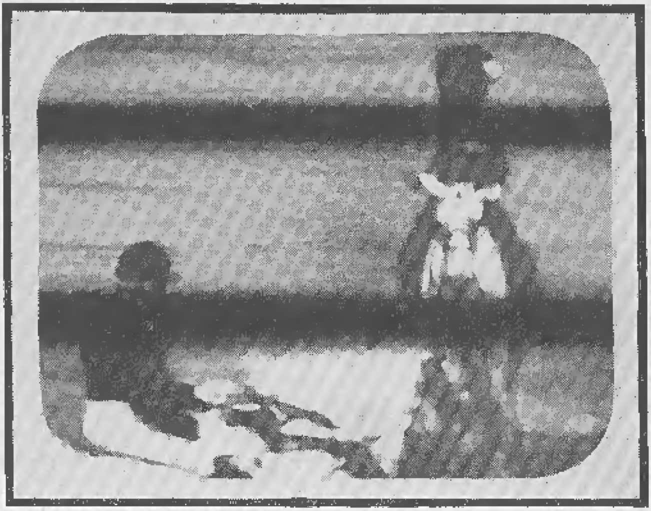
Insulation adequate to the applied voltage is most important. It must be remembered that when a receiver has been in use for some time, dust and damp deposits may appear which will reduce the effectiveness of tag strip insulation, and suitable spacing should be allowed between high voltage points. In EHT circuits, large deposits of dust may occur due to the particles of dust becoming charged and being attracted to the field between a high voltage point and earth. This may reach a stage where the high voltage will break down the layer of dust and set fire to the original insulation.

These are general points and, if careful thought is given to layout and positioning of components, no trouble should be experienced.

It is suggested that the following procedure be adopted when testing the receiver for the first time—it is assumed that the circuits have been visually checked.

Remove the power rectifiers and switch on, checking that the heaters light up and, if possible, measuring the AC voltage across the heater pins of the valves. If an AC voltmeter is not available, a 6.3V pilot bulb will do. Switch off, replace the rectifier valves, and connect a DC voltmeter from the cathode (or heater) of the power rectifier to chassis. Switch on and wait for the HT voltage to rise. It should not exceed the maximum surge voltage rating of the reservoir capacitor. Shortly after, the voltage should settle down to the normal level, and thereafter remain steady.

The meter may now be disconnected, and the voltage on all other smoothing capacitors



Showing typical hum bars. In this case, as there are two, the trouble is with 100cps ripple, from full-wave rectification.

(JOHN CURA 'TELE-SNAP')

and HT leads measured. To ensure that all valves are operating, measure the voltage drop across their bias resistors or, should there be no bias resistor, across any resistor supplying voltage to the anode. If a valve is taking no current, no bias voltage will be developed, and there will be no voltage drop across an anode resistor. With all voltages reasonably normal, alignment, etc., may be carried out.

The reservoir capacitor in any power supply has to withstand, apart from the applied voltage, a high AC current. This may exceed 100 mA in certain cases, and care must be taken to see that the correct half is used, when using a double capacitor in one can. Some manufacturers indicate on the can which section should be used, but as a general rule the plain foil, which should be used as the reservoir, is marked with a red spot and the etched foil, which should be used for smoothing is left plain or marked with a yellow spot. In some cases, the maximum AC current will also be stated. The AC current will be much higher with half wave than with full wave rectification.

Fuses should be placed in the HT circuits rather than in the mains leads to the power transformer. The initial surge, when switching on, will generally blow a 1A fuse if this is inserted on the primary side, and fuses with a higher rating than this will not give protection against short circuits in the receiver. It is not very practical to fuse low tension supplies, so this is seldom done. The main disadvantage in having fused circuits arises during testing, when a momentary short with a testing prod blows the fuse—and this can cost a lot for replacements, apart from lost time.

A fault which has the effect of reducing the efficiency of the smoothing circuits will cause a variety of defects in the picture, which may show as follows: Curved vertical edges of the raster, possibly in the form of a sine wave—One or two wide horizontal bars (depending on whether half or full wave rectification is used). These will show as areas of light and dark, grading evenly, and often without sharply defined limits. They can be caused by smoothing capacitors of low value or having disconnected internal connections. This may be checked by connecting across the existing capacitors, in turn, another of suitable capacity, and observing the change in the distortion of the raster. It must be borne in mind that electrostatic CRT'S mounted in close proximity to a mains transformer may show a similar distortion to hum modulation on the line time base. With an unsynchronised raster showing on the screen, the wavy edge will move up or down depending on the speed of the frame time base. If the raster is synchronised, however, the effect will generally be stationary, as the transmitter is usually locked to the 50 cps mains. It is advisable that, in the event of distortion of this type, a mu-metal shield be used to reduce the effect of the magnetic field on the CRT. These are generally manufactured to fit closely round the neck of

Contd. on P.108

QUERY CORNER

A "Radio Constructor" Service for Readers

Interference from Vibrators

I have been experimenting in using a 6 volt vibrator unit to feed my communication type receiver, in order that the receiver might be operated in the car. Unfortunately, the results so far obtained have not been very promising, as reception has been marred by strong interference from the vibrator. What is the best method of preventing such interference ? E. Charles, Glasgow

Vibrators may be broadly divided into two classes, the synchronous and the non-synchronous types. Those coming within the latter category simply function as circuit interruptors, in much the same manner as do the contacts on an electric bell or buzzer. The synchronous vibrator, on the other hand, has a second set of contacts which are made and broken in synchronism with the main contacts, and these are used to rectify the output of the HT transformer. The main, or primary, contacts on a vibrator are connected in series with the primary of the HT transformer, where they serve to interrupt the current. Thus the transformer is supplied with an alternating current of approximately square waveform. Now because the rate of change of a square wave current is very high, peak inverse voltages, which may easily be of the order of 1,000 to 2 000 volts, are induced in the transformer windings as a result of their high inductance. These high voltages may easily cause radiation from the transformer or its associated wiring, or may result in excessive sparking at the vibrator contacts. Whichever is the case, the connection of a damping capacitor across the secondary of the transformer normally reduces the peak voltage to a safe level and minimises contact sputter Excessive sparking at the vibrator contacts must be avoided at all costs as it results in severe radiation, rapidly burns the contacts and causes heavy battery drain.

