Radio Constructor

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EDITORIAL

Brows—High and Low

OUR extract from Mr. Bollard's letter certainly stirred up some interest. This month we are publishing replies from other readers and more will follow next issue. The comments of readers only go to show that our task is difficult—some want more advanced articles, some want them simpler and others feel that the standard is ideal as at present. We like to feel that everyone is getting his moneys-worth and so our wisest policy will be to try and cater for all tastes. In this direction it would appear on balance that the beginners could do with some extra space and in view of this fact we are working on a series of articles specially designed to help the newcomer. Also in mind are special constructional articles for the beginner.

Novelty

Although our articles on the conversion of surplus gear are ever-popular, many of them will be admitted as being "much of a muchness." It is, therefore, with special interest that we receive such articles as "Utilising the Neon Tube," published in this issue. To many readers, particularly to the newcomer, it will be a revelation what uses one can put this adaptable little component. On the same level, we are publishing an article in the next issue on surplus motor generators.

This type of article is the way to keep a magazine lively and interesting. However absorbing may a reader's interest be in receivers, test gear and so forth, he can quite easily get a trifle bored if he gets nothing else to read about. Here we must make a plea to readers—if you specialize in any out of the ordinary aspect of radio, or have any specialized knowledge, drop us a postcard stating what you have in mind and we will let you know if we can accept an article on the subject. Despite our interest in unusual topics it does not follow that we are not interested in descriptions of the more mundane radio equipment. On the contrary, articles of any nature are always welcome. May we hear from you ?

Fireworks

A story with a moral can be found in our article "Testing Without Tools." The experienced constructor will find many practical truths in the text and we feel that the author will cause many readers to think furiously. We would though, whisper a word of warning to beginners not to take some of the advice too seriously !

W.N.S

NOTICES

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

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

ALL CORRESPONDENCE should be addressed to *Radio Constructor*, 57, Maida Vale, Paddington, London, W.9. Telephone: CUN. 6579.

High Fidelity Battery Amplifiers

C. SUMMERFORD

discusses some interesting points

DESIGNERS of battery receivers and amplifiers have always to bear in mind that, to keep running costs at a reasonable level, the utmost gain must be obtained from a relatively small number of valves. This probably applies more to the AF portion of the receiver than to the pre-detector circuits, and for this reason the output valve is usually a pentode or tetrode. Furthermore, coupling between output valve and the preceding stage is quite often by intervalve transformer. A typical circuit is shown at Fig. 1, where the valve V1, although shown as an ordinary AF amplifier, will quite probably be a grid-leak detector. In fact, this will almost certainly be the case if the receiver is of the "straight" variety.

Allowing that the full gain of the Fig. 1 amplifier will possibly be required in certain circumstances, for the greater part of the time—such as, when listening to the local station—nothing like the full AF gain will be needed. Therefore, as, in this latter case, there is gain to spare, it would be advantageous if some of the surplus could be utilised to improve the characteristics of the amplifier, at the same time arranging things so that these characteristics may be changed simply by turning a knob.

Negative-Feedback

The way in which this may be accomplished is ridiculously simple and, as shown in Fig. 2, only requires the addition of one fixed capacitor, one fixed resistor and a potentiometer. These three components form an AF potentiometer between V2 anode and grid return and, as will be seen, absorb a small portion of the AF voltage appearing at the valve anode and feed it back to the grid circuit in phase opposition to the grid signal, thus reducing the overall gain by an amount dependant on the values of C, R and VR. The feed-back may be likened to reaction in the opposite phase, *i.e.*, whereas reaction is *positive* feed-back which increases gain at certain frequencies, this type of feed-back is *negative* and decreases gain and so tends to flatten the response curve of the output stage.

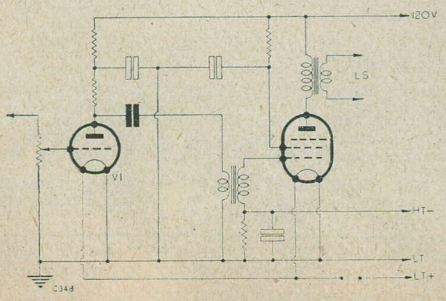


Fig. 1.

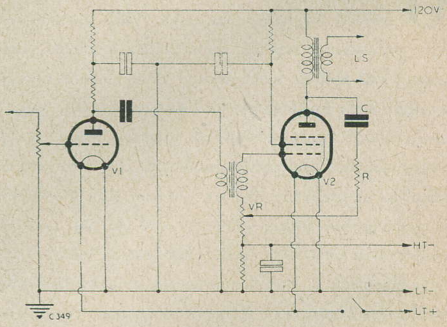


Fig. 2.

Speaker Resonance

One of the greatest benefits to be derived from an application of negative-feed-back to the output stage is the elimination, or at least great reduction, of the drumminess of reproduction caused by speaker cone resonance. Most loudspeakers suffer in greater or lesser degree from this nuisance which is caused by the cone continuing to vibrate after the signal has ceased. The speech coil movement in the magnetic field is large at the resonant frequency, and causes a larger voltage than normal to appear in the coil. This back voltage is then transmitted to the anode of the valve via the output transformer. When the output valve is a low impedance triode it absorbs power from the speech coil and quickly stops it from vibrating, thus effectively damping the loudpseaker.

Pentodes and tetrodes, on the other hand, are of high resistance and, absorbing little power, leave the speaker relatively undamped.

By applying negative-feed-back as shown at Fig. 2, an equivalent to the lowering of the valve resistance is achieved. This is due to the fact that in the feed-back loop anode and grid potentials are changing in the same direction when a voltage is applied to the anode, and therefore, the change of anode current will be greater than it would be if the voltage were applied to the anode alone.

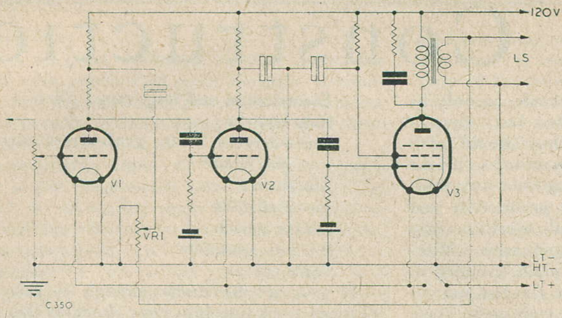


Fig. 3.

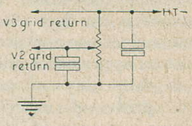


Fig. 3a.

Amplitude Distortion

The second kind of distortion experienced with pentode and tetrode output valves is that of amplitude or harmonic distortion. With a normal battery pentode giving an output of about 400 milliwatts the total amplitude distortion is not likely to be less than 10 per cent. As about 5 per cent of this will be composed of odd-order harmonics (always offensive to the ear) the reproduction is likely to be decidely unpleasant. Luckily, the negative-feed-back will drastically reduce this distortion also. For instance, a 10 per cent feed-back loop will reduce the total amplitude distortion to 1 per cent, of which odd harmonics will be a half.

Summing up then, negative-feed-back allows the characteristics of the pentode or tetrode to be modified so that they are ostensibly those of a low impedance triode in the quality sense, whilst still retaining the high wattage output at relatively low HT current and grid bias voltage.

With regard to the values of C, R and VR in Fig. 2, these must be assessed in conjunction with the characteristics of the output valve. The resistor R should first be decided upon and should not be much less than eight times the optimum load, otherwise power will be lost. Taking an average optimum load figure of 15,000 Ω, this will make R = 120,000 Ω. VR should be about a fifth of this which works out at 24,000 ohms, but 20,000 ohms would be quite suitable. The isolating capacitor C requires to have a value that is small in impedance at the lowest frequency required compared with the value of R. In this particular case 0.25μF would be perfectly satisfactory.

Resistance Coupled Amplifier

An even simpler method of applying feed-back is shown at Fig. 3, the only extra component required in this circuit being VR1. It will be seen

(*continued on page* 594)

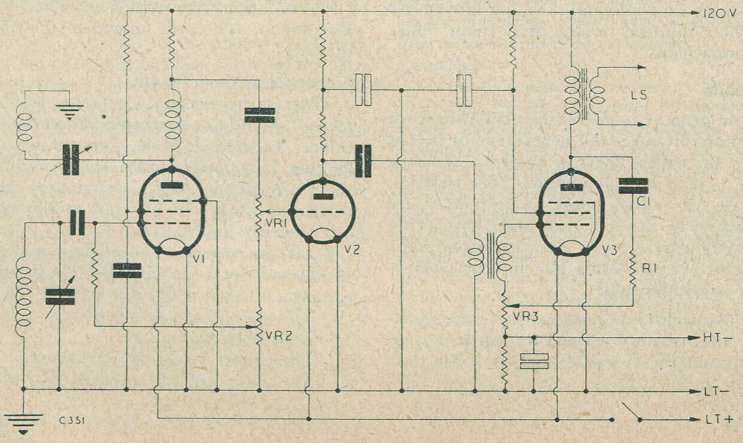


Fig. 4.

Better Construction

IT is no secret that first-class work can only be done with first-class tools, but equally important is the fact that they should have careful and correct use and proper storage. Some trades insist on apprentices making their own tools although in these days of mass production and machinery, pride of individual workmanship seems to have lost some of its importance. Making one's own tools is not only good training in metalwork and tempering but it teaches one to value and use them correctly as well as to store them with the care they deserve. The radio amateur with any appreciation of craftsmanship soon learns the pleasure of owning or using good tools, but only too often does his interest in the hobby overshadow his pride in good work and tool consciousness. The temptation to push on with an experimental hook-up is so irresistible.

CENTRE TAP

gives some useful advice for the newcomer to radio construction

In his impatience he is often guilty of using a screwdriver to reamer a hole, to prise off a rivet or to lever open a case. It does not do these jobs satisfactorily and it ruins the edge so that if it is not re-ground before the next time it is put to its legitimate use it spoils the cut in the screw-head. If you must mis-use tools, limit it to the old ones, and treat the good ones as the old soldier is supposed to treat his rifle. By buying good tools, and if you have no workshop, keeping an orderly tool box, the resolution to look after them comes almost automatically.

The Essentials

Unless you propose undertaking elaborate work a big collection of tools is not necessary but it is as well to start off with a chest of ample dimensions and to add to it as occasion arises. See that the additions are all quality tools. Cheap ones are more expensive in the long run and they rarely give full satisfaction in use. They certainly don't inspire pleasure in possession nor do they encourage precise workmanship.

We all have different ideas on just what constitutes the indispensable minimum in the way of tools, but personally I would suggest a list that included the following :—

Hand drill
Hammer
Hacksaw
Bench vice
Electricians and long-nosed pliers
Side cutters
Screwdrivers from grub-screw size up to ¼in. blade
Tin shears
Assorted files
Centre punch
BA box spanners
Tank cutter

If you are fortunate enough to have a permanent work bench in your shack or den so much the better, but if you are a flat-dweller and have to be content with a corner of the kitchen or living-room, the above collection, properly stored, should enable you to engineer a sound constructional job.

In these days of housing difficulties the constructor with a permanent workshop is the exception rather than the rule and a tool chest of ample size to accommodate those outlined above and the subsequent additions that will inevitably be collected, is quite as important as the tools themselves.

To keep the tools in first-class shape each must have its space and be held there by the usual tool clips. It is amazing just how many tools you can house in a small chest if you use the inside of a deep lid and a couple of drop-in trays, or even a " fold-in " flap with small tools fitted to each side. The flap is, of course, hinged to the front edge of the box.

Engineering the Chassis

There is no reason why even an " exhibition piece " should not be turned out on the kitchenette table. Indeed, I have seen many professional looking jobs made under such conditions. But there are far too many constructors who use this to excuse work which is not merely amateurish, but clumsily amateurish.

