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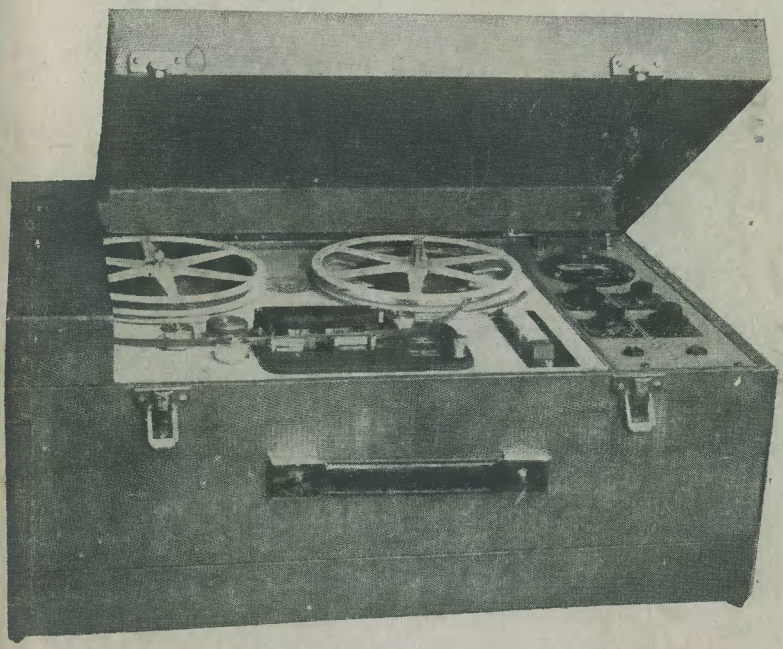

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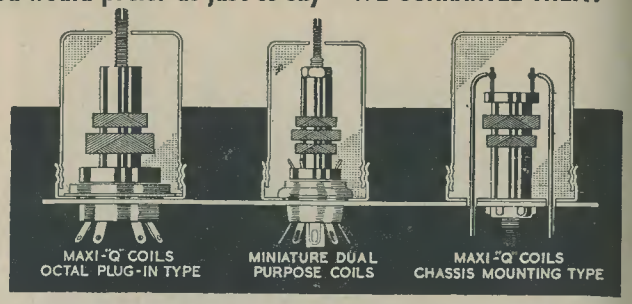

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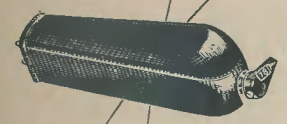

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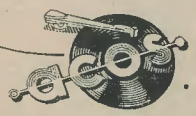

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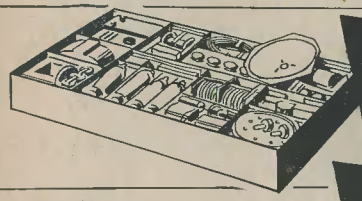

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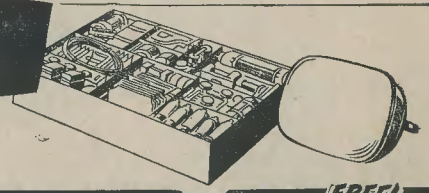

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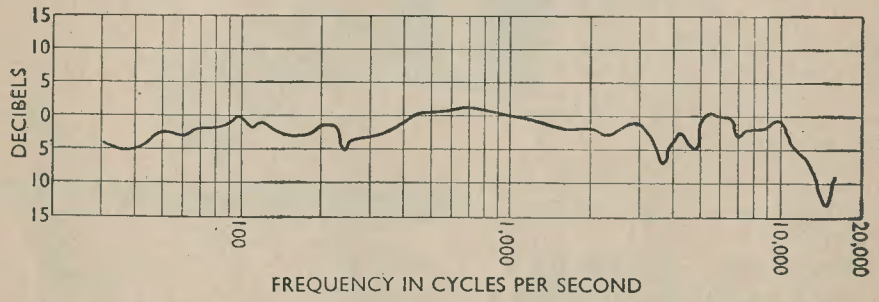

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Editor
C. W. C. OVERLAND, G2ATV

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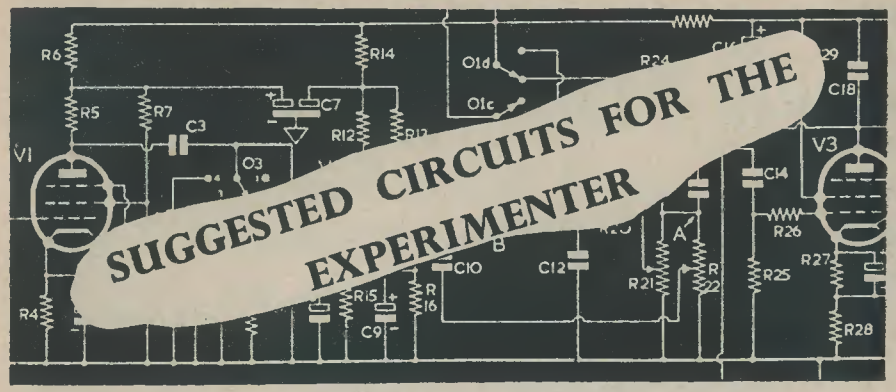