The exact value of the damping capacitor is fairly critical, and is best determined by trial and error methods whilst observing the input voltage waveform to the primary of the transformer by means of an oscilloscope. It will be found that with the correct value of capacitance across the secondary, the input waveform will closely approximate to a square wave but with slightly sloping vertical sides. If an oscilloscope is not available, satisfactory operation may be obtained by trying various values of damping capacitance and using that value which provides a minimum of sparking at the vibrator contacts. It will be found that this value will also result in minimum battery current drain for a particular rectified output from the supply unit. A damping capacitor may conveniently consist of between one and four separate capacitors, each having a value of 0.005 μF and a working voltage of 2kV.

So much then for interference from either the vibrator itself or that radiated by the transformer. Other causes of interference are radiation from the power supply wiring or from the input and output leads. It is good practice to enclose the complete vibrator unit within an earthed metal screening box, so that it is shielded from the remainder of the receiver. This done, radiation from the input and output leads may be minimised by the use of two RF filters. The input filter is connected in the positive battery lead

QUERY CORNER

"Rules"

(1) A nominal fee of 2/- 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 a more general interest will be reproduced in these pages each month.

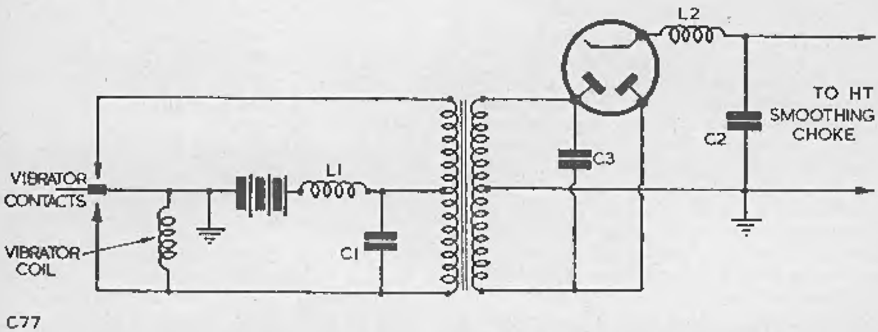


Fig. 1: A non-synchronous vibrator, indicating the position of the filters and the damping capacitor C3.

as close to the transformer as possible, and consists of L1 and C1. The choke L1 carries a relatively large peak current and must therefore be wound with heavy gauge wire in order to avoid undue loss of voltage. About 40 turns of 18 swg enamelled copper wire wound on a ½-inch diameter former will be quite adequate. The output filter consisting of L2 and C2 may employ a standard RF choke having an inductance of between 2 and 5 millihenrys. The earth return lead to the battery should be as short and as stout as is practicable.

Fig. 1 indicates a typical non-synchronous type of vibrator power pack showing the method of connecting the filters and damping capacitor referred to in these notes.

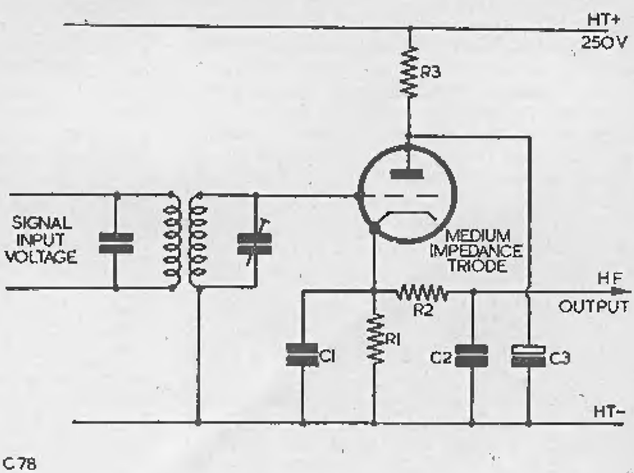
The Infinite Impedance Detector

The infinite impedance detector appears to be very popular among constructors of high quality receivers. Can you give me any information regarding this form of detection?

F. Gauld, S.E.5.

The infinite impedance detector is capable of handling a large signal input voltage with a very good degree of linearity, and hence low distortion. As it does not depend upon grid current for its rectification properties, there is negligible damping of the tuned circuit. This is the feature which largely contributes towards its popularity in receivers which are designed for high quality sound reproduction. The load resistor is in the cathode circuit of the valve and is bypassed

Fig.2: The infinite impedance detector. Typical circuit values are: R1, 100 k Ω; R2, 50 k Ω; R3, 50 k Ω; C2, 200pF; C3, 2μF 350V.



to RF by means of a shunt capacitor. The DC voltage developed across this load by virtue of the steady anode current is also the bias for the valve. This bias is of such a value that the valve is operated close to its anode current cut-off point. Rectification is thus obtained in much the same manner as with an anode bend detector, but with the added advantage of the high input impedance already mentioned. It is most important, if distortion is to be avoided, that the signal input voltage is of the order of 10 volts or more, and for this reason the detector must be preceded by at least two stages of RF amplification.

Perhaps one of the disadvantages of this detector is the difficulty of obtaining an AVC voltage, as the cathode of the valve increases positively as the signal voltage increases. It is the writer's opinion that the best method of deriving an AVC voltage, when an infinite impedance detector is employed, is to take a tap from the output of the last RF or IF amplifier, depending upon whether the circuit is straight or superhet, and to feed the signal thus obtained into a further amplifier stage and hence to a diode rectifier. This arrangement provides amplified, delayed AVC which can easily be adjusted to give a level response.