Good construction should be a source of pride and pleasure and the only additional things needed to make all that difference are :—

The need to work to a plan.
That little extra care.
The proper tools correctly used.
The thoughtful application of ordinary commonsense.
And the guidance found in any good handbook or learned from a little practical experience.

The Easy Way

Writers on good workshop practice invariably start off with points that seem boringly obvious. Maybe they are, or it may just be common sense, but even so many constructors still don't put them into practice.

If, as invariably urged, we " don't start mounting any of the components until ALL the drilling is done," we all readily agree it's plain commonsense, and too obvious to be worth mentioning. But how many keep to it? The temptation to try a component for ' fit ' is too great and then it is left in position as there are " only two or three more holes and it won't be in the way." It probably isn't in the way of the drill point, but it is in the way of your knuckles as you start to drill and as a consequence we have chipped components or a scarred chassis where the drill, used perhaps at an angle, slipped.

However, we will leave such obvious and elementary truths to the good sense of the reader and consider some of the less apparent points.

Cutting and Shaping

Cadmium-plated steel makes the ideal chassis but is hardly practicable unless one has a fairly well-equipped workshop and even then it becomes hard work. With the smaller chassis, aluminium is equally as good and very easy to work. Dural is unsuitable as it will not bend, but it makes excellent panels, etc.

The cutting of ali or dural with a hacksaw is both easy and quick, and a true edge is more easily obtained if the saw is used at a low angle thus cutting along the surface and not across it. Bending is done after scoring fairly deeply and then clamping firmly between hard wood blocks along the bending point. Should it be necessary to " beat " it to ensure a clean right-angle bend use either a wooden drift or a leather faced mallet. Soft metals like ali or dural scar easily.

Long edges can be scored deeply on both sides and then bent forward and backwards until it breaks and a clean edge obtained by finishing off with a file.

The polished surface can be preserved if it is covered by paper held in position at the edges with adhesive plaster. Screening should always be designed with a dual purpose whenever possible. Not only to do its original job but also to help to maintain chassis strength and rigidity.

Square and rectangular holes should be carefully scribed out and a series of small holes drilled around the perimeter when the piece can be knocked through and the hole finished off with a file. It is assumed, of course, that a centre punch is always used when drilling. It is quite impossible to accurately drill even a single hole without, let alone a row of holes required to leave a straight edge for a drop-through transformer or a full-scale dial. In drilling, too, it must be remembered that a drill is meant to cut its way through and not to be pushed through as many unfamiliar with metal work seem to imagine.

Round holes for valve-holders, meters, etc., are best cut with either an adjustable tank-cutter or an Enox ring saw. For readers unfamiliar with the latter, it consists of a casting around which a strip of hacksaw blade is fitted, ring fashion. A different one for each size hole is, of course, required, as is the case with the Q-Max punch. The latter, by the way, gives a very clean finish.

Holes for wiring leads carrying current should always be lined with rubber grommets but holes for RF wiring are better left plain and a wide clearance allowed. This is particularly important in short-wave work.

Both to avoid the possibility of microphony and to ensure a smooth drive, it is advisable to mount the tuning capacitor on a rubber mounting, particularly if the speaker is to be fitted close to the chassis.

Finish

If, as already mentioned, it is intended to retain a polished surface, protective covering should be used until all danger of scratching is past. Even so, frequent cleaning of the work bench is essential to avoid scratching from the filings and swarf.

A plain enamel finish can look every effective if carefully applied, especially if a cellulose enamel is used. In any case the surface must be " matted " with fine emery cloth to enable the enamel to get a good bite and avoid later flaking as well as to remove any possible traces of grease.

Crackle or crinkle finish can be imitated by stippling with a brush on the enamel when nearly dry. The following method has also been found to give excellent results. 5 per cent aluminium stearate is added to ordinary enamel and it is then baked in an oven at approximately 110 degrees F. until wrinkles form when the temperature is increased up to about 300 degrees F. until it hardens. A plain stove finish can be obtained in a similar way.

The highly popular aluminium " satin finish " can be easily effected by treating in a bath containing a solution of lye, for about a half-an-hour or a little more. Four tablespoonfuls of lye to each gallon of water is used for the solution and several pieces can be treated at the same time as long as no overlapping is allowed.

Assembly

Ceramic-mounted components should be fitted with cork or fibre washers to prevent cracking when tightening up, and locking washers are advisable on all components. A small dab of shellac on each nut will ensure them not loosening however much vibration or movement they will get. Nuts are best locked by a second nut but even so, without a locking washer, or shellac, they are liable to loosen through the continual expansion and contraction due to changing temperatures.

Perhaps the chief drawback to the use of aluminium or dural is the impossibility of soldering chassis return leads directly to it, but this can be overcome by using a narrow strip of copper foil bolted to the chassis and running its full width. If all chassis return leads are soldered to it, the usual crackles brought about by imperfect (electrical) connections due to surface oxidisation of contact joints, will be obviated.

HIGH POWER 12″ PERMANENT MAGNET LOUDSPEAKER

GOODMANS R22/12—20 WATT

This unit initiates their new range of Medium and High power reproducers known as the "AUDIOM" SERIES (Regn. Pending).

The 'AUDIOM R22'—20 WATT 12″ fully dustproof Permanent Magnet Loudspeaker forms part of Goodmans' efforts, not only to remain in step with the latest developments in Electrical Acoustic Reproduction, but to retain the lead in meeting the requirements for loudspeakers with regard to rational design, effectiveness and reliability of performance.

Further information on this new unit may be obtained from Goodmans Industries Ltd., Lancelot Road, Wembley, Middx.

Industrial Opportunities ahead for Radio Retailers

The importance of sound basic training for the service engineer was emphasised by Mr. C. H. Gardner, of the valve division of Mullard Electronic Products Ltd., at the inaugural meeting of the Nottingham branch of the Institute of Practical Radio Engineers. Mr. A. E. Smith, a prominent Nottingham retailer was elected Chairman, and Mr. L. B. Taylor, who has for some time been active in the Institute's interests, was elected secretary.

Dealing with the importance of basic training for service engineers, Mr. Gardner said that in the retail side of the radio industry there was a ready made network for the maintenance of industrial electronic apparatus. Many thousands of pounds of extra turn-over could be secured in this direction by the service departments of dealers. This type of business would only be obtained, however, if manufacturers and users alike had faith in the capabilities and in the technical standing of service engineers employed in such retail service departments.

ERRATA.

"A Surplus Superhet": Page 569. The words following "Fig. 3" should have read "The Power Pack" Also the rectifier V should have read "5Z4G" and not "5Z5G."

"An Improved Vision Unit": Page 573. The suppressor grids were omitted from V3, V4, and V7. These, of course, should be taken to chassis. In the sync separator circuit, R47 should be shown as connected to HT+B. Finally, in the frame time base circuit, the capacitor marked C21 (in series with VR2) should have read C24, the value of which is 0.1μF.

New Mullard Valve Booklet for Service Engineers

A new pocket-sized booklet containing a comprehensive record of the Mullard range of valves has been produced specially for service engineers.

The booklet is the first of its kind to be issued by Mullard since the end of the War. It has fifty-eight pages, and can be carried around as a complete valve reference. It contains the same information as the Mullard wall chart issued earlier this year.

In addition to prices and purchase tax, information includes operating data and characteristics, base connections and diagrams.

The booklet carries a complete list of equivalent types of valves in other makes, and there are recommendations for the substitution of obsolete types by modern valves.

(*BATTERY AMPLIFIERS— continued from page* 591)

that here the feed-back voltage is taken from the secondary side of the output transformer and fed to the return path of the decoupling capacitor of V1. As the feed-back voltage will be over two stages VR1 will need to be quite small—not more than 100 Ω—and the slider will probably have to be set at about 20 Ω.

Any reader of this journal who contemplates building an amplifier to this design may prefer automatic bias to the battery bias shown, and for that reason a suitable circuit is shown at Fig. 3a. Incidentally, which side of the output transformer is connected to the feed-back loop and which is to be earthed will have to be decided by trial and error. Wrong connection will, of course, make the feed-back positive instead of negative and will make itself apparent by a nasty whistle.

Dual Feed-back Circuit

Fig. 4 gives circuit details of a rather more ambitious arrangement. Actually, the circuit is that of Fig. 2 with the addition of a pentode grid leak detector which also has feed-back applied. Here again the number of extra components required is small—three for the output stage and one (VR2) for the detector. There is no need to be too precise as to the value of VR2 but, assuming that C is 0.05μF and R and VR1 are each 1.0M Ω then 50,000 Ω should be suitable for VR2. It will, in all probability, be possible to dispense with either one or both of the feed-back variables and insert simple half-watt fixed resistors in their place. The circuit as shown has variable positive feed-back at RF, and variable negative-feed-back at AF, so combining good selectivity with good quality.

There is, of course, no reason why an RF stage should not precede the detector.

FROM THE MAILBAG

Our readers write . . .

THE VOICE OF 1920

Perhaps I am one of those 1920 " practical " point-to-point wallahs you refer to (May Editorial). I certainly can go back to those interesting days, and I certainly saw more construction carried out then than I do these days. Naturally, components are more expensive but even so I feel that more would be done if assistance were given by the technical press to popularise the construction of equipment.

To-day we get a list of parts, half a column of data and the circuit. No doubt some will say " What more is needed ?" Plenty, I think. Can you wonder that so many use surplus gear or ready-for-the-air receivers?

The whole problem could be dealt with if we went back to the 1920's when the popular radio magazines were 100%. Paper is no doubt a problem, but what about a series of construction articles, the real thing ? Let us see what the gear looks like, give some idea where the bits and pieces go. Why make everything so obscure ?

Give full details, in time, of a complete station layout with receiver and transmitter, the latter for low power working for newly licensed hams, with full facilities for increasing power later.

Yours faithfully,
R. F. Shackleford
(Reading, Berks.)

1949 SPEAKS UP

In the May issue you ask, as a result of a correspondent's letter, " Are we too high-brow?" My own view on this is simply " NO!"

If anyone thinks so, his knowledge of amateur radio is more limited than he cares to admit. If he is a " raw recruit " his opinion is of course excusable, but on the other hand he may be one who is typical of so many—too lazy to get down to brass tacks and who wants someone else to build his receivers for him and then comes forward to take a bow on his remarkable achievement.

If one wants the real " low down " he can learn all this at his local radio club, but it appears there are still some who just want to dabble in " wireless " and create a big impression on his friends, incidentally knowing nothing about the subject.

As an example of what can be done if the enthusiast *really wants to,* I would like to mention that as secretary of the local ISWL Chapter I have recently introduced a Junior Section to the club. We have youngsters who six weeks ago hadn't the foggiest notion on how to build gear but who, after suitable tuition, have now completed receivers (even making their own coils) from data taken *solely* from the pages of " Radio Constructor " and " Short Wave News." An open invitation is extended to any Doubting Thomases. Therefore, if these youngsters can do it in six weeks what have the point-to-point people been doing in the last decade or two ?

Best wishes,
Claude Aspinall
(Tarleton, nr. Preston)

DETAILS ?

As a reader from its inception, I find the magazine has improved considerably and I like the latest idea of the Quiz. I am also very interested in the articles on surplus gear conversion.

In common with other radio magazines, however, I think that quite a few of the constructional articles do not give sufficient detail. I know that paper shortage is the great bugbear and can only look forward with hopes to an increased size in the perhaps not too distant future.

Yours truly,
T. G. O'Neill
(Liverpool).

A BASE IDEA ?

I think that useless padding should be avoided, i.e. " Marking Valve Bases " in the April issue. This is not a very practical idea. Much better is a small loose-leaf booklet with the valve base and the most important characteristics for each valve marked on separate sheets. When a piece of equipment is being made, the data on the relevant valves is extracted from the booklet and placed on the workbench.