The circuits presented in this series have been designed by G. A. FRENCH, *specially for the enthusiast who needs only the circuit and essential relevant data*

No. 50. AN "ECONOMY" SWITCHING CIRCUIT FOR ALL-WAVE COIL SYSTEMS

ONE OF THE ESSENTIAL REQUIREMENTS OF the domestic "all-wave" superhet receiver is that it should be capable of covering the conventional long, medium and short wave bands. Since few receivers of this type incorporate an RF stage this involves the switching-in of two coils for each of the three bands received, one coil in each band operating at signal frequency and the other at oscillator frequency. In all, six coils are employed.

It follows from this requirement that the wave-change switching circuits employed in all-wave receivers are liable to become a little complex. Assuming that each of the six coils consist of one tuned and one coupling winding, the minimum wave-change specification is for that of a four-pole three-way component. If the switch is to have a "Gram" position also, a further pole is required; whereupon the switch becomes a five-pole four-way component. A switch of this type is almost certain to be relatively bulky and cumbersome, and is rarely available in single-wafer form. Further, the number of wires connecting the contacts of such a switch to the coil tags themselves is proportionately large, and unless especial care is taken with the layout of the receiver can lead to a cluster of RF wiring around the switch, with consequent losses.

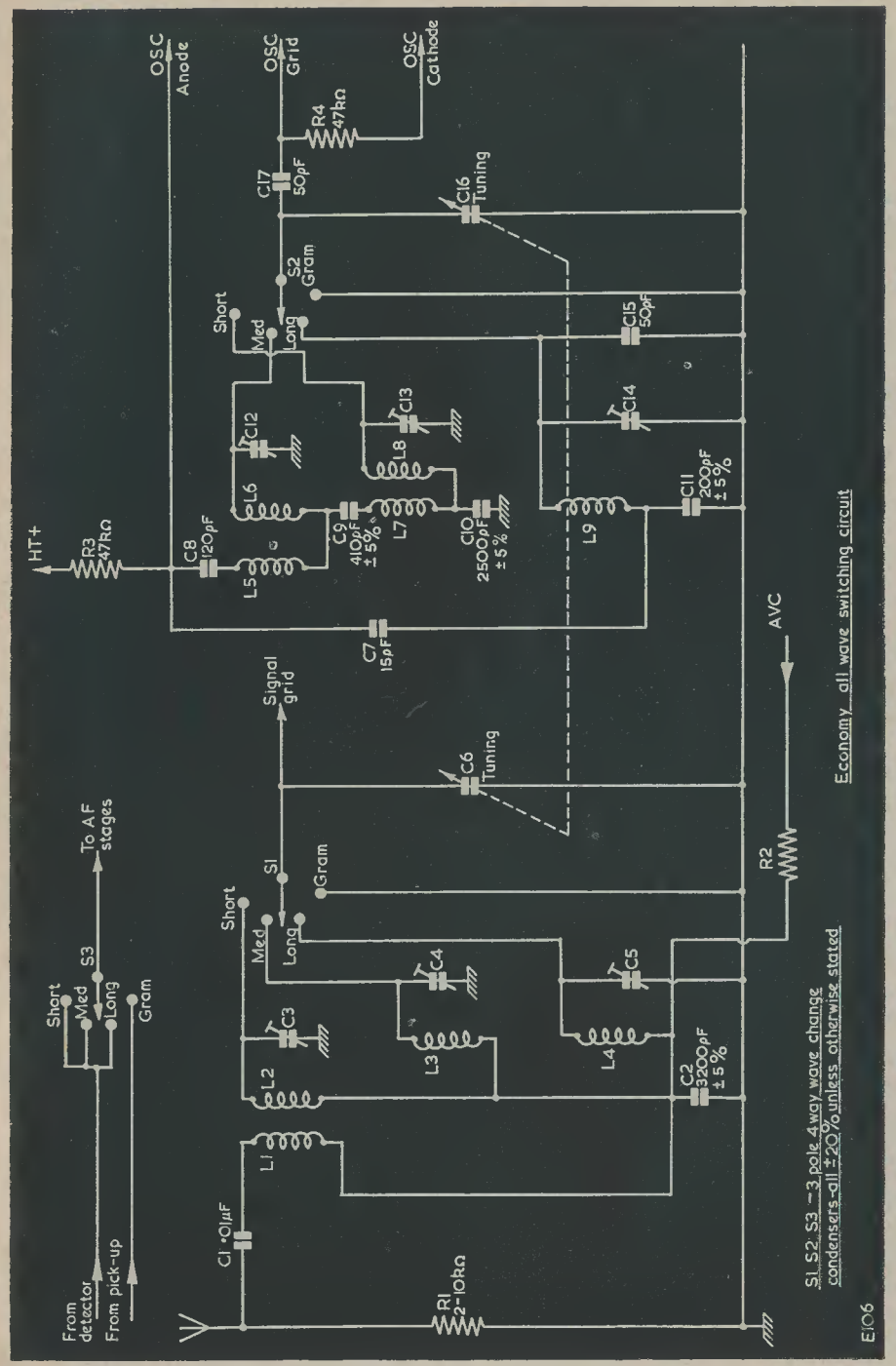
Many attempts have been made in the past to reduce the number of switch contacts incorporated in commercial all-wave receivers. Unfortunately, a large number of the arrangements employed have introduced complications of their own making. A typical, and particularly undesirable, example of such complications is given by the presence of "parallel trimming"; with which one trimmer, although intended to be adjusted on one band only, in practice affects the trimming of other bands as well. Better, and more thoughtfully designed, circuits have employed specially-tooled switch wafers capable of carrying out the necessary coil switching without introducing involved faults of this nature.