Stabilisers in Parallel

I have several small neon stabilisers which I would like to use in parallel in place of one large stabiliser, is this practicable?

H. Tauber, Leeds.

It is not satisfactory to directly connect two or more neon stabilisers in parallel, as the striking voltage of the individual tubes will differ slightly. Because of this one tube will strike before the others, and thus reduce the voltage to a level where it will be impossible for the other tubes to strike. It is, of course, possible to employ equalising resistors in series with each stabiliser, but this procedure will greatly reduce the efficiency of the circuit on a voltage stabilising device, and is therefore not to be recommended.

Answers to Quiz

(1) This form of amplifier, with its two phase-splitting valves each driving its own output valve, is virtually two amplifiers in push-pull, each of which can function alone. In the absence of V2, only one output valve was receiving an input and so the maximum power was halved. The gain, stabilised by negative feedback, remained unchanged. Had V1 been removed instead of V2, there would have been no signal, unless the input were applied to V2, in which case the other side of the amplifier would have operated single-ended.

(2) Either. With two equal value resistors in series the voltage is shared equally, and with two in parallel the current is halved. In either case the wattage, i.e., current x voltage, is divided between the two and they may therefore be of 1W rating.

(3) The visible effect is not so evident as the audible distress associated with harmonic distortion, but it should be avoided as the conditions which create it may have other undesirable effects. Phase distortion, which is of no consequence in the simpler type of audio equipment, is very serious in TV and must be avoided.

(4) Mr. James did not give the answer to the problem when writing, so your "Quiz Master" is himself a victim in this case. If Mr. James has another solution differing greatly from that of yours truly, we shall be glad to hear from him again.

In a bar magnet of 5 ins. length, the variation in its power of attraction will vary distinctly between the ends (or poles) where it is strongest, and the centre where it is weakest. Place bar 'A' flat on the table and butt the end of bar 'B' down to it, so forming an inverted 'L' at the ends or an inverted 'T' at the centre. If the attraction is stronger in the 'L' position than in the 'T' position, then 'A' is the magnet. If the attraction is equal at all points along 'A', then 'B' is the magnet. Gravity will not seriously affect the experiment, unless the magnet is weak.

(5) The filament of an incandescent lamp or bulb has a resistance which varies with the temperature, being highest when bright and lowest when cold. Shunted across the output transformer, it by-passes more of the low-level signals than it does of the high-level ones, thus in some degree compensating for the compression introduced at the transmitter or recording studio. The writer does not recommend the idea, for it causes distortion, and is useless if speech-coil feedback is used.

(6) The choke is an inductive load which boosts the high frequencies, thus compensating for losses due to stray capacitances. With care, however, the 2.5 Mcs bars can be resolved without the use of a choke.

YOUR WORKSHOP

In which J. R. D. Discusses Problems and Points of Interest connected with The Workshop side of our Hobby, based on Letters from Readers and his own Experiences.

IN a recent issue of the Radio Constructor, the editor, G2ATV, raised the question of the constructional facilities offered by readers' workshops. He also asked readers for information concerning their own workshops in order to help the Radio Constructor maintain its policy concerning constructional articles. For instance, he commented that it would be pointless to publish the details of building a certain item of equipment which necessitated, say, the use of a lathe, if hardly any readers possessed such a machine.

This appeal produced a response from readers considerably in excess of what had been originally expected. Not only was it possible from the replies to formulate an average idea of the capabilities given by readers' workshops, but it was also found that the amateur takes, as he always has done, a great pride in the ingenious adaption of whatever equipment he has on hand in the space available in his own home. Really, on second thoughts, the generous response is not to be wondered at since the constructor's workshop has, after all, always been something in the nature of a holy of holies: a place in which many pleasant hours are spent pursuing one of the most fascinating of hobbies and where many original designs are tried out. Who knows how many new ideas and successful inventions have originated from the small domestic workshop, created by the ready minds of keen experimenters? Indeed, were it not for the fact that the term applies more to the amateur transmitter, this article would perhaps be better under the more affectionate title of "Your 'Shack' " !

In addition to the evidence of good craftsmanship shown by readers in their references to their workshops, their letters raised a number of questions concerning the best possible methods of carrying out certain operations with the minimum of equipment, and about a large number of miscellaneous points ranging from chassis-cutters to oscilloscopes.

Owing to this great interest it has been decided to print this present series of articles. As the various points raised are somewhat unconnected it has been found best to deal with them in this form. This layout enables the largest number of interesting and *relevant* points to be dealt with in the shortest space, without the necessity of maintaining a steady flow of connected subjects such as would be required by the normal type of article.

All the items dealt with in these articles have been raised by readers, or by points encountered by the writer and his colleagues in their own experience of the hobby. The answers given are by no means entirely the views of the writer himself; in many cases they are the result of discussion between himself and his colleagues.

Aerial and Earth Systems

If it is at all possible, it is always advisable to have at least *one* good outside aerial. If general work is being carried out there is no necessity to bother about cutting the aerial to special frequencies, etc., all that is necessary being to have it as high and as far removed from earthed objects as is possible. (It must be remembered that an aerial which is only, say, five feet from a metal gutter has, in theory, an effective height of that amount only). Stranded copper wire should be used, and the aerial and its down-lead should be well-insulated, and removed from sources of interference.

If the particular workshop is devoted to a certain amount of service work it would be a good plan to have an *inefficient* aerial as well. This is because, when a receiver has been made to work well on the good aerial it may still give poor results when used with its original aerial. It is therefore well worth while having an inside aerial, say six to eight feet long, mounted along the wall for testing domestic receivers.

Should the workshop be within television range, and television work is being carried out, a television aerial is also, of course, needed.