Yours faithfully,
D. J. Cross
(Stoke, Coventry).

UTILISING THE NEON TUBE

By C. H. WEBB

Some of the many uses of this adaptable component.

AMONGST the great amount of surplus material on the market are considerable numbers of neon tubes. To the average constructor these may not appear so attractive as the even vaster quantities of cheap valves. Never-the-less, the simple neon can be made to perform a great number of jobs and also provides a fertile field for the radio experimenter.

The neon tube contains, naturally enough, neon gas but at the very low pressure of approximately 10 mm of mercury. Also included are two electrodes. When a certain potential is applied across these electrodes the stream of electrons passing from one to the other splits the molecules of gas. These are separated into positive and negative ions, and the whole process is known as *ionisation*. In the case of neon gas there is also a characteristic emission of yellowy-orange light and the whole is similar in action and effect to the Aurora Borealis.

The speed of the electron stream is determined primarily by the potential difference across the electrodes. With slow moving electrons (and consequent low PD) the gas will not ionise. There is an optimum " striking " voltage and in most cases this is about 90-100 volts. Most surplus neons have this voltage stamped on the metal base, and in some cases it may be as low as 50 volts. The current taken by a neon is usually a matter of a few milliamps at the most. The small ¼-watt type take microamps. This information is in most cases stamped after the striking voltage.

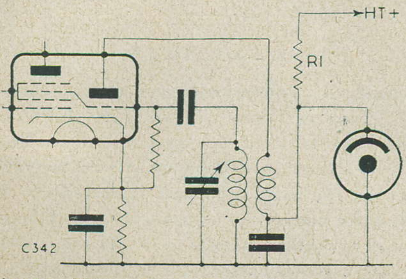


Fig. 1. Neon tube used for voltage stabilisation to prevent frequency drift. R1 acts as a series resistor for both the oscillator anode and the neon. Suitable tubes are the VR150/30, VR105/30 and the Mullard 7475.

It should be mentioned that once the striking voltage has been attained the neon will remain aglow at smaller voltages.

Uses of the Neon

The various uses of the neon tube fall under three main headings : (i) as a voltage stabilisor ; (ii) as an oscillator ; (iii) as an indicator.

In the case of voltage stabilisation the neon acts as a compensating load in parallel with an external load. This compensating load increases or decreases inversely to the action of the external load. Consequently the load on the rectifier is maintained constant and output voltage remains also at a constant level.

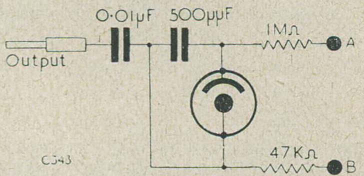


Fig. 2. A simple AF oscillator giving a 1,000 cps. note. Point A is connected to HT positive and B to chassis. A Bulgin NL1 or Osglim ¼-watt neon may be used.

It is not the intention of this particular article to deal with complicated stabilisation which may involve two or three valves as well. The neon on its own can, however, keep voltage constant most desirably where there is small current drain. In particular this is associated with the stabilisation of local oscillators where fluctuations in supply voltage can mean frequency drift. The neon thus maintains a constant voltage on the oscillator anode and the constructor building superhets or signal generators for use on short-waves is strongly recommended to fit a neon stabilisor as shown in Fig. 1. With weak signals on the higher frequencies—and other things being good !—a great improvement is usually noticed. Calibration will be more reliable and there should not be that annoying need for retuning every few minutes.

A word or two is needed here. Some neons contain a built-in series resistor so that whilst the neon is of the 90-100 volt type the whole is intended for use with voltages of the order of 250 volts. For frequency stabilisation where the

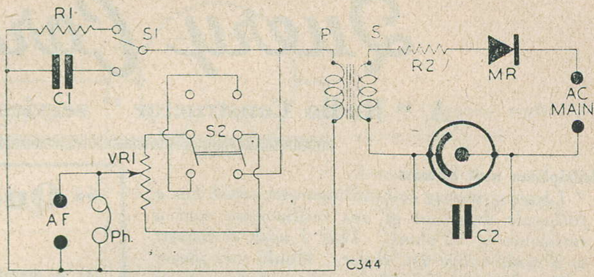


Fig. 3. A simple instrument giving an AF source and acting as a resistance-capactance bridge. R1 should be 1,000 Ω and C1 0.001μF. VR1 should be 10,000 Ω and wire wound. Note that the transformer is arranged to step down.

oscillator anodes needs around 90 volts this series resistor must be removed. This is usually an easy matter. The neon should be stood in methylated spirits for a while. The base can then be removed and the series resistor taken out. Plaster-of-Paris can then be used to cement the neon and base together again.

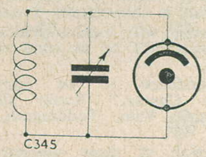


Fig. 4. Absorption wavemeter using the neon tube.

Neon AF Oscillators

Probably the best advantage of the neon tube is that it can be made to act as a relaxation oscillator and thus produce an audio frequency note. For checking AC or Universal receivers a simple piece of test-gear may be made as shown in Figure 2. This can be built easily into a disused fountain-pen body. An AF note of approximately one kilocycle will result from the values shown. This piece of gear is powered by the receiver under test, point A going to the HT+ line whilst point B is connected to the chassis.

For the constructor who wants to make a really useful piece of gear, which is also compact, Figure 3 is recommended. This is a combined AF source and resistance and capacity bridge. Any selenium rectifier rated for 240 volts can supply the power, the main requisite being small size. The AF transformer can also be midget size as it carries such small current. In practice the neon oscillator gives such a large output that the transformer is arranged to step down.

S_1 selects the range required. With the values of R_1 and C_1 shown resistors up to 100K Ω and capacitors down to 100μμF may be measured. By experimenting with these values the constructor may extend these ranges as required.

S_2 is a double-pole-double-throw switch which determines whether resistance or capacity is to be measured. In operation the unknown component is connected across the terminals AF. The AF note is heard in the earphones and VR_1 is adjusted until a point is reached where the note is at its minimum strength.

The arm of VR_1 is calibrated against a scale by simple reference to a number of known resistors and capacitors. Naturally the longer the pointer attached to the spindle the longer the track and the greater the accuracy of the instrument.

The potentiometer should be preferably wire-wound and should be free from crackles.

AF for testing purposes may be arranged by having spare terminals paralleled across the 'phones.

Neons for Indication

Neons, being usually small, are very handy for voltage indication, provided the voltage concerned is above the figure needed for striking.

A simple absorption meter can be constructed as shown in Figure 4. When coupled inductively to an oscillatory circuit a heavy voltage will be built up across the coil and capacitor at the point of resonance. Provided this voltage is high enough it will light the neon tube.

For the constructor who has a great amount of gear in use neons may be installed to indicate that voltages are correct and no breakdown has occurred in the power supplies.

Thus the two neons installed in Figure 5 will tell the experimenter that everything is still all right with the power-pack. N_1 deals with incoming AC and N_2 with the rectified DC.

These are but a few uses of the simple neon tube and the true radio experimenter will doubtless find many more.

Fig. 5. Neons may be installed as voltage indicators in the power pack. Series resistors may be from 1-5 MΩ dependant on the current taken and consequent voltage drop.

Query Corner

A "Radio Constructor" service for readers

Multipliers and Shunts

"I have a moving coil milliammeter which has a full-scale deflection of one milliampere and a resistance of 50 ohms. This I wish to convert to a multi-range DC meter. Would you please tell me how to calculate the values of the various resistors which are required in order that I might obtain different voltage and current scales."

B. Langley, Birmingham.

By means of easily constructed shunt resistors the meter current range may be extended to any desired value; and similarly by employing series or multiplier resistors any required voltage range may be obtained. The shunt resistors are connected across the terminals of the meter and serve to by-pass a proportion of the current which is to be measured. By this means only a fraction of this current flows through the meter and consequently the current required to provide full-scale deflection of the indicating needle is greater than it would be if no shunt were present.

The value of the shunt resistor necessary to multiply the scale of the meter by N times is given by $R = \frac{Rm}{n-1}$ where Rm is the resistance of the meter. For example, if it is required to extend the range of the meter in question from 1mA to 10mA the shunt resistor should have a value of $R = \frac{50}{10-1} = 5.55$ ohms.

Turning now to the problem of using the milliammeter as a voltmeter, this may be achieved by connecting a multiplier resistor in series with the meter. The value of this resistor should be such that when the desired full-scale deflection voltage is applied to the instrument the current flowing through it will be one milliampere. It is desirable that no current shunts are connected in circuit when the meter is used to measure voltage. This is because the lower the current required to deflect the needle of a voltmeter, the lower is the load which the meter imposes on the circuit under test. The value of a multiplier resistor may be calculated from the formula

$$R = \frac{V}{I} - Rm$$

where V is the required full-scale deflection voltage and I is the full-scale deflection current of the meter. It will be found when using this formula that the resistance of the meter will be extremely low compared with the multiplier resistance and hence the formula may be simplified to: $R = \frac{V}{I}$

Having decided upon the values of the resistors which are required to construct a multi-range meter the problem of obtaining components having these values will arise. It will be noted that some are non-standard and the possibility of getting these from a local dealer is extremely small. However, dealing first with the low resistance shunts these may be readily constructed from lengths of suitable resistance wire. Care must be taken to ensure that the wire has ample current carrying capacity as any tendency for it to heat up whilst a measurement is being made will reduce the accuracy of the reading.

Voltage multiplier resistors should be of the type whose value is within ± 2 per cent or less

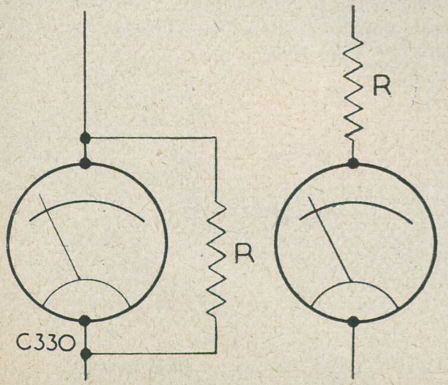


Fig. 1. Left—shunt resister to increase current range. Right—series resister to increase voltage range.

"Query Corner" Rules

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

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

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

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

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

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

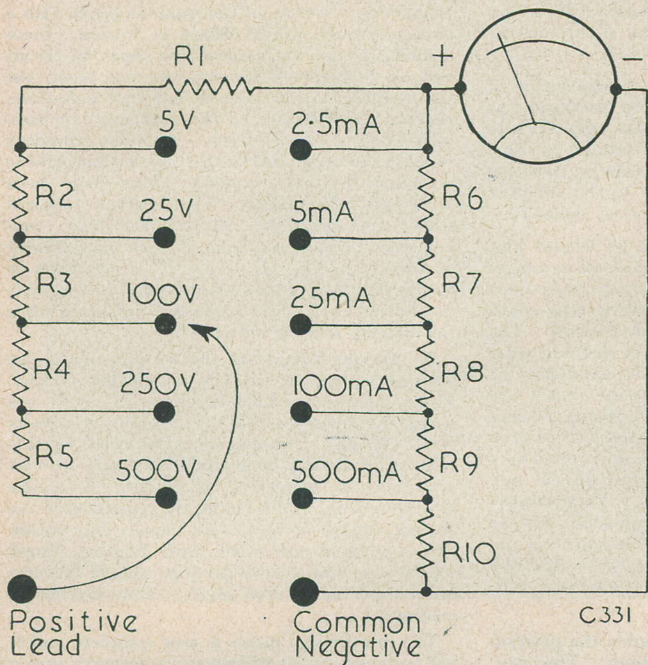


Fig. 2. Circuit of multi-range meter. Values are:—

Sesies resistors.