Since the war the popularising of "bottom-end" aerial coupling circuits has gone a long way towards simplifying wave-change switching. This is due to the fact that it is possible, with the bottom-end circuit, to carry out signal frequency coil switching using a single-pole set of contacts only. However, this does not solve the problem of the oscillator coils of the receiver which, even with bottom-end anode coupling arrangements, normally still require two poles.

The situation is further complicated by the advent of the present very popular "miniature," single-wafer, switch. This switch, of which similar models are made by at least three well-known manufacturers, is extremely simple in construction and cheap in price; and it is very familiar to home-constructor circles. It has twelve fixed contacts arranged around its wafer and is readily available in any combination which can be served by this number of contacts (viz. two-pole six-way, three-pole four-way, and so on).

The Circuit

This month's circuit illustrates a superhet coil switching arrangement which requires two poles only. As a result, it has the



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considerable advantage of allowing a twelve-contact "miniature" wave-change switch to be used in a three-pole four-way application; the third pole being employed for "Gram" switching. This application is illustrated in the diagram. Other advantages are provided by the small amount of wiring required between coils and switch tags; and by the fact that the circuit is extremely attractive for small and compact receiver layouts.

Although the signal frequency switching arrangement is quite conventional, a few words explaining this part of the circuit might not be out of place at this point. The aerial is connected, via C1, to L1; this being the short wave aerial coupling coil. The other end of L1 connects to C2, the bottom-end condenser. At short wave frequencies, the impedance of C2 is very low; with the result that the lower end of L1 can be considered as being connected to chassis almost directly. In consequence, L1 affords a high degree of coupling between the aerial and the short wave tuned winding, L2. On medium and long waves these conditions are reversed, however, since the few turns given by L1 have so low an impedance at these frequencies that the aerial can be considered as being connected almost directly to C2. Thus, bottom-end aerial coupling for medium and long waves is achieved without upsetting the inductive coupling which exists on short waves. So far as coil selection is concerned, all that is then required is the switching of the tuned windings; this being carried out by the single-pole switch S1.

The oscillator circuit is of more interest, since it also employs a single-pole switch (S2), to select the coils which are required. Switching, once more, is to the tuned windings. The coupling circuit is unconventional and applies feedback simultaneously to all three coils without switching. As may be seen from the diagram the tuned windings are connected to the grid of the oscillator, the feedback circuits being shunt-fed from its anode. The two coupling condensers, C7 and C8, are a necessary feature of this particular arrangement.

To appreciate the functioning of the oscillator switching circuit it is advisable to commence by considering what occurs when S2 is set to the "Short Wave" position. In this position the grid of the oscillator is connected to L8, the tuned winding of the short wave oscillator coil. Feedback is then obtained from the anode of the oscillator via C8, via the *self-capacity* of the coil L5, and via C9 to the short wave feedback winding, L7. This feedback is sufficient to allow oscillation at the frequency selected by L8 and the tuning condenser C16. (The condenser C10 is, of course, intended purely for padding purposes).