The earth connection is really as important as the aerial system. Although the conduit or earthing lead of the mains wiring may be used for earthing electrical equipment such as soldering irons, etc., it does not always make a good earth connection at radio frequencies. This is due to the fact that the mains earthing lead often travels all over the building before it finally reaches the workshop. If it only has a short run, say ten to twenty feet, then it may, of course, be used.

However, the best earth connection is a direct lead from the window of the workshop (assuming that it is not in such a building as a block of flats) to a copper spike or strip, or a large tin buried in soft, damp ground. *All* connections should be soldered and heavy copper wire used to take the connection to the workshop. A good alternative, should, this prove impossible, is provided by a connection to the incoming pipe of the cold water system. Gas pipes should *never* be used for earth connections. Apart from the fact that screw joints in gas pipes are painted and therefore offer high resistance junctions, the danger of a spark makes the practice dangerous and, in some places, illegal. It is also, of course, illegal to use telephone earths.

Outside Workshops

Should any precautions be taken if a concrete floor is fitted?

Most definitely, yes! It is quite dangerous to handle mains equipment such as AC/DC receivers, or indeed any mains chassis out of its cabinet, whilst standing on a concrete floor. Despite the fact that the workshop may be dry, this type of floor still makes a good earth connection for the feet and you may get some nasty shocks. If the process of fitting floorboards is too expensive, some wooden duck boards may be made up as shown in Fig. 1, and these will minimise the chances of shock.

As regards running the mains wiring to your workshop, your local electrician should be able to advise on any byelaws, etc., which may affect this.

Test Equipment

This depends to a great extent upon what work is being done. A testmeter is almost essential, a multi-range high resistance job being preferred. Many amateurs make their own testmeters from 0—1mA (or similar current) movements in company with home-made shunts and series resistors. Quite a few good bargains in meters have been offered on the surplus marke*

A signal generator is extremely useful but not *entirely* essential unless one is going in for service work or fairly advanced experiments or construction.

Something of the same applies to oscilloscopes, valve voltmeters and so on, although these are not entirely essential for ordinary service work.

Capacitance and inductance bridges, particularly the former, are very useful for experimental work. These are usually home-constructed and calibrated against known components already on hand.

Very many useful tests can be carried out by means of headphones, neon bulbs and so on. A pair of high resistance phones connected in series with, say, a grid bias battery may be used for almost any continuity test;

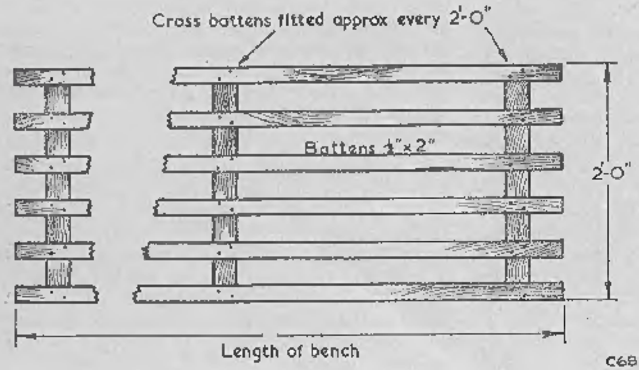


Fig. 1: How a duckboard may be made. Its purpose is to keep the feet from concrete floors and so prevent shock.

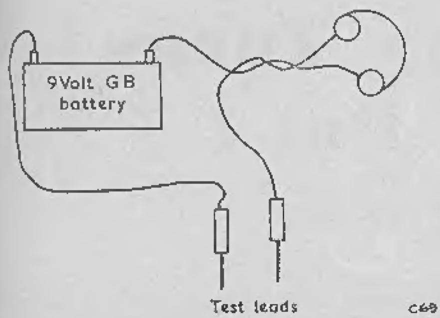


Fig. 2(a): A pair of high resistance headphones connected as shown here may be used to carry out tests for continuity and for leaks in capacitors.

and a very approximate idea of the resistance or inductance connected to the test leads obtained from the loudness of the "clicks" in the headphones. See Fig. 2(a). The headphones may also be used to check leakage in capacitors whose value is greater than about 0.001 μF (although a higher energizing voltage than the 9 volts offered by the GB battery may be needed for this test). When the test leads are connected to the capacitor there should be a noticeable click. If no click is heard, the capacitor is open-circuit. When they are taken away, however, there should be no click because the capacitor should by then have charged up to the value of the energizing battery. Should there be a click when the leads are taken away, then the capacitor is leaky and cannot hold a charge.

A neon bulb offers an even better check. If this is connected as shown in Fig. 2(b) it may be used for continuity tests or for checking capacitors. The value of the limiting resistor R should be sufficient to prevent the neon lamp "burning" when the test leads are shorted together, and 5,000 to 20,000 ohms will usually suffice: in many cases this limiting resistor will be found incorporated in the base of the bulb.

Connecting the test leads to different values of resistance will cause the bulb to glow at varying intensities and at different parts of its internal structure, thus enabling a fairly accurate guess as to the value of resistance to be made. For this reason, a "bee-hive" bulb such as is used for standby mains lighting is best for this job, as it has a large spiral electrode. Connecting it one way will cause the gas round the spiral electrode to be ionised; whilst, if reversed, the central plate will glow. The first method of connection is the best and can soon be found by experiment. This type of bulb should "read" resistances up to 1 Meg Ω.

If the bulb is to be used for checking capacitors something of the same procedure as applied for the headphone test may be used. When the test leads are connected to the capacitor the bulb should "strike", giving a flash. If the capacitor is in good condition it should then be charged up and the bulb will stay extinguished. If the capacitor is leaky it will keep losing its charge and the bulb will flash at regular intervals according to the resistive value of the leak.

The DC supply for the neon may be obtained from a pair of old HT batteries in series. It does not matter if their internal resistance is high so long as they have a good "off-load" voltage. Alternatively, it may be obtained from, say, the HT supply of a mains receiver if one is kept permanently in the workshop. The supply used should be well smoothed as, otherwise, the capacitor test cannot be carried out. AC is, of course, useless.