*R*1	2,000 Ω	1 *watt.*
*R*2	10,000 Ω	1 *watt.*
*R*3	40,000 Ω	1 *watt.*
*R*4	100,000 Ω	1 *watt.*
*R*5	200,000 Ω	2 *watts.*

Shunts.

*R*6	16.82 Ω
*R*7	13.36 Ω
*R*8	2.5 Ω
*R*9	0.668 Ω
*R*10	0.167 Ω

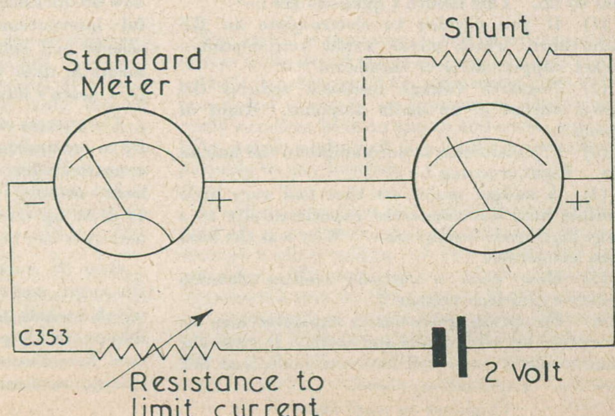
The meter is 0-1 *mA* (*resistance* 50 Ω).

of that stated. If trouble is experienced in obtaining a certain resistance value it may generally be made up from a number of components. However, failing this it is possible to slightly increase the resistance of carbon resistors by reducing their cross-sectional area. This may be achieved by carefully filing a flat on the body of the component, the increase in resistance will be governed by the depth and length of the portion which is removed.

The methods of range selection may be divided into two classes, those which employ rotary or push-button switches and those which employ plugs and sockets. The switch methods suffer from the disadvantage that unless a specially-made heavy duty switch is used, slight variations in the contact resistance will result in inaccurate readings being obtained on some of the current ranges. The multirange meter about to be described has been designed, therefore, around the plug and socket system.

Fig. 2 shows the complete circuit of the instrument. It will be seen that the sum of the individual currents shunts remain permanently connected across the meter. This is something of a disadvantage as it increased the current drawn

Fig. 3. Method of connecting standard meter in series with meter under construction when adjusting current shunts.



by the meter on the voltage ranges. However, with the shunt resistance values shown on the diagram this current is only 2.5 mA.

Because all the shunts are permanently in circuit the formula for calculating their value as previously quoted only provides approximate figures. This is no real disadvantage as each shunt must be adjusted to provide an accurate scale reading. The procedure to be adopted when constructing the meter is as follows:—

1. The shunt resistors must be wound first as the accuracy of the instrument on all its ranges is dependent upon them. These are made from resistance wire, which may be easily purchased, or alternatively taken from an old rheostat. The length of wire required to shunt the meter in order that it should read 2.5mA FSD should now be determined. The total resistance must be 33.5 Ω. When the approximate length of wire has been found, either by measurement or trial and error methods, it should be neatly wound on a paxolin former, a space being left between each turn to allow for tapping points. Final adjustment of the shunt may be obtained by passing 1mA through the meter and then connecting the shunt across it, adjusting its length so that the meter reads 0.4mA. This corresponds to a full-scale deflection of 2.5mA.

2. The next step is to determine the position of the tapping point on the shunt. This procedure is simplified if another meter is available with which to check the accuracy of the calibration. The 500mA tap must be made first by connecting a section of the shunt in series with a circuit through which 500mA is flowing. Commencing by having none of the shunt in circuit and then gradually moving the tap along the shunt until the meter reads full-scale deflection. Having correctly located the tap it may be carefully soldered into position. A similar procedure should then be applied to the 100mA shunt and so on until the four tapping points have been accurately determined. The current required when making these adjustments may conveniently be obtained from a 2-volt accumulator or shown in Fig. 3. Care must be taken to ensure that the wire used for the shunts is capable of carrying the current which will be passed when the meter is reading full scale.

3. Having completed the current shunts the voltage multiplier resistors should be tackled. Firstly connect the 2,000 Ω resistor in circuit and check the meter reading for accuracy on 5 volts FSD. If any adjustment is required to this resistor it should be made before the 25 volt multiplier is connected in circuit. A similar procedure is then adopted for the remainder of the voltage ranges in turn. All connections within the instrument are made with 22 swg tinned copper wire and each solder joint should be carefully inspected as bad joints means inaccurate readings.

The multi-range meter is now complete and it will be found that it will retain its accuracy over a very long period of time, and should also be capable of withstanding the rough usage which such instruments are occasionally subject.

"RADIO CONSTRUCTOR" QUIZ

Conducted by W. Groome

Here is the second instalment of our quiz. Most readers who have written to us are in favour of the feature. Why not write and tell us what you think of the quiz, how you find the questions and so on. This month's quesions are:—

(1) If you decided to electro-plate an RF inductance, which metal would you deposit—nickel, copper, silver or chromium?

(2) Negative voltage feedback reduces the power output of an audio amplifier. Right or wrong?

(3) 5% distortion is not audible to the human ear. Right or wrong?

(4) A midget mains set that had very little audible hum was connected experimentally to a large high grade loudspeaker. Why was the hum then intolerable?

(5) How does a cathode resistor develop negative grid bias voltage?

(6) To obtain treble-cut, a capacitor may be connected between anode and earth. It gives the same result if connected between anode and HT positive. Explanation, please!

(Answers on page 605)

UNITED NATIONS EDUCATIONAL, SCIENTIFIC AND CULTURAL ORGANIZATION

The World Radio Caravan

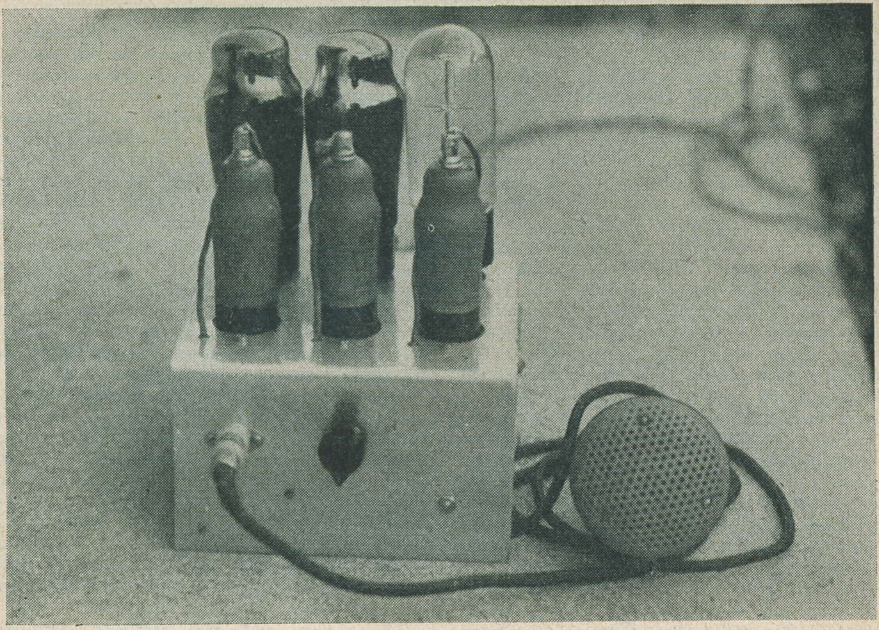
a part of Unesco's broadcasting programme

Radio organizations in all parts of the world are now broadcasting programmes illustrating successful international developments in education, science and culture as well as national developments in these fields, based on material sent out by Unesco's Radio Unit.

The success of these programmes was confirmed by a committee of radio experts from seven countries who, it was announced recently have been meeting in Unesco House since May, to draw up recommendations on how the Unit's activities can be extended.

Over 30 countries are already making use of the scripts and recordings sent out from Paris and which include the Unesco World Review, a 15-minute weekly programme of short news items and two five-minute commentaries on subjects of international interest.

(*continued on page* 605)



The "6-8"

AN AC/DC HIGH GAIN AMPLIFIER FOR PA WORK

By

EDWIN N. BRADLEY, A.I.P.R.E.

THE 6-valve 8-watt amplifier shown diagrammatically in Fig. 1 was developed to meet a sudden call for speech equipment at a local sports meeting. The news that only limited transport was available, together with a quick review of existing gear and components, were both un-encouraging. Existing amplifiers were ruled out on account of size and weight and it appeared that a new amplifier, using stocks to hand, must be built for AC/DC operation. The amplifier must be built to a chassis size of something less than 6in. square and 4in. deep, so that for transport the amplifier could be placed within the speaker box baffle and it was accordingly decided to build up something simple in semi-midget form, to tolerate an expected high hum level, and to strip down the circuit as soon as the job was done.

The amplifier, however, is still in existence and proves to be one of the most useful articles in the writer's workshop. The apparently inevitable hum failed to put in an appearance, quality was really excellent both on speech and music, and the light weight and small size of the gear make it portable to any location.

It will be seen from Fig. 1 that the circuit consists of a two-stage voltage amplifier feeding, through a phase-splitter V3, into a push-pull output stage. The only valves ready for immediate use were 0.2 amp AC/DC types so that the heaters are connected in series. In areas where the amplifier is intended solely for DC operation the heater of the phase-splitter V3, may with advantage be made the last in the chain, the heater sequence then being V3, V5, V4, V2, V1, but for

AC and AC/DC operation the sequence shown in Fig. 1 should be used.

The input circuit to V1 is shown as suitable for a moving coil microphone; the original amplifier is used with a moving coil microphone. To use a crystal microphone with the amplifier it would be necessary to dispense with T1 and increase R1 to something between 1 and 3 megohms or as specified for the microphone used. This might well lead to hum; the present low impedance grid circuit of V1 is conducive to a quiet background.

The volume control with which is ganged the mains switch appears between V1 and V2. If it is required to use the amplifier with a gramophone pick-up, the pick-up sockets should be connected directly across the volume control, R6. The microphone jack should then be short-circuited and R6 used as a direct control on the input to V2. Pick-up sockets are not shown in the diagrams but they may be fitted at any convenient point on the front chassis wall.

Negative feedback over V2 and the output stage is provided from the secondary of the output transformer. The speaker and this transformer are mounted separately from the amplifier in the box baffle previously mentioned, and connection between the output stage, power supply and feedback circuit, and the loudspeaker circuit is made by a 5-way plug and socket. The socket, a 5-pin valveholder, is mounted on the rear chassis wall and the speaker is fitted with several yards of 5-core cable terminating in an old 5-pin valve base taken from a mains triode.

POWER SUPPLIES

The heater chain requires 84.9 volts at 0.2 amp and the excess voltage is dropped across a C1C barretter which ensures correct heater operation over a much wider range of mains voltages than will be encountered. Half-wave rectification is provided by a SenTerCel selenium rectifier fitted below and across the chassis, the chassis width being made to suit this component, and over long periods of operation the rectifier barely warms up. Surge protection is given to the rectifier and, to a degree, to C12, the reservoir capacitor, by a limiting resistor, R24.

The choke, to fit below the small chassis, is of 10 Henries type commonly in wide supply, and with a 16 μF smoothing capacitor gave adequate smoothing.

POWER OUTPUT

The output power of 8 watts or so may seem inadequate for outdoor use, but in the writer's experience this power is amply sufficient for many PA applications. The original amplifier with a 10in. permanent magnet speaker correctly matched in gave perfect audibility over a wide field and could be heard distinctly at a distance of $\frac{1}{4}$ mile.