When S2 is set to the "Medium Wave" position the grid of the oscillator connects to L6, the medium wave tuned winding. The lower end of this winding is taken to the medium wave padding condenser C9. This condenser connects to chassis via L7 and C10. Both L7 and C10 have negligible impedance at medium wave frequencies, with the result that their introduction between C9 and chassis has very little effect on the characteristics of the medium wave oscillator tuned circuit. The anode of the oscillator is coupled to L6 via C8 and the feedback coupling winding L5; thereby allowing oscillation at medium wave frequencies to take place.

For long wave reception, S2 is set to the "Long Wave" position. This connects the tuned winding L9 to the grid of the oscillator. Feedback from the anode of the oscillator is then achieved by connecting it, via C7, to the padding condenser C11; the latter then acting as the condenser in a bottom-end coupled oscillator arrangement. (More accurately, Colpitts). Thus, oscillation is obtained at long wave frequencies when S2 is in the appropriate position.

When S2 is set to "Gram," the grid of the oscillator is disconnected from all tuned circuits; thus preventing oscillation and any risk of radio break-through. This method of connection results also in zero bias at the oscillator, however, with the consequent possibility of high cathode emission. Fortunately, by using the anode load of 47 kΩ recommended in the circuit (R3), cathode emission is kept well within the maximum specified for conventional frequency changers. Also, the presence of the grid leak (R4) allows the formation of a small negative space charge at the grid, this assisting further in reducing the cathode emission.

The signal grid of the frequency changer is taken to chassis in the "Gram" position as well. As a result, the signal grid is then effectively biased by the voltage dropped across the frequency changer cathode bias resistor.

Interaction

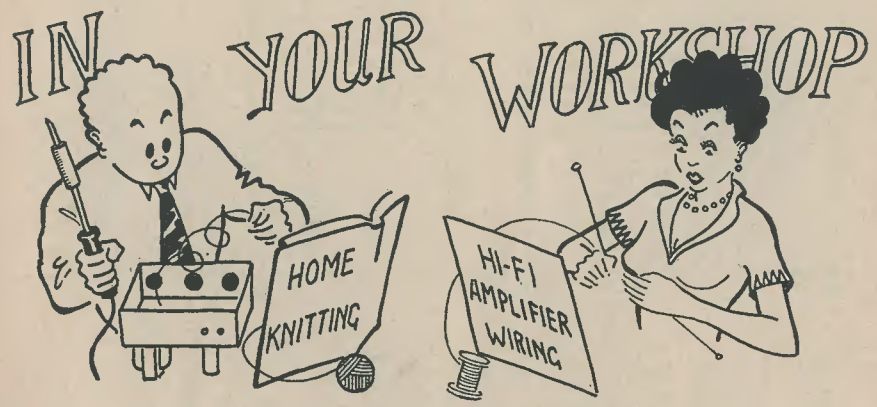
It may have been noted that the long wave padding condenser, C11, has a slightly unconventional value; and that an additional condenser, C15, has been connected across the long wave oscillator trimmer, C14. The purpose of C15 is to ensure that the frequency of resonance given by the long wave oscillator coil (in parallel with its self-capacity and C14) cannot rise sufficiently high to fall within the band covered by L6 when S2 is set to the "Medium Wave" position. If this eventuality were not guarded against, there would be an absorption of oscillator RF energy at the interacting frequency. The introduction of C15 necessitates a corresponding decrease of inductance of L9, this being normally within the range of adjustment of its iron dust core; together with a compensatory increase in C11, which would conventionally have a value around 150 pF. Long wave tracking does not suffer in consequence.

Coils

Readers who wish to experiment with this circuit will find that it copes perfectly with almost any conventional coils having Q factors above 65 or so. Variable iron-cored components are, of course, essential for the oscillator coils; since no variable capacitive padding is incorporated. Similar coils are preferable for the signal frequency circuits as well. A mains-type frequency changer should be used; excellent results being given by the 6K8, 12AH8, or similar valves.

Acknowledgment

The writer wishes to give grateful acknowledgments to Allen Components, Ltd., for the generous facilities which have been made available to him to enable this circuit to be developed.



In which J. R. D. discusses Problems and Points of Interest based on Letters from Readers and his own experience.

I would like to begin this month by thanking those readers who were good enough to write to me during the past four weeks or so. My correspondents' letters were prompted by my recent remarks on the subject of coils, iron-dust cores, and Q-factor.* Several readers expressed surprise at the figures given in this particular article for the Q-values of practical and frequently-met coils; and especially at the rather low figures given by some of the iron-dust cored medium and long wave coils which were dealt with. However, I can guarantee that there was no "book-cooking," and that the data given in the article was obtained with the aid of a reliable laboratory type Q-meter.

Since it appears that the practical treatment of tuned circuits is of interest to readers, it might be worth while devoting a little more time to this subject. I would like to deal this month, therefore, with one of the more interesting sections of a modern receiver—the aerial tuned coil and coupling circuit.