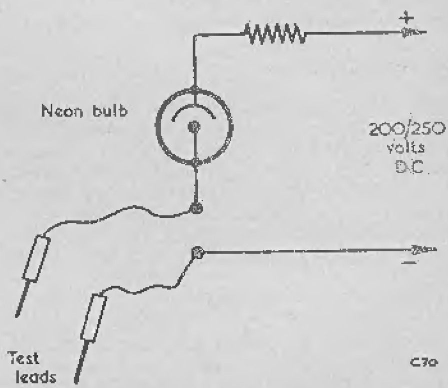


Fig. 2(b): Illustrating a method of using a neon bulb for resistance tests and checks for capacitance leakage.

Correction. In the circuit diagram of the 'Mains Transportable Receiver' in our last issue, the input was shown as 'AC/DC.' With capacitor feed to the valve heaters, this is obviously incorrect, and should read 'AC' only.

How Many Turns Shall I Put ?

by P. BARRATT, ISWL/G889

MANY beginners who are building their first sets approach the tuned stage component values somewhat empirically, and the frequent technique with coil design is to make something which "*must* be too big"-and then chop off turns.

This is all unnecessary, but it has been found that a surprising number of beginners are ignorant of the few basic formulae which so simplify the job and which—important to many—need very little maths for their application.

For completeness, we will start with a fundamental relation between frequency and wavelength, i.e., $f = \frac{300}{\lambda}$ (1) where f is frequency in Mcs., and λ is wavelength in metres. An alternative form is $\lambda = \frac{300}{f}$ (2)

This is obvious when it is considered that the velocity of the wave front will be the wavelength multiplied by the number of waves per second. The velocity is 3×10^8 m/sec., but by using Mcs. for the frequency the expression is simplified and gives the above result—the most useful form for SW work. As an example, a frequency of 8 Mcs. would correspond to a wavelength of $\frac{300}{8 \text{ m.}}$ or 37.5 m.

In the tuned circuit, we have a parallel arrangement of an inductance and a capacitor (Fig. 1). For such a circuit there is a certain fundamental frequency which, if a potential difference of that frequency is applied across the inductor or capacitor, sets up oscillations of that frequency in the circuit. These oscillations are only slightly damped compared to the effect produced by other frequencies, higher or lower (Fig. 2). This is the "resonant frequency" of the circuit, and the variation of this frequency is called "tuning".

The usual arrangement is that of a fixed inductance (the property of the coil, and dependent on its dimensions) and a variable capacitor. The minimum and maximum capacity values are usually specified, and the problem resolves itself into the determination of the number of turns necessary on, and the dimensions of, the coil.

Let us call the capacity in a given circuit "C" (in pF) and the inductance (dealt with below) "L", measured in μHenries. Then the resonant frequency "f" (in Mcs.) is given by

$$f = \frac{10^3}{2\pi \sqrt{LC}} \quad (3) \text{ where } \pi = 3.142.$$

How do we use this formula? Well if we put "f" as one extreme of the frequency range to be covered, then by substitution in the formula (using the minimum capacity value if the frequency used is the highest limit, and vice versa) we obtain a value for the inductance necessary. Using this value in the formula with the other capacity limit gives us the other frequency limit, and hence the range covered by a given inductance is determined.

The accuracy of these methods is quite sufficient for constructional work and have been tested frequently in practice. If it is preferred to work in wavelengths, the formula becomes $\lambda = 1.885 \sqrt{LC}$ (4), using (1) and (3).

The inductance of the circuit is the coil property, and depends on the dimensions and the material on which the coil is wound. As a rough definition it may be taken that the self inductance of the coil is a constant determining the EMF of self-induction set up across the coil by the current in it changing. The required formula will not be derived but will only be stated here, and is

$$L = \frac{4\pi n^2 a}{10^3 b} \ \mu H \quad (6)$$

where n=total number of turns, a=cross sectional area, b=length of winding. a and b are in sq. cms. and cms. respectively.

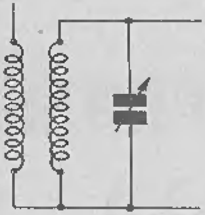


FIG 1

C73

For those who prefer to work in inches, the formula is $L=\frac{4\ 2.54\pi\ n^2\ a}{10^3 b}$ μH (6)

(This assumes a long coil, but the error is not too great).

Thus we can calculate the required inductance and the range that will be covered, also the necessary coil dimensions. An example will probably best show the methods used. Suppose the capacitance varies from 20 to 150 pF (μμF), and the lowest wavelength required is 15 metres. Then by (4)

$$15=1.885\ \sqrt{L\ 20} \text{ and}$$
$$15^2=1.885^2\ L\ 20$$
$$\therefore L=\frac{15^2}{20\ 1.885^2} = 4\mu H$$

For the highest wavelength of the range,

$$\lambda=1.885\ \sqrt{\frac{150\ \ 15^2}{1.885^2\ \ 20}} = 40 \text{ metres.}$$

This is probably on the high side, but indicates the limit, i.e., an inductance of 4μH will cover a range of say, safely, from 15 to 35 metres. As regards the coil, from (5)

$$L = 4\mu H = \frac{4\pi\ n^2\ a}{10^3\ b}\ \mu H$$
$$\therefore\ 10^3 b = \pi n^2 a$$

Suppose we want 10 turns altogether on the coil. Then $n=10$ and the relation becomes a=3.18 b. We may now choose our most convenient length, say 5 cms. (*b*), and this gives *a* (the cross sectional area) as 15.9 sq. cms. Now the area of a circle of diameter $d = \frac{1}{4}\pi d$. From this, we find that the diameter must be 4.5 cms., i.e., a coil wound with 10 turns to a length of 5 cms. and with a diameter of 4.5 cms. will tune over the required range.