STABILISING THE AMPLIFIER

First tests on the amplifier showed up a form of instability often encountered on high gain circuits (the full gain over V1 and V2 is of the order of 2,000 to 3,000 times, allowing for feed-back). As the gain control was advanced the low hum level rapidly rose to an annoying degree until, at about one-half of full rotation of R6 the speech was masked by a form of muffled distortion accompanied by a low hissing. Setting the amplifier to work near an ordinary radio set tuned to the local station immediately caused strong radio interference and the amplifier trouble was identified as very high frequency parasitic oscillation. The amplifier was then stabilised by using grid stoppers in the output stage, R19 and R20, and also by the use of screen stoppers in the two input amplifiers, these resistors being coded as R25 and R26, high component numbers being allotted to these two resistors to make them more outstanding amongst the other resistors of these stages.

Constructors puzzled by unidentifiable instability in other amplifiers might do well to try the effect of equivalent resistors at the screen pins on the valve-holders, between the electrode and its feed and decoupling circuits. Resistors not higher than 100 ohms in value may be used on audio stages; radio amplifiers may also be stabilised by screen resistors though in this case a serious loss of gain may be expected unless resistances not higher than about 10 ohms value are used.

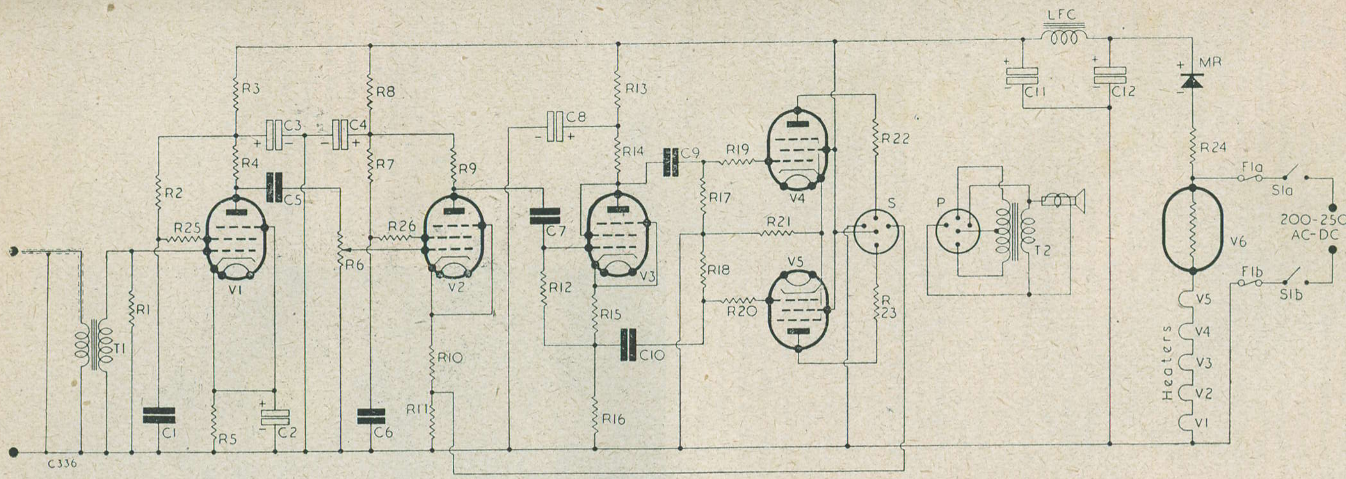
The screen and grid stoppers completely stabilised the circuit, and R6 then gave smooth control over the whole of its range, whilst the whole amplifier can be judged by the fact that no screening whatever is needed on the input grid circuit, an open microphone transformer and plain rubber covered grid leads being used. For indoor operation however, some screening is recommended, as there is then much more likelihood of hum-pick-up from house wiring.

CONSTRUCTING THE AMPLIFIER

The amplifier is built on an aluminium chassis $5\frac{1}{2}$in. wide, $5\frac{1}{2}$in. deep and $3\frac{1}{4}$in. high. The front wall of the chassis carries, from left to right, the co-axial microphone input socket, the gain control R6, and, on the lower right, one end of the tubular metal rectifier which is provided with an insulated, screwed, mounting spindle.

Below the microphone input socket, and behind the wall, is mounted the microphone transformer. That used in the original amplifier was a very small component but there is room for practically any type of microphone transformer. If no suitable transformer is to hand a Wearite 'potted' 60 : 1 transformer in the 'Hyperloy' series, type 207, can be fitted in the available space with ease.

On the rear wall of the chassis, from left to right, is mounted the output 5-way socket, the fuse box, the LF choke and the other end of the rectifier. The socket and LF choke are mounted inside the wall, below the chassis top deck, whilst the fusebox is on the outside of the wall. One bolt, adjacent to speaker socket is common to both the fuse box and the LF choke, and



COMPONENTS LIST FOR THE '6-8' AMPLIFIER

R1, R3, R8,	47,000 Ω
R2, R7, R12,	330,000 Ω
R4, R9,	620,000 Ω
R5, R10, R15,	4,700 Ω
R6,	0.5 M Ω variable. Gain control.
R11,	220 Ω
R13,	33,000 Ω
R14, R16,	68,000 Ω 5%
R17, R18,	220,000 Ω 5%
R19, R20,	10,000 Ω
R21,	135 Ω. Use 120 Ω, 1 watt, and 15 Ω, ½ watt, in series.
R22, R23,	33 Ω 5%
R24,	33 Ω 1 watt.
R25, R26,	47 Ω

All resistors 20%, ½ watt unless otherwise specified.

C1, C6,	0.1μF. 350 V wkg Tubular.
C2,	25μF. 12 V wkg Electrolytic.
C3, C4, C8,	8μF. 450 V wkg Electrolytic.
C5, C7, C9, C10,	0.1μF. 350 V wkg Tubular.
C11, C12,	16 plus 8μF. 450 V wkg Electrolytic.
T1,	Microphone transformer, to suit microphone used.
T2,	Output transformer, 10 watts capacity, to match speaker to 4,500 ohms anode-anode load. (Ratio for 3 ohms voice coil = 38 : 1).
	10in. permanent magnet speaker.
L.F.C.	10 Henries, 100 mA. Radiospares type.
Rec.	SenTerCel selenium rectifier, H35-26-1L. 250v 100 mA.

V1, V2, V3,	Mullard EF37.
V4, V5,	Mullard CL33.
V6,	Philips C1 or C1C.

5 octal chassis mounting valve-holders.
1 British 4 pin chassis mounting valve-holder.
1 „ 5 „ „ „ „
1 5-pin valve base.

F1a, F1b,	2 amp fuses, with Belling-Lee double holder L1033/C4.
S1a, S1b,	2 pole on-off mains switch, ganged with R6.

Chassis, bent from sheet aluminium to 5½in. x 5 5/8in. x 3¼in.
3 grid clips.
1 control knob.
Co-axial input socket and plug, Belling-Lee L604/S, L604/P.
Capacitor can clip, nuts, bolts, wire, sleeving, etc.

the choke is mounted at an angle, its other fixing hole being secured by another bolt. The choke is separated from the wall surface by a washer on each bolt, to give clearance below the choke for the second fuse box bolt.

Under one fixing bolt of each valve-holder should be secured a soldering tag so that each valve has its own earthed point, and the return leads and by-pass leads for each stage and valve should be taken to that valve's earthed tag.

With the main components mounted, wiring should commence with the heater circuit. Fairly heavy wire, well covered with good sleeving, should be employed, and the wiring should be kept close against the underside of the chassis deck both to save space and shield stray hum fields. With the heater circuit completed, the bias circuit for each stage should be added. In the case of V1 and V2, pin No. 1 on the holder should be earthed directly to the appropriate soldering tag. Pin No. 5 is wired directly to pin No. 8. The bias components supported across pins Nos. 1 and 8 are kept close up to the valve-holder, though not sufficiently close to touch other tags.

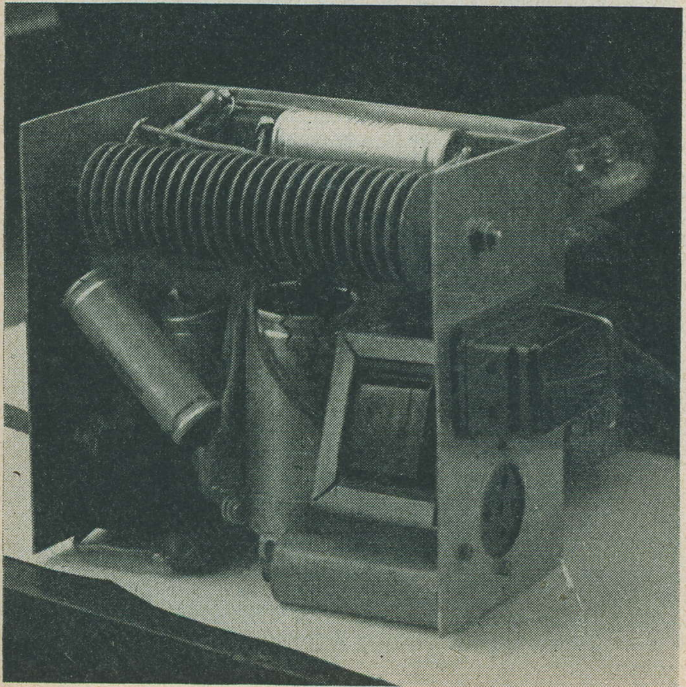
Stopping resistors—R25, R26, R19 and R20—must be soldered right at the correct tags on the valve-holders with their leads cut off as short as possible.

The space under the chassis does not permit of group board construction and all components were mounted in the wiring except for the reservoir-smoothing capacitor, C11, C12. This has to be a fairly large component since it is charged up immediately the amplifier is switched on, thus attaining peak voltage, and despite the fact that the amplifier HT line runs at about 200 volts a 450 V wkg capacitor is necessary to avoid breakdown. C11, C12 is therefore placed in the chassis last, and is held securely by a can clip round the capacitor, the clip being held in turn by a 2½in. 4BA bolt passed through the chassis top deck, with a nut below the chassis. The can clip is held about 2in. down the bolt by a further two nuts.

The three by-pass capacitors, C3, C4, C8, were held in the wiring by 18 swg tinned copper wire which was found adequately strong to hold these capacitors in place. Other wiring was carried out with 22 swg tinned copper. Every wire and component lead must be covered thoroughly with good insulating sleeving.

NEGATIVE FEED-BACK CONNECTIONS

Until the amplifier can be tested the leads from the secondary of the output transformer, T2, to the two negative feed-back pins of the plug P should be soldered on only temporarily. With the circuit and wiring carefully checked plug in P and, with the volume control kept right down, switch on and allow the circuit to warm up. The microphone may be plugged in or may be short-circuited.



Under-chassis view of the amplifier. The rectifier can be see connected across the sub-chassis. The five-pin holder beneath the fuse box is the speaker socket. In the photo heading this article the valves are, reading left to right, V1, 2 and 3 along the front and V4, 5 and 6 at the rear.

Advance the volume control to check the feed-back connections. If the connections are made in the correct sense the control may be turned up to full volume, but if the connections are in the wrong sense a shrill howl will be heard as soon as R6 is turned. If this is the case reverse the connections to the feed-back pins of the plug P and solder permanently.

Care must be taken not to confuse a loud-speaker-microphone feed-back howl with a negative feed-back howl. The amplifier is sensitive and the loudspeaker and microphone cannot be used together in the same room with the gain control turned up fully. If in doubt, short out the input jack any howl is then certainly due from the secondary of T2 must be reversed in connection.

OPERATING THE AMPLIFIER

Note Well. The amplifier is constructed for AC/DC operation and therefore has the chassis in direct connection with the mains supply. Whether used indoors or outdoors, the chassis *must* be connected to the neutral side of an AC mains supply, or to the earthed negative side of a DC mains supply. In some cases incorrect DC wiring, with an earthed positive, may be found, and under no circumstances should a microphone amplifier of any type be used on such a supply. If the chassis is connected to the ' live ' or line side of an AC supply or to an incorrectly wired DC supply which has an earthed positive line, touching the chassis of the amplifier or metal parts of the microphone will give a very severe and dangerous shock.