*Page 140 October 1954 issue.

Aerial Coupling

The primary function of the aerial coupling circuit in a receiver is to enable RF energy to be transferred from the aerial system to the grid of the first RF amplifying valve. In most receivers this process is carried out by primarily coupling the aerial system to a tuned circuit, the voltages built up across the latter being then applied to the valve. Completely aperiodic (i.e. untuned) aerial coupling circuits are hardly ever encountered in modern receivers; although they are used frequently by communications services. Aerial input circuits of the type which cover a large band without the use of a panel tuning control (e.g. the aerial input circuits of many FM receivers), are not truly aperiodic; they merely employ a tuned circuit with a "flat" response.

For many applications it is advantageous to make the aerial coupling circuit transfer as large a degree of RF energy from the aerial system to the first valve at the frequency required as is possible. The reason for this is

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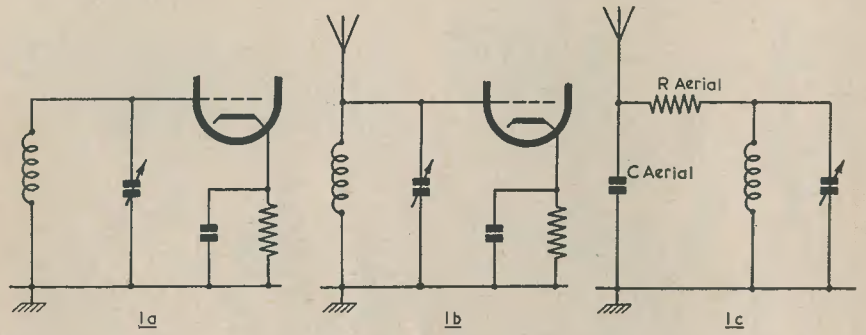
that the greater the amount of signal energy transferred, the greater is its strength in proportion to the inevitable noise generated by the components of the first stage; and, hence, the greater the overall signal-to-noise ratio of the receiver. Such a design policy is fairly simple to put into practice in cases where the receiver is intended to operate at fixed frequencies and with aerial inputs of known and constant impedances. Examples of applications of this type are to be found in many communications receiving stations, and, to a somewhat lesser degree, in domestic television receiver installations and the like.



E108

Fig. 1 (a). The tuned circuit connected to grid and cathode of the first stage of a receiver

(b) A possible, but impracticable, method of coupling the aerial to the tuned circuit

(c) Showing the impedances introduced to the tuned circuit by the aerial-earth system

Unfortunately, conventional domestic receivers designed for the "broadcast" bands (i.e. long, medium and short waves), by no means fall into this category, since they may be connected to any of a widely divergent field of different aerial systems. There are, also, other complications; which will now be dealt with. To do this it would probably be most advisable to commence with the medium and long wave bands first, as these require a somewhat different aerial coupling technique to that employed on short waves.

Medium and Long Waves

Fig. 1 (a) shows a parallel tuned circuit connected to the grid and cathode of the first RF amplifying valve of a TRF or superhet receiver. The variable capacity in this tuned circuit follows normal practice and consists of a condenser which forms part of a two- or three-gang component (more probably the former). What we want to do now is to couple an aerial to this tuned circuit. Before we can do this, however, we have to take into account two important points. The first of these is that one of the jobs of the tuned circuit is to contribute materially towards the overall selectivity of the receiver. In a TRF receiver this fact is of obvious importance, since the first tuned circuit has to play a considerable part in the process of separating the required signal from those others which are very close to it in frequency. In the superhet —assuming that no RF stage is fitted—the first tuned circuit has to completely separate, on its own, the required signal from those whose frequency falls on the second channel (i.e. from those whose frequency is twice the IF above the required frequency). Although the requirements of the superhet aerial tuned circuit may seem, at first sight, to be less stringent than those needed for the TRF receiver, in practice this is not necessarily so. A high degree of selectivity is still required in the superhet circuit in order to prevent *powerful* carriers at the second channel from interfering with *weak* carriers at the required frequency. The second point which has to be taken into account when considering aerial coupling arrangements is that the aerial tuned circuit must always track accurately with the other tuned circuit or circuits in the receiver.