If the value of capacitance is unknown, a rough value may be found for the maximum or a given intermediate position if the area of plates overlapping is determined. This is generally inaccurate, but is good enough if a capacitor is being cut down. The formula for capacitance, with air spacing, is

$$C = \frac{0.0885\ A\ N}{D}\ \text{pF}$$

where D = thickness of air gap between consecutive stator and rotor vanes in cms., A = overlapping area of plate in sq. cms., and N = number of separating air gaps. The use of this formula is obvious since D, A and N are all found by direct measurement and calculation. It must be emphasised, however, that this is very rough.

This is perhaps a rather sketchy outline, but if it is followed the results are of great use to the beginner-constructor and need only

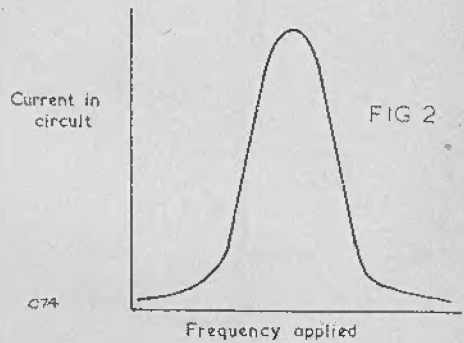
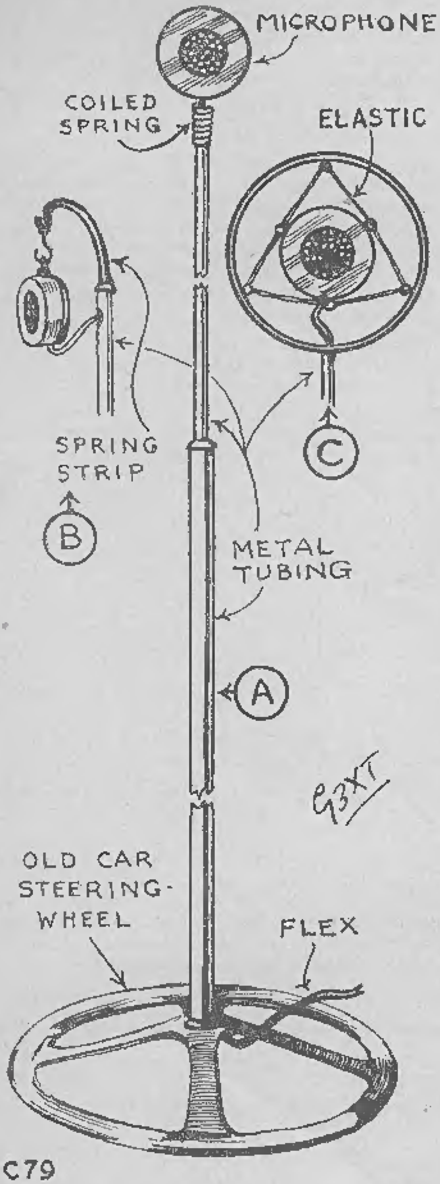


FIG 2

a little knowledge of maths to apply. The writer will be only too pleased to help on any points missed herein—if he is able to! The address is 314, Lynn Road, Wisbech, Cambs.



"No Cost" Microphone Stand (A), (B) and (C) show alternative methods of microphone suspension.

NO - COST MICROPHONE STAND

by G3XT

THE microphone stand shown in the sketch illustrating this article was made at no cost to the writer, being constructed entirely from discarded "odds and ends"! It is equally useful for public-address work with a suitable amplifier and loudspeaker, or in the shack with an amateur transmitter.

The original model was constructed somewhat hastily for outdoor use with PA equipment at a local féte. But a much better version could be devised quite easily and made with very little extra trouble, incorporating such obvious improvements as fully shock-proof microphone suspension, and a telescopic adjustment for height.

An old car steering-wheel, rescued from the scrap-heap at a local garage, forms the base, and a very good, substantial base too ! It has the great advantages of looking presentable, standing firmly even on rather "bumpy" ground out of doors, and being almost impossible to knock over accidentally.

The vertical column carrying the microphone is made of tubular metal. Actually a couple of old curtain rods were used in the G3XT version ! The diameter of the lower one has to be governed by the size of the centre hole in the steering-wheel ; that of the upper tube is a size or two smaller. If the mike is to be used only with the operator in a standing position, the upper tube can be a tight wedge fit in the lower one.

If, however, one prefers the improved version with a telescopic height adjustment which enables the microphone to be lowered to armchair level for use in a sitting position, then the upper tube or tubes must be made to slide down smoothly inside the bottom one, and a suitable locking-ring with thumbscrew must be fitted to fix the mike at the required height.

In the original model the microphone was supported on a rather crude spiral spring which was soldered to the top of the upper tube. This does not give complete shock-proofing, however, and a proper suspension with elastic cords or some equivalent shock-absorbing arrangement is definitely preferable, as it prevents any nasty "jarring" noises when the stand is moved about with the mike switched on—especially if it is a sensitive carbon type.

The mike leads were threaded down neatly inside the hollow tubes, and secured at the bottom to one of the radial struts of the steering wheel, with black insulating tape. The whole stand was enamelled glossy black, in pleasing contrast with the silver-plated microphone case. But any other colour-scheme in one or more tints could be used to present a pleasing appearance, especially if the microphone is required for public-address work in full view of an audience.

If the microphone used is of an insensitive type requiring a small pre-amplifier, this could probably be mounted on one of the radial struts of the steering-wheel base, where it would be least conspicuous and add still further to the stability of the stand.

Despite its scrap-heap origin, the whole contraption can be nicely finished to give it quite a professional appearance, and very few people looking at it would ever guess that it had (so to speak) risen phoenix-like from the dustbin !