A small 200 volts neon bulb is always carried with this amplifier, and is connected between the chassis and earth before the amplifier is plugged into the mains point to be used, whether the neutral line can be identified or not. For outdoor use the bulb is earthed directly into the ground by a lead terminating in a sharp prod ; for indoor use the earthed side of the bulb is taken to the nearest true earthed point, a water main being preferred.

The amplifier is then plugged in and switched on. If the bulb lights the chassis is shown to be ' live ' to earth and the mains plug is then reversed. On AC mains this allows the amplifier to work correctly, and it is then safe to the touch, but on DC mains the amplifier must be given a minute to warm up after the reversal of the plug. If, after the minute, the amplifier will not work the mains connection is proved incorrect, the chassis now being connected to the positive side of the mains which, in turn, is the earthed side of the supply. On this type of DC line this, or any other type of DC amplifier, cannot be used with safety.

ANSWERS TO QUIZ.

(1) Silver. Mainly because of its high conductivity.

(2) Negative feed-back does not reduce the available power output. It reduces the sensitivity of an amplifier so that a larger input is necessary for full output.

(3) Wrong. 5% has been regarded as the maximum tolerance but this amount could be torture if entirely third harmonic. A critical listener can detect much lower degrees of distortion and for high fidelity it is usual to design for less than 1% total.

(4) The set is guilty, but the fault was concealed by the inability of its tiny speaker to reproduce low frequencies. The better speaker probably has an excellent response at 100 cps and 50 cps.

(5) The grid is required to be negative with respect not to earth but to cathode. A resistor between cathode and earth " lifts " the cathode above earth by the voltage drop in the resistor. Earth is therefore negative with respect to cathode. If the grid is returned to earth via a resistor or tuning coil, it, too, will be negative to cathode.

(6) The two methods amount to the same thing because as far as AC is concerned, HT positive is at, or very near to, earth potential.

(*UNESCO—continued from page* 600)

A recording studio has been set up in Unesco House and mobile recording equipment was recently acquired by the Radio Unit.

An important recommendation for the use of this mobile equipment was made by the radio experts' committee, who proposed that it should be sent to several European countries early next year to record sound documentation for programme of special interest to Unesco. Radio producers from several national radio organizations would be invited to collaborate in producing these programmes.

At a lunch at which the radio experts were present in Unesco House recently, Mr. Torres Bodet, Director General of Unesco, described the mobile equipment as the " world radio caravan " and said that everything would be done to obtain approval from Unesco's General Conference for the " caravan " to visit different countries.

The experts also urged Unesco to continue the arranging of programme exchanges between different countries on the lines of the recent " Music and Folklore " programme made from contributions by seven countries, and also to support the plans being drawn up for an international " University of the Air."

LOGICAL FAULT FINDING

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

By J. R. DAVIES

4: INSTABILITY

(d). Miscellaneous Causes of Instability. (RF and IF)

There are a few causes of RF and IF instability in badly-designed receivers, and especially in home-constructed apparatus, which cannot be easily typified save under the heading "miscellaneous."

When an RF or IF current is rectified for detection purposes, there is a certain proportion of RF (or IF) in the rectified output. If this is not filtered away, it is possible for the AF section to amplify this voltage and feed it back capacitively to an early stage of the receiver. Therefore it may occasionally be adviseable to connect some additional form of filter circuit to the detector to ensure that not too much RF or IF finds its way into the AF stages. If this addition to the receiver is considered necessary it should be made with discretion. If the set worked perfectly well until the instability occurred there is no point in fitting extra components as there is obviously something else wrong with the receiver.

In the case of the straight receiver wherein the detector is usually of the leaky-grid or anode-bend type, the extra filtering may be added quite conveniently in the anode circuit, as shown in Fig. 12(a). The 10K Ω resistor shown in the diagram may be replaced by an RF choke, if desired. If this form of filtering has already been fitted to the detector (as is quite possible) there is no need to change the circuit and the instability should be looked for elsewhere.

The double-diode-triode of a superhet represents a different problem. Fig. 12(b) shows a conventional second detector stage. It can be seen that there is already quite efficient filtering in the diode circuit before the AF is applied to the triode grid. What is not generally realised, however, is that, as the diodes and triode are both in the same envelope, it is possible for the triode grid or anode (or their wiring below the chassis), by reason of capacitive links, to pick up sufficient IF voltages to cause subsequent amplification and possible instability. For this reason it is quite often beneficial to add a filter circuit to the *anode* of the double-diode-triode valve. The circuit used can be of the type shown in Fig. 12(c). It can be seen that this is the same as that shown in Fig. 12(a), save that the values are smaller, and that there is no need for an RF choke. The smaller values of capacitor are used to obviate any attenuation of the high-frequency end of the AF spectrum, and because a smaller proportion of RF appears on the anode of the double-diode-triode than does on that of the straight set detector.

In some badly-designed receivers, it occasionally happens that the IF stage is so made that the set is very near oscillation all the time. When these sets are lined up by unskilled hands, it is suddenly found that they become unstable. There is a reason for this. What has happened is that these unskilled hands have aligned the IF transformers to an incorrect frequency; and very probably a frequency higher than the correct

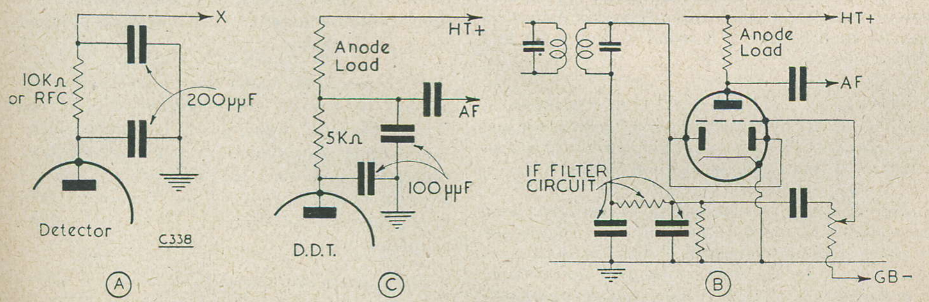


Fig. 12 (a). Additional RF filtering that may be added to the anode circuit of a leaky-grid or anode-bend detector. "X" is the connection originally taken to the anode of the detector.
(b). A typical double-diode-triode circuit.
(c). Provision of additional filtering (this time in the anode circuit) in the double-diode-triode circuit.

one. At this higher frequency, the IF coils offer a higher " Q," the IF stages give more amplification, and the receiver goes over the oscillation point. The remedy is obvious. The IF transformers should be re-aligned to their correct frequency by means of a calibrated signal generator.[1]

It is also possible for instability to occur when the amplification factor of the IF or RF stages is accidentally increased in other ways. (We are still talking about badly-designed receivers.) It may sometimes help, therefore, to see that the RF and IF valves are receiving their correct bias.

A little hint concerning some of the older straight sets that are still giving yeoman service would not be out of place here. If the set has a high-impedance outlet to an extension speaker, it is often inadviseable to run the aerial lead-in close to these speaker wires as this may cause feed-back.

2. Instability in the AF Stages

We have already touched upon the symptoms of this particular trouble when we mentioned the various types of instability in the last article.

Instability in the AF stages may be caused by reason of any of the following :—

(a) The case where feed-back is caused via a common connection (see previous article).

(b) The case where feed-back is capacitive.

(c) The case where feed-back is inductive.

(d) Miscellaneous causes.

(a) Feed-back via A Common Connection. (AF)

The treatment of this fault is the same as that for the cure of RF instability through the same cause. We simply check all decoupling capacitors, especially the electrolytic capacitor between HT positive and chassis. Earthing points also need checking, especially if they are common to several circuits. (See Fig. 10(a).)

(b). Capacitive Feed-back. (AF)

Again we look to a previous paragraph, this time that concerning capactive feed-back in RF and IF circuits. The things to look for are the same. All screened leads, screening cans, etc., should be inspected, as also should the valve shields, particularly if the valves are of the metallised type.

(c). Inductive Feed-back (AF) and " Threshold Howl "

Inductive feed-back should not occur if the set has been working successfully before it became unserviceable. However, in new home-constructed receivers there may be some trouble. If inter-valve transformers are used they should be positioned at right angles to each other and to the speaker transformer, and their shielding, if any,

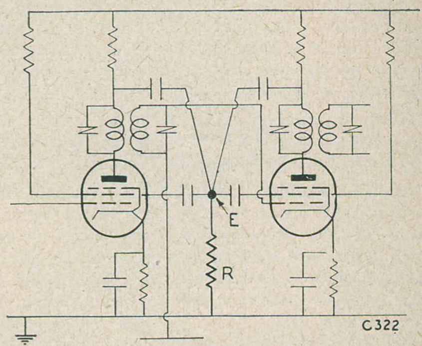


Fig. 10(a). Indicating how a badly connected earthing return, if for several circuits, may actually assist feed-back. The feedback voltages, at different stages of amplification, are built up across the resistance " R," which represents the resistance of the joint. (E is the earth tag with high resistance joint.)

connected to chassis. An AF choke should be treated as a transformer.

There is also a possibility of " threshold howl " if an inter-valve transformer is used. This appears as a howl, usually in a straight receiver, whenever reaction is advanced to oscillation point. It is due to the inter-valve transformer having a resonance somewhere in the middle of the AF spectrum. It may be cured by connecting either a capacitor, Fig. 13(a), or a resistor, Fig. 13(b), across the primary.

The purpose of the capacitor is to lower the resonant frequency of the transformer to such a point that its " Q " becomes too low to permit of self-oscillation. The capacitor should have a capacitance as low as possible, and should not exceed 0.002μF.

The resistor shown in Fig. 13(b) has the effect of damping the transformer. It should have a value as high as possible, and never be lower than 50 K Ω.

(d). Miscellaneous Causes of AF Instability

There are a few miscellaneous causes of AF instability worthy of note.

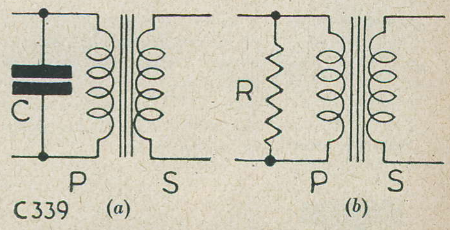


Fig. 13. Showing the addition of a capacitor or resistor to clear " threshold howl ". The capacitor should be around 0.002μF and the resistor 50,000 Ω.

[1] *" Calibrated signal generator." If the reader does not possess a signal generator, it is well worth while to knock up a simple modulated oscillator working in the neighbourhood of 450-470 kcs. An old IF transformer will furnish the necessary coil, and it may be calibrated against a borrowed generator, if this is possible.*

A point that needs checking is that of the control grid returns. The grid leaks should be in good order, and if a grid bias battery is used, this should be checked and replaced if its internal resistance is high.

A high internal resistance in the HT battery, if a battery set is in use, may also cause AF instability. The faulty battery should be replaced.

Again, instability, usually in the form of distortion, may occur when the AF valves are not receiving their proper voltages and bias. It will be sufficient now to state that this point should be checked, as we shall deal fully with the question of correct valve voltages under the heading of "Distortion."

3. Feed-back Via An Acoustic-Mechanical Path

Feed-back via an acoustic-mechanical path occurs when the sound waves from the loudspeaker strike a microphonic component in the set, thereby setting up vibrations in sympathy. These vibrations are amplified as electrical impulses and fed to the loudspeaker again, thus causing the oscillation. The cure is to find the microphonic component and to replace or repair it.