Some of the potential difficulties which complicate the design of an aerial coupling arrangement can be seen very clearly if we consider the most obvious coupling circuit of all. This is given by the simple process of connecting the aerial directly to the top of the coil, as is shown in Fig. 1 (b). Although such a circuit must obviously allow the transfer of RF energy from the aerial to the signal grid, it is not a practicable arrangement. There are two disadvantages, these being illustrated graphically in Fig. 1 (c). The first of these is that the aerial introduces an additional capacity across the tuned circuit, this capacity being given by that which exists between the aerial wire itself and earth. The aerial-earth capacity may vary anywhere between 30 and 300 pF for the average domestic aerials normally encountered; and such capacities would be enough, in themselves, to completely upset the tracking of the receiver. The second disadvantage is that the aerial-earth capacity is now, itself, part of the tuned circuit. However, this capacity is, as shown in Fig. 1 (c), connected in series with an effective resistance (the equivalent resistance of the aerial-earth system) and so its Q factor is low; resulting in a reduced Q for the whole tuned circuit. Selectivity, therefore, becomes reduced as well. Put more succinctly, the aerial *damps* the tuned circuit.

(This has not taken into account the inductance of the aerial. However, unless the aerial is very long, its inductance will not be large, and it is fairly safe to treat the aerial-earth system as being largely capacitive so far as medium and long waves are concerned).

These difficulties may be partly overcome by fitting a condenser in series with the aerial. Unfortunately, to prevent tracking errors and damping, this condenser has to be very small, (less, say, than 20 pF), and so signal transference is low. The series condenser does not, therefore, represent a satisfactory solution.

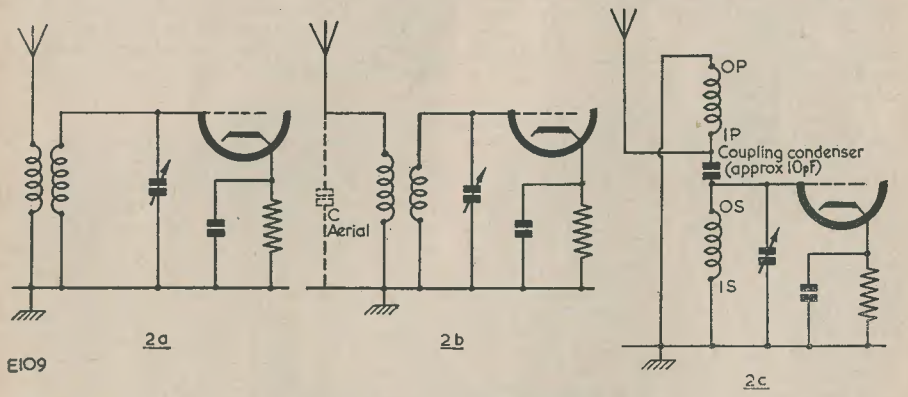
Coupling Coils

A far better method of coupling the aerial to the tuned circuit is by means of a coupling coil, as illustrated in Fig. 2 (a). This circuit has two outstanding advantages. First, the degree of coupling may be varied by altering the distance between the two windings. Secondly, the degree of coupling at different frequencies can be adjusted, if desired, by varying the number of turns in the coupling coil.

The major problem to consider when using the circuit of Fig. 2 (a) is this: how tight should the coupling be between the two coils?

The reference books tell us that, if the coupling coil is so sited in relation to the tuned circuit coil that maximum RF current flows in the latter, selectivity is halved. This degree of coupling is consequently too tight for medium and long wave reception. The situation is further complicated by the fact that it is impossible to know what type of aerial will eventually be connected to the receiver. Most designers get over this trouble by incorporating a fairly loose coupling into their designs and accepting the fact that this is a long way short of the optimum when their receivers are used with short, inefficient, aerials. Perhaps fortunately (or unfortunately), domestic medium and long wave listening in the UK appears to be confined mainly to the Light and Home programmes only, with the result that this policy goes some considerable way towards satisfying most listeners. Those who live in bad reception areas or who wish to obtain good reception of Continental programmes are then free to use larger aerials as they wish.

Some receivers, and especially those in the "midget" class, are provided with a small amount of throw-out aerial wire cut to length.



E109

Fig. 2 (a). A conventional aerial coupling coil

(b). The use of a resonant coupling coil

(c). A method of connecting a resonant coupling coil to ensure even response over the whole of a band with a short aerial

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This often signifies that the aerial coupling has been designed for an aerial of that specific length only. Connecting an additional aerial to the throw-out wire would then cause excessive damping of the aerial tuned circuit and loss of selectivity.

Coupling Turns

Many amateurs and some commercial manufacturers use aerial coupling coils which are fairly loosely coupled to the tuned coil and which have about a quarter to a third of its number of turns. Although coupling coils of this type are somewhat frowned on by the experts, they nevertheless give quite good results in practice, and especially so if the tuned circuit has a high value of Q. One of the major disadvantages of this scheme is that it is possible for the coupling winding to resonate with the aerial capacity at a frequency which lies within the band being received; giving thereby an undesirably high degree of coupling at that point, and consequent tracking error and damping. A second disadvantage is that the amount of signal transfer is liable to drop quite noticeably at the low-frequency end of the band, where tuned circuit Q is at its lowest value. The first disadvantage can be overcome, of course, by connecting a condenser of some 150 pF in series with the aerial when this is liable to have a high capacity to earth; but the second disadvantage is inherent, and can only be minimised by keeping tuned circuit Q as high as is economically feasible.