The Editor Invites

articles from readers, of a nature suitable for inclusion in this magazine. Articles submitted for publication should preferably be typewritten, but ordinary writing is acceptable if clearly legible. In any case, double spacing should be used, to allow room for any necessary corrections. Drawings need not be elaborately finished, as they will usually be redrawn by our draughtsmen, but details should be clear. Photographs should preferably be large (half-plate) but in any case the focus must be good. Much useful advice to prospective writers is given in our " Hints for Article Writers ", which will be sent free on request.

"from our MAILBAG"

Mains/Battery Receivers

Dear Sir,—Regarding the letter from a Mr. W. Savage on page 29 of the August issue, it would seem clear that he has omitted to fit a by-pass capacitor between the cathode of the output valve and chassis. The valves are being over-run by the audio output current which when using the signal generator is 400 cycles, and will therefore not be read on DC instruments.—D. N. Corfield (Valve Application Dept., Standard Telephones and Cables Ltd.).

Dear Sir,—The reason for the valves brightening was that the heavy note caused a large AC current to be superimposed on the residual DC heater current. The meter, being a DC type, would not register this, but the valves, being purely thermal, would glow according to the total applied power.

Two causes are evident. (A) The cathode by-pass capacitor on the output (mains) valve is O/C or not of sufficient capacity. It is advisable to fit capacitors of the order of 100 μF (electrolytic). (B) Bias conditions on the output valve not correct, or it is being over-driven, so that it does not operate in true Class A.

(A) is most likely as this capacitor MUST be fitted to keep the AC component of the anode current from the other valve heaters. Perhaps your correspondent had hoped to obtain negative feedback and omitted this by-pass. In this particular case this method of feedback is not possible.

To be absolutely sure of this point, it would be advisable to fit an AC meter in series with heaters and build up the by-pass capacity until there is virtually no AC in the heaters.—
L. F. Sinfield (Luton).

Dear Sir,—When the set is static the bias to the output valve remains constant at the value given in the maker's data, the current through the bias resistor being the normal valve current. However, when a signal is applied this is not the case. The note of a signal generator (I bet your correspondent uses a service oscillator !!) is an AC sine wave. When it is applied to the set, the standing bias on the output valve makes it have a DC component. The peak to peak variation causes the valve current to vary by equal amounts up and down from the normal value. This current is that through the cathode bias resistor. By Ohm's Law, since R is constant the PD across R varies with the current, so that the voltage available in the heater circuit of the other valves has an AC component. This voltage variation introduces a current variation in the heaters too rapid to affect a normal "dead beat" meter, which registers the mean current, which is the same as that given by the normal standing bias of the output valve with no signal.

All right, you say, but that leaves us very little better off than before. But wait ! I have only gone over the preliminary facts. The mean current in any AC circuit is always zero as measured on a DC meter, since the negative and positive peaks cancel each other out. However, it is not the mean but the RMS current which matters in the heating effect of an AC supply. Therefore the actual current through the valve heaters is not the same as that through them when the set is static, but that current plus the RMS current of the signal's effect on the bias .

In a set employing adequate AVC, as a commercial model would, the trouble would not arise. The signals would never reach the output stage amplified beyond a certain amount, and the small extra current would be allowed for in the design.

Mr. Savage would probably find that his set would be satisfactory on normal stations as the effect would not be noticed with the insensitive aerial of a portable set, but the strength of a signal generator signal together with its very tight coupling would give a noticeable increase to the effect, with no apparent cause or reason, as he observed.—
D. R. Bilston (Cavendish, Suffolk).

Re-building a Short-Wave Band

Contd. from Next Page

"Dont believe in aerials," I was told, "set works all right without. Not having wires hanging round MY house."

I argued, I pleaded, but in vain. He sure meant it—He wasn't having wires hanging round his house. Of course the short wave wouldn't work without. He told me that the set had been ruined. I told him that it hadn't, and that it would be OK with an aerial. He told me that he wouldn't pay for something that didn't work. I told him that it WOULD work—with an aerial! He told me that he WAS NOT HAVING AN AERIAL !!! I told him . . . Well, what I told him is nobody's business. Still, I could have used the money—and the parts I keep getting done out of !

How to RE-BUILD A SHORT WAVE BAND

by H. DUDLEY STILTON

THERE is an old saying, so I am told, which informs us that: 'Those who know most, say least'. Which probably was the reason why I was the only one who was doing the talking. There was also a motto hanging on the wall which stated: 'Better to be thought a fool, than to open your mouth and prove it'. Which again explains why everyone listened,—except me!

The subject under discussion was, originally, communication receivers, and the general view was that the more valves there were, the better the set. Yours truly, being in a very clever mood, promptly got up and informed the company at large that it was a lot of hooey, and that you could get just as much with one valve as with ten !!!

One of the company, deciding that this was too good a chance to miss, took me up on it. He bet me a pound that I was wrong, and could prove it–I never learn, do I?–I accepted the bet.

I now spend all my evenings at home, working out how to build a television set,—and with only one valve, too. Still, I have great hopes of the magic-eye that I'm using!

Seriously, though. A chap was telling me, the other day, that a friend of his had a set which would receive television sound, and would it be possible to make his set receive same? I told him that as long as he was prepared to pay for it, he could have the Follies Bergere on it.

"Oh no," he said, quite seriously, "I couldn't do that—the wife would object."

I looked at him in amazement, but I think he must have been kidding me—because he could always send the wife out, couldn't he?

To continue. I agreed that it would be possible to get television sound, and to cut a long story short, I fetched the set in and started work.

The set was the usual long, medium, short and gram. type. So I decided the simplest thing would be to build a separate unit, rather than to try and get his set to tune so high. It used a 6K8, so it may have done it. Still, I decided that the simplest job would be the best—and cheapest. So, naturally, the choice was for a one valve, super-regen, pre-set tuned to the Midland station, and brought into operation by the gram. switch.