The main offenders in the matter of microphony are valves and tuning capacitors. It is quite simple to find the faulty component as, when lightly tapped, it will cause a note to be heard in the speaker. In the case of microphonic tuning capacitors, howls will only occur when the set is tuned to a station, and the effect will be more noticeable on the short-wave bands.

The best cure for a microphonic valve is replacement. If, however, replacement is not considered worth the expense, or if the valve is the first of a long amplifying chain and the trouble is more or less unavoidable, it can be fitted with a little sound-proof jacket! See Fig. 14.

A microphonic tuning capacitor does not always require replacement (sometimes a difficult task), as it will usually work satisfactorily if it is mounted in a "floating" manner. It may be mounted on rubber grommets as shown in Fig. 15, care being

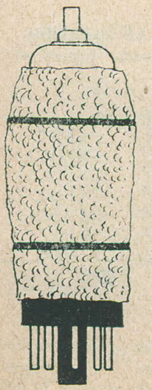


Fig. 14. Where expense is a prime consideration, a microphonic valve may be fitted with a sound-proof jacket as shown. The valve is covered with cotton wool, held in place by rubber bands.

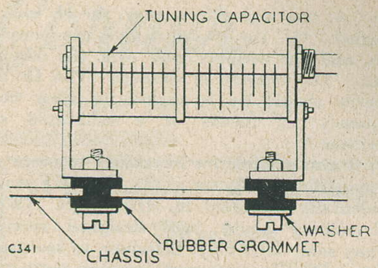


Fig. 15. A vibration-proof mounting for a tuning capacitor.

taken to see that the connecting wires to it are of a flexible nature. An alternative course is to mount the whole receiver chassis on rubber mountings, as, very often, the feed-back is carried via the wood of the cabinet. If the sound waves from the loudspeaker impinge directly on to the tuning capacitor a "screen" of felt or similar sound-absorbent material may be placed between the two. This is a somewhat "Heath Robinson" arrangement, however, and is *not* recommended for commercial repair technique!

SUMMARY

Instability

1. Instability in the IF or RF Stages

(a) Check all decoupling capacitors.

(b) Check all earthing connections, particularly those common to two or more circuits, and that to the moving vanes of the tuning capacitor.

(c) Check all screening, including metallising of valves.

(d) In new home-constructed receivers, ascertain that all coils are correctly positioned with respect to each other.

(e) See that RF and IF voltages are not appearing on anode of detector or double-diode-triode valves.

(f) See that IF transformers are aligned at correct frequency, and that valves have correct bias.

(g) Keep aerial and high-impedance extension speaker leads apart.

2. Instability in the AF Stages

(a) Check all decoupling capacitors and earthing points.

(b) Check all screening and appropriate valve metallising.

(c) If the receiver is a newly-constructed job, make sure that all transformers and chokes are correctly positioned with respect to each other.

(d) If "threshold howl" is present, the primary of the associated transformer should be damped, either by a resistor or by a capacitor.

(e) Check grid leaks and the grid bias battery, and see that valves have correct working voltages.

(f) Check HT battery (if used), for high internal resistance.

(*continued on next page*)

The "Free Deck" Chassis

A novel design by " Centre Tap " which possesses many advantages for the home-constructor and experimenter, particularly those with limited workshop facilities.

SINCE the passing of the " breadboard," the engineering of the chassis has, for many constructors, been something of a problem. Only too often do we find a makeshift chassis is used : one already drilled for valve-holders, IF's, transformers, etc., and almost as often a makeshift receiver results. Component positions become dictated by existing holes instead of by good design and as a consequence, long leads, unwanted couplings, cramped wiring and general instability result.

In considering this problem I have devised, what, for the want of a better name, I have called the " Free Deck " Chassis. It has a steel frame for strength and rigidity and an aluminium mounting area for easy workability.

Among its other advantages the following are quickly apparent :—

Cheapness. Upon rebuilding the constructor needs only to buy a single panel to have a new chassis.

Rigidity. The sides of the chassis, being permanent, are made of steel of fairly stout gauge giving greater strength.

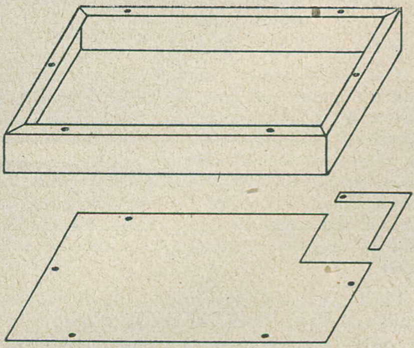
Efficiency. The frame (being of steel) enables chassis return leads to be soldered to it.

Better Construction. A new " free deck " (which will cost less than half the price of a new chassis) will enable exact replica layouts of recommended circuits whenever a new design is tried.

Versatility. The " free deck " may be of two pieces fitted side by side. This would enable the power unit (transformer, rectifier choke, electrolytics, etc.) and if desired the audio stage to remain unchanged and even left in position if the experimenter decides to re-design the rest of the set.

Speedy Construction. Components requiring square or rectangular holes such as drop-through mains transformers can be fitted by simply cutting a suitable area from the " free deck " before fitting into position.

Simpler Wiring. Awkward connections, valve pin wiring, etc. can be soldered in position while still easily accessible, *i.e.*, before the " deck " is fitted to the frame.



The "FREE DECK" Assembly

The chassis sides are of steel with a ½in. turned-in edge, to which the " deck " is bolted. The bolts themselves will in most instances be also useful for fixing components. For a small chassis four bolts should suffice and for larger sizes up to eight should be used.

Below is illustrated the " deck " cut to accommodate a drop-through transformer. An angled cut from the wasted piece should be used along the turned-in edge of the frame to provide a level seating for the transformer.

(*LOGICAL FAULT FINDING—*
continued from page 608)

3. Feed-back Via An Acoustic-Mechanical Path

Ascertain faulty component. A microphonic tuning capacitor causes howls only when a station is tuned in. Other microphonic components may be found by judicial tapping. Valves are the most likely offenders. The cures are replacement, or the fitting of some method of preventing sound vibrations from the loudspeaker reaching the faulty component, either via the air or via the material of the cabinet.

COMBINING THE
R208 AND R1116

By ROBERT K. ASTLEY.

BOTH the R208 and the R1116 are government surplus receivers and for use on the 'Ham' bands are an excellent buy. The R208 is a six-valve Superhet, driven from either the mains or a 6-volt Vibrator pack from a car battery of at least 75 amp/hour capacity. The line-up is as follows :—

EF39	RF stage.
6K8G	Mixer/Oscillator.
EF39	First IF (2 Mcs.).
6K8G	Second IF (2 Mcs.) and BFO.
6Q7G	2nd Detector, AVC, and IF amplifier.
6V6G	Power output of approx. 2 watts.

There is a built-in 6in. loudspeaker, and jack outputs to low resistance phones, or a 600 ohms line. Phones can be used with speaker or without, and there is a muting jack in the HT line.

The coverage is from 10 Mcs to 60 Mcs in three bands, with both audio gain and RF gain controls, and a variable BFO pitch control. Though rather broad on 14 Mcs, it is excellent on 28 Mcs and 60 Mcs, and also on TV sound.

The R1116 on the other hand is a battery-operated 8-valve Superhet, covering from 142 kcs to 1,600 kcs, and from 2 Mcs to 20 Mcs. This is accomplished in seven bands. There is a BFO, manual volume control and two main dials. Tuning is done with permeability tuned coils in the oscillator section, and with normal air-spaced capacitors in the aerial circuit. It is a double superhet, with a first IF of 1.7 Mcs, and a second IF of 100 kcs. This has the effect of giving good second-channel-rejection, whilst at the same time obtaining good quality. The receiver is driven from a 120 volt HT battery, a 10½ volt grid bias, and a 2 volt accumulator with a capacity of about 45 amp/hours. It will easily drive an 8in. speaker without any modifications whatsoever.

The line-up is as follows :—

DIODE	Noise Limiter across input.
220TH	First Mixer/Oscillator.
210VPT	First IF (1.7 Mcs).
220TH	Second Mixer/Oscillator.
210VPT	Second IF (100 kcs).
210DDT	Detector, AVC and IF amplifier.
240QP	Double Pentode QPP output giving about 1 watt.
210LF	Triode BFO.

The writer recently moved into a house which had the mains laid on. He decided that he did not wish to part with the R1116, and being practically-minded did not see the fun of buying an eliminator for the HT supply when he had a mains set in the form of the R208. Surely there was a way to obtain the "juice" from the R208 without impairing its use or necessitating a lot of fiddling in order to change from the one to the other.

Finally, it was decided to take the HT from the R208 and also to eliminate the QPP output valve in the R1116, thus saving a 6 ampere drain on the accumulator, and take the output through the 6V6G, thus giving a greater output and better quality. The remainder of this article describes the necessary modifications. All components are referred to by the official designations, and only those sections necessary for a clear understanding of these modifications are shown.

First let us deal with the changes in the R1116, all the components of which are marked to correspond with the numbers shown on the official diagrams.

Remove the four leads encased in the red binding at the rear of the receiver from the output panel next to transformer marked T6, that is the two telephone output leads and the two screened microphone leads.

Take a lead from the T or M negative point on the output panel ; this is the negative or earth line between the two receivers. Another lead is then joined in at the transformer T5 side of capacitor C58 ($0.1\mu F$) ; this is to be the audio frequency path between the two receivers. These two

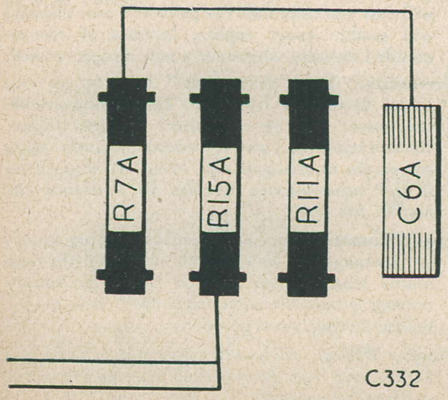


Fig. 1 (a). Before modification.

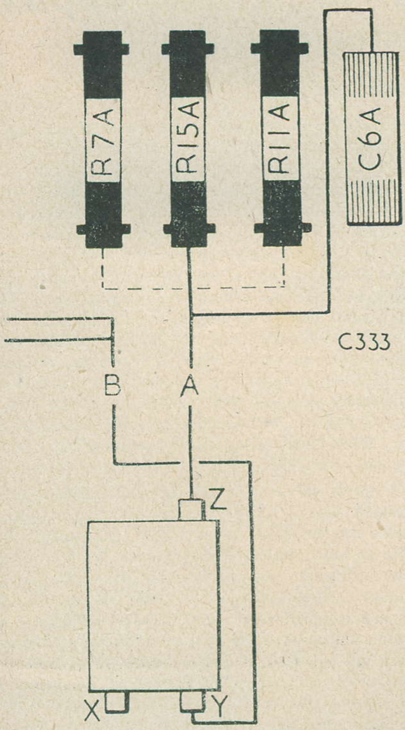


Fig. 1 (*b*). *After modification.*

leads are taken out at the back of the R1116 through the original grommet used for the red encased leads, and are joined to a No. 9 plug, the tip of which carries the negative lead.

Remove the output valve, as this will no longer be required.

Now we will deal with the alterations in the R208, which are greater in number and somewhat more complicated.

There are four output jacks in the left bottom corner of the panel. Two are marked LR phones, the left one being an open jack and the right one a closed jack. The bottom two are marked LINE, which is an open jack, and MUTING, which is a closed jack.