A more conventional method of coupling medium and long wave aerial tuned circuits is illustrated graphically in Fig. 2 (b). In this instance the aerial coupling coil has many more turns than the tuned circuit coil, and is intended to resonate with the aerial-earth capacity at a frequency *below* the band being received. Thus the falling characteristic given by the drop in Q of the tuned circuit as the frequency of reception is lowered is compensated for by the rise in signal energy transfer as the resonant frequency of the coupling coil is approached.

One of the difficulties with designing coils of this type is that the resonant frequency of the coupling coil and aerial-earth capacity must not fall within the band being received *whatever* aerial is used. This necessitates winding a proportionately very large number of turns on the coupling coil. Also, the coupling coil must not be allowed to resonate at the intermediate frequency when it is used in a superhet, or the receiver may become unstable. Because of this, a medium wave aerial coupling coil fitted in a superhet must not merely resonate at a frequency below 600 kc/s (500 metres) but at a frequency below the IF; which would, in most cases, be a frequency below 465 kc/s. At a frequency as low as this the beneficial effect of the rise in coupling factor would be somewhat lost. Some designers are liable to "cheat" a little, so far as this point is concerned, by making the coupling coil resonate at the IF when a very short aerial, or none at all, is used. The resulting tendency towards instability is then subdued by connecting a low-value resistor (some 2 to 5 kΩ) between the aerial and earth terminals.

To ensure a gradual rise in coupling factor at the lower frequency end of the band being received, the Q of the coupling coil has to be kept low; usually to a figure around 40. This is normally achieved by winding the coupling coil with very thin wire, such as 42 to 44 swg.

The next difficulty that arises with a coupling coil having a large number of turns is that such a coil has a fairly high self-capacity. Because of this, signals picked up on a short aerial at the high-frequency end of the band tend to by-pass the turns of the coil and complete the aerial-earth circuit through the self-capacity instead. The result is that it is now the signals at the high-frequency end of the band which become attenuated!

The solution is to employ a larger aerial or to add a small coupling condenser as shown in Fig. 2 (c). This condenser must be small in value (around 10 pF) to prevent tracking errors. The connections to the coils must be poled in the sense shown in Fig. 2 (c) or the condenser will reduce, instead of increase, the signal transfer given by the inductive coupling.

Bottom-End Coupling

A method of aerial coupling for the medium and long wave bands which appears to cause some confusion is that known as "bottom-end coupling." This is an arrangement by means of which the aerial is coupled into the capacitive section of the first tuned circuit, and it employs no coupling windings or coil tappings whatsoever.

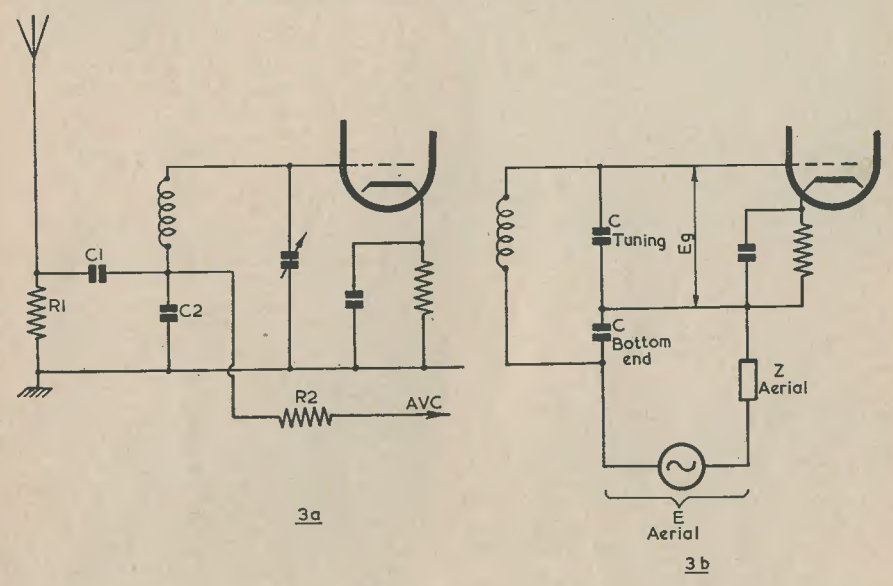
The basic bottom-end coupled aerial circuit is shown in Fig. 3 (a). Only one coil is used, this being that which is employed in the tuned circuit itself. The earthy end of this coil is connected to chassis via the "bottom-end condenser," C2, whose value usually lies between 2,000 and 5,000 pF. This condenser functions also as an AVC (or bias) decoupler, the AVC voltage being applied through R2. The aerial is connected to C2 via an isolating condenser C1 (whose value is usually around 0.01 μF), and is taken to earth through a low-value resistor, R1.