Looking through the American ARRL Handbook, I found just the circuit I needed. I must admit that I have never built a one valve set before—beneath my dignity!—so I read the 'gen' quite carefully. It pointed out that the setting and adjustment was very critical. Just fancy, very critical, and on a one valve set too. Ha, ha, ha.—that was BEFORE I built it.

After building it for the fourth time, and still getting no results, I decided that after all it was rather, err,—shall we say, difficult! I decided to seek advice. But how to ask for advice on a ONE valve set, without appearing too ignorant? Just then I heard a familiar chug-chug outside, and knew that Matt had arrived in his three-wheeler.

"Just the man," thinks I, "let's see how clever he REALLY is." (I've never known him to be beaten yet—worse luck!)

I dragged him upstairs, and showed him my creation.

"Hmmmm," he said.

When he is dealing with radio, that is the full extent of his vocabulary. After you get to know him, you can tell whether the problem is hard, medium, or easy, just by the length of his Hmmm. This particular Hmm was only short, meaning it was easy. I chuckled to myself. He looked at it for a moment, grabbed the soldering iron and changed a resistor. The set immediately started working. As Frankie Howerd says, 'I was ama.a.azed! I was more than that, I was floored. I lifted my foot to kick myself, but Rex got in the way, and I kicked him instead. He promptly took a chunk out of my leg. I let out a yell, and chased him downstairs. The XYL was just coming upstairs with two cups of tea. They met. The XYL went one way, and the tea went the other. I dashed downstairs and bent to pick her up. The dog thought I was going to murder her, and bit me again.—Have you ever tried typing standing up? . . .

To return to the point once more. We found that if we replaced the grid condenser with a 5-50pf variable trimmer, we could adjust it until maximum gain was obtained; and the H.T. voltage IS critical.

Apart from that, very efficient results were obtained—but DON'T use a cheap coupling transformer, because for some reason or other 'it just don't work'.

The set was eventually finished and returned. I plugged it in and looked for the aerial lead. Finding nothing, I asked where it was.

Contd. on previous Page

Valve Tester

contd. from P.93

some valves, a mutual conductance figure is given that is greater than the anode current of the valve. To take an example, the triode section of a 6Q7 has an anode current of 1.1 mA and a mutual conductance of 1.2 mA per volt, at a grid bias of 3 volts. When a case like this is encountered, the bias change carried out by S11 should be of such a nature that it reduces the bias. Thus, in this case, reducing the bias to 2 volts will give the required mutual conductance reading.

It may also be found that it is not always possible to connect the valve under test to exactly the voltages shown in the tables. For example, valves that need, say, anode voltages of 250 or 200 have to be connected to the 210 volt supply. In practice, however, this will only cause a slight reduction of the mutual conductance in the first case and a slight increase in the second. This point should be remembered when the minimum permissible meter variations are made up for the cards.

The value for minimum meter variation will, of course, be worked out from the figures given by the manufacturers. In most cases, the figures given on the cards should be between 75 and 80% of the maker's figure.

A Warning

There is still one final outstanding point of importance, and that is that no switches should be adjusted whilst the unit is switched on and the valve under test is plugged in. Therefore, before any changes are made, the valve should be removed or the tester switched off. It is advisable to make out a notice to this effect and mount it in a prominent position on the front of the valve tester.

TV Picture Faults

contd. from P.95

the CRT, this being the part of the tube where the electron beam is most easily disturbed.

EHT supplies provided by a mains transformer are similar to the normal power supplies, apart from the additional smoothing required. Great caution should always be observed when adjusting power supplies of this type, as there is a tendency for the capacitors involved to remain charged for very long periods, and this can be lethal.

Line flyback and RF oscillator EHT systems, however, require very low value smoothing capacitors, and as a result discharge very rapidly and are often termed non-lethal. They are not so robust, as a general rule, as the mains transformer types. The following faults are those most likely to occur. Brush and corona discharge—this is due to the high voltage being developed across inductors and circuits constructed of very fine gauge wire. If such a wire is given a high potential, the air immediately in the region of the wire may ionize, and power can actually be dissipated in the surrounding air. The possibility of insulation breakdown is therefore fairly great, unless special care is taken in the design. Radio frequency radiation—this is unlikely in a manufactured RF oscillator type of EHT supply, as effective screening is usually incorporated. It is advisable, if one intends to construct a unit of this type, to give some thought to this problem, as an unscreened or radiating oscillator can be a considerable nuisance to domestic receivers operating on long waves. Similar effects can occur with the line flyback type of EHT supplies, and long leads carrying high sawtooth voltages should be avoided if possible. The smoothed EHT may be run any distance without possibility of radiation.

The main points to be careful about are to avoid small diameter wire unless this is well insulated, to make soldered joints without points (it is far better to make a big 'blob' here), to give adequate spacing and to maintain a reasonable degree of screening where required.

Brush discharge over the glass of the CRT round an anode "pip" may often be avoided by smearing the region with a little petroleum jelly.

(to be continued)

Intercoms

contd. from P.83.

These measures are necessary to ensure that feed back is reduced to a minimum.

The Various Systems Discussed

In this series of articles we have discussed not only the best type of amplifier which may be used on intercom systems but have also reviewed various methods of conversing with and calling individual stations.

Some of the installations which have been shown have commercial counterparts. The system described in the present article has been designed by the writer and he is not aware if there is any similar commercial model. Nevertheless, the perfection of its operation and the facilities which it provides should make it well worthy of consideration by those interested in this branch of radio.

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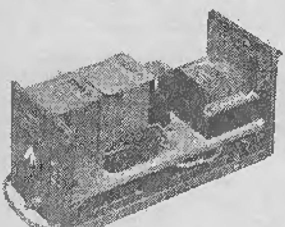

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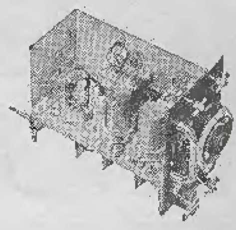

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