Remove the two leads between the LINE jack and the output transformer. Join the side of the jack farthest from the panel to earth or chassis. The other side is joined to pin 5, the control grid of the 6V6G, the output valve. This line, which carries the audio signal between the two receivers is now isolated from the HT supply by the grid coupling capacitor C7H (0.01μF) in the R208 and C58 (0.1μF) in the R1116. *The audio conversion is now complete ; all that is necessary is to plug in to the No. 9 plug carrying the leads from the R1116 into the LINE jack on the R208.*

Now we will deal with the alterations necessary to obtain the HT supply to the R1116 from that of the R208.

Remove the negative HT lead from the four-pin plug at the rear of the R1116, as this will no longer be required, the earth or negative line having already been completed in the audio conversion. The positive HT lead is taken to the tip connection of a No. 9 plug. That completes the alterations to the R1116.

Now let us go over to the R208. Remove the leads to the MUTING jack and join them together. This jack is not much use to you unless you have a transmitter and require to mute the receiver without turning off the heater supply.

Under the chassis and just behind the 6V6G and the 6Q7G, you will find a panel carrying a collection of capacitors and resistors. See Fig. 1, in which the alterations to the wiring on this panel are clearly shown ; in (a) before and in (b) after the modifications have been made. ' A ' and ' B ' in Fig. 1 (b), are the points which go to the original MUTING jack.

The lead from the top of C6A to the top of R7A is disconnected from the top of R7A and taken to the bottom of R15A. A lead is then taken from the bottom of R15A to the MUTING jack ; this is shown as ' A ' in Fig. 1 (b).

The two leads connected to the bottom of R15A are disconnected and taken to the MUTING jack; this is shown as ' B ' in Fig. 1 (b). Note that this MUTING jack has three connections, ' X,' ' Y ' and ' Z.' Point ' A ' is joined to point ' Z.' and point ' B ' is joined to point ' Y.'

Between points ' X ' and ' Z ' is placed a resistor of approximately 12K Ω, of about 2 watts. In the writer's case he used two 25K Ω, 3 watt resistors as they happened to be on hand. The result is that when the jack is closed the current passes from ' Z ' to ' Y,' but when it is opened by inserting the No. 9 plug carrying the HT lead from the R1116, the current finds its way via the resistor or resistors to ' X ' and then via the plug to the R1116.

The final alteration was to remove the left hand, that is the open, phone jack and in its place put a SPST switch. The heater line was then broken between pin 7 of the 6V6G and pin 7 of the 6Q7G and the leads taken one to each side of the switch, so that when using the R208 as an amplifier for the R1116 both the LT or heater supply and the HT supply to all but the 6V6G valve are cut out.

The right hand phone jack was not touched as its use muted the built-in speaker and is used for driving an 8in. external speaker, or LR phones (moving coil) when on the ' Ham ' bands.

The above conversion could no doubt be carried out with any combination of receivers, but a word of warning. Check the voltage output from the mains receiver with a reliable meter before connecting to the battery receiver. If necessary try other values of resistors until the required voltage is obtained. Battery valves are usually rated for a maximum of 150 volts, and don't forget to allow for the surge when first switching on.

The Poor Man's Guide to Radio Repairs

—or TESTING WITHOUT TOOLS

By Dudley Stilton

RADIO repairing is, of course, a highly skilled trade, requiring, for rapid work, a considerable amount of tools and instruments. Repairs however can be effected without recourse to any instrument at all. As an example let us take a small AC/DC set, which on test is found to be "dead."

We can ascertain that the valve filaments are OK by two methods, namely, to switch the set on and see that any one of the filaments light up, proving that all the filaments are OK. The more spectacular way, which impresses and delights any starry eyed YL, is to short the rectifier filament to earth, which causes quite a decent spark. The effect of course is enhanced if one should repeat the performance and set the line cord on fire, and if the set should be plugged in so that the chassis is hot, this will bring forth loud applause, for to see someone hopping about shouting obscene words, while the whole caboodle rains forth showers of sparks and flame, is truly a spectacular sight.

Having found that the valves are in order so far as continuity is concerned, we can now proceed to the output stage. The set will now have been on for some minutes so we can test the output valve. This is, in a service shop a very complicated business, requiring a valve tester, a book of figures and a mathematical mind. Our way however, is far more simple, and twice as effective. All we do is to take the valve firmly between thumb and forefinger. If the valve is not doing its job, nothing will be felt, and a slight pull, a flick of the wrist and the valve will be deposited in the scrap box where it belongs. If however the valve is OK a sharp smarting sensation will be felt and the efficiency of the valve can be calculated, with very little practice, from the size of the blister which will be found on aforementioned thumb and first finger. This again, will impress any audience one may have.

Before leaving the output stage, we can test that the loudspeaker unit is in working order by grasping a metal screwdriver in the hand and placing firmly on the grid pin of the valve, whereupon a slight hum should be heard from the speaker. Now by grasping the chassis firmly in the hand and placing the screwdriver on the anode or screen pin, we can ascertain whether the set is receiving its full quota of HT voltage. If after this test, you still have the chassis firmly grasped in the left hand and the screwdriver in the right hand, the HT supply is obviously dead. On the other hand, should the screwdriver suddenly depart for destination unknown, and the chassis become far too heavy to be held in one hand, we can be assured that the HT line is functioning correctly. We may now proceed to stage three, which is the testing of the double diode triode. This is a particularly interesting test, because we can now get even with our, up to now, appreciative audience. Before starting the test, we make sure that the chassis is alive, by correctly inserting the plug to produce that desired effect. Then remove the grid cap from the valve, and with a look of blind innocence, request the audience to place his or her ear in close proximity to the loudspeaker, whereupon we smartly but firmly place our index finger on the grid cap. The noise which should emerge from the speaker and the reaction of the audience should produce an effect worthy of an encore. If however, nothing does happen, a similar effect can be obtained by accidentally moving the chassis until the metal frame of the speaker touches the ear of our audience. This effect compensates one for the knowledge that the valve is probably unserviceable.

We now move to the IF or intermediate frequency stage. This can be tested in a similar manner to the DDT stage, but the noise will not be as loud, unless it happens to be a top cap anode. Finally we arrive at the frequency changer. This valve is a work of art, whose chief function seems to be to make everything as complicated as possible and lets the rest of the set sort it out as best it can. Some sets must be more clever than others because they can make a good job of it for years on end, while others can't even make a start, This, of course, is where the service engineer comes into the picture, for with his mass of knowledge and instruments, he can sort it out. But we can do the job far more simply. We just put a new frequency changer in—well, we've just tested the rest of the set and found not a thing wrong, so it must be that!

We have now reached the stage where we have *not* repaired the set by sensory nerves. We must now use our optical nerves. The first things to examine are "those little loose screws in the tin cans that we tightened up because they seemed so loose"—yes, well if they **have** been tightened up, we may as well send it to a service shop—(we are also making up excuses—just in case). Apparently they are undisturbed, so we now touch the aerial on to the aerial socket. If we hear a fairly loud click in the loudspeaker, we have at last traced our fault—the oscillator isn't doing its job. We tried a new valve, so we know that that is not the cause, so we switch the set to long wave and also to short wave. If there is still no response we know now that the defective component is common to all waves—this gets easier—i.e. the anode resistor, which is a cinch to test. Just lay your finger across it! If the set doesn't start playing, we shall provide a good substitute for "hot" music. If of course it does play, it is advisable to fit a replacement, as being an integral part of one's own radio becomes a very

(*continued on next page*)

INEXPENSIVE TELEVISION

More Answers to Readers' Queries

Interest in our Televisor continues on a high level and we are constantly receiving letters from readers on various aspects. We are continuing the publication of certain queries which we feel will be of general interest to those who are building their own receiver and who are generally interested in the design of television gear.

B. Sellers of Kenilworth found that he has had to modify the values of certain components in the time base circuit in order to improve linearity and interlace. This is due to the fact that the values of resistors and capacitors obtainable on the "surplus" market may often differ from the values marked. The average tolerance, of course, being of the order of plus or minus 20%. As the time base circuits are rather critical, any slight variation of the nominal value will immediately show up as a fault on the screen. The obvious remedy is to experiment with slightly varying values.

R. Harper of Kingsbury, London N.W.9, has a raster in the form of a parallelogram, although the picture itself appears upright. This may be due to the CRT being in the proximity of a mains transformer and the spot tends to form an ellipse caused by the magnetic field. The remedy here is to mount the tube well away from the main power pack. This reader also experiences a slight cramping on one side of the picture and we suggest that he modifies the anode loads of the line amplifier, e.g., at present each anode has a 100,000 Ω load, but by reducing one of these resistors to around 50,000 Ω the trouble should be eliminated. The resistor in question is easily found as by shunting each anode load in turn with a 100,000 Ω resistor will determine the anode load to be modified.

In the synch. separator and time base circuits, can EF50's and SP61's be used in place of the 6AC7's, asks *R. W. Adams* of Nottingham. From reports received it would appear that these valves can be used quite satisfactory without any circuit modifications of any kind. Incidentally, we gave a table of suggested alternatives on page 11 of the Data Booklet 2.

R. B. Miller of Bexley (Kent) is obtaining good results but has two faults which he has been unable to remove. His picture is cramped in both directions, frame and line, and also folds over. This is again due to non-linearity or overloading in the amplifiers. We suggest that the experiments with both the line and frame amplifiers anode loads be carried out as mentioned in our reply to reader R. Harper (see above).

J. B. Nunn of Cricklewood, London, N.W.2, has had trouble in the line oscillator, namely that the picture tends to pull out in certain places. This 'pulling out' has no regularity and seems to occur always at the wrong moment. A remedy for this defect which seems to be very effective, and incidentally was tried by this reader, was to modify the differentiator circuit in the line oscillator substituting for R6 two resistors in series of 4,700 and 47,000 Ω. The lead from C20 is disconnected from the suppressor grid and taken to the junction of the two new resistors. The 47,000 Ω resistor is taken to the grid end and the other resistor is on the earthy side, and as explained above is merely a substitution for R6. This reduced the amount of synch. voltage applied to the line oscillator, since before the input was too great and resulted in erratic synchronisation.

Nicholas Carter, Bayswater, London, W.2, sends along some useful information on alternative CRT's. He originally used a VCR97 with 2,500 volts but since then has progressed to a 12″ tube. This latter tube, a VCR131, with green screen, short persistence, fits the same holder as the VCR97. The characteristics are similar and, using the same line and frame amplifiers as in our Inexpensive Televisor, it is possible to scan the tube completely. EHT required is 2,500 volts. He has also tried a VCR517 (with a blue screen). This is of medium persistence but it is not unduly noticeable. Many VCR517 tubes are available but prospective buyers should be wary since there is no external indication of what colour the screen will be as the majority of these tubes are of a yellow screen and of long persistence. Some tubes are marked VCR517A and some VCR517B, but this is no indication of the screen colouring. The only sure way to determine if the screen is blue is to test it!

(THE POOR MAN'S GUIDE TO RADIO REPAIRS—continued).

boring job, especially if the family want to hear a programme that we don't.

The next suspects are the two $100\mu\mu F$, or thereabouts, capacitors that look at you so innocently, as much as to say "Well I'm OK don't look at me." Now if we had a capacity tester, we could soon tell which was and which wasn't the defective component—but how to tell without ? That's easy, whip them both out and replace them. We know a better way than that—bridge them with another capacitor and when the set works that is the bad one. If we can make it work like that our service engineer will be sending us sets to repair, but due to the capacity of our hands it is very unlikely that this will be the case.

We now switch on the set and while we are waiting for it to warm up we can work out how much the charge will be, let's see—30/- should see us through, for time, two capacitors and "technical knowledge." The set should be playing by now—that's funny—where's the nearest service depot—what did you say, somebody put an X65 in and it should be 6A8G—how much—18/6 ? Funny thing, we always thought that bloke was a barefaced robber—that's cheap enough—wonder how much test instruments cost nowadays ?

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