The functioning of the circuit may, perhaps, be more easily understood if it is re-drawn as shown in Fig. 3 (b). As can be seen, it really consists of a simple tuned circuit into part of the capacitive half of which the RF voltages appearing between aerial and earth are injected.

Fig. 3 (b) helps to make clear the fact that, when bottom-end coupling is used, the degree of coupling between the aerial and the tuned circuit is liable to vary considerably over the range of the tuning condenser. Coupling is tightest at the low-frequency end, where the tuning condenser has maximum capacity; and lowest at the high frequency end. The change in the degree of coupling is not gradual, unfortunately, and varies at its greatest rate when the tuning condenser approaches its position of minimum capacity. However, it is rarely that the circuit approaches a condition of very loose coupling, since stray and trimming capacities connected effectively across the tuning condenser nearly always have a value which is in excess of some 60pF or so.

The input impedance between aerial and earth terminals offered by the bottom-end coupled circuit is fairly low, and it is this fact which sometimes puzzles amateurs who are more familiar with the inductively coupled type of circuit. Due to the low input impedance both an aerial *and* an earth connection should be employed, as otherwise sufficient signal pick-up will not always be obtained. The necessary earth connection is automatically given with mains receivers by means of the mains wiring, this wiring being coupled to the receiver chassis either via the capacity existing between primary and secondary of the mains transformer, via (more preferably) the 0.01μF anti-mains modulation condenser fitted in most receivers between the chassis and one side of the mains, or via the direct connection given by AC/DC power-supply circuits. Battery sets employing bottom-end coupling should have an external earth connection taken to their chassis.

Because of the low input impedance of bottom-end aerial coupling circuits, the type of aerial used has very little effect on tuned circuit damping or tracking. This is, indeed, one of the great advantages of this method of coupling, since it is possible to connect a very large aerial directly to the aerial terminal of the receiver in which it is employed without incurring any serious loss in selectivity at all. As a result, bottom-end coupling circuits become especially



E110

Fig. 3 (a). The basic "bottom-end coupled" aerial input circuit. (A further isolating condenser would be connected in series with the aerial for AC/DC receivers).
(b) Illustrating the manner in which aerial-earth RF voltages are injected into the bottom-end coupled circuit. The impedance of the aerial-earth system (mainly capacitive on medium and long waves) is represented by "Z Aerial"

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attractive for the construction of "miniature" equipment, because it is then feasible to obtain good selectivity with small iron-dust cored coils whose Q factors are around 70 to 90. Bottom-end coupling would give a very high degree of selectivity indeed when used with really high Q coils.

One of the main disadvantages of bottom-end coupling is its susceptibility to mains modulation. Reference to Fig. 3 (a) will help to clarify this point. Mains modulation is liable to occur when a mains voltage (usually picked up capacitively) appears between the aerial wire and the receiver chassis. What next happens is that this mains voltage is applied to the condenser potentiometer formed by C1 and C2 in series, a proportion (that across C2) being then applied, via the coil, directly to the grid of the first valve. With AC/DC receivers mains modulation of this type can be especially difficult to clear, although the process of reversing the mains plug often helps. With AC receivers, the solution which is usually most successful consists of connecting the receiver chassis to a reliable earth. Mains modulation may be reduced in intensity by reducing the value either of R1 or C1 —Fig. 3 (a)—but this process is liable to result in a loss of signal strength. In bad cases, mains modulation can usually be cleared completely by replacing R1 with a good all-wave choke.

Short-Wave Coupling

I had hoped to mention short-wave aerial coupling as well this month; but it seems that I have now filled my allotted space. This topic will, therefore, have to be left until the next issue.

BOOK REVIEWS

UNIT CONSTRUCTED TV RECEIVERS, by E. N. Bradley. 92 pages, 42 diagrams and illustrations. Price 6s. Published by Norman Price (Publishers) Ltd., 283 City Road, London, E.C.1.

A useful booklet with some original ideas about constructing TV receivers at home. A series of units is described which can be made from standard components. The first two are for short-range and long-range receivers, full details being given for making tuning coils.

Time bases, tube units and power supply units for both electrostatic and magnetic deflection are fully described. Working drawings for making chassis are provided, and the wiring diagrams are particularly clear. The time base and tube unit designs are for 3" and 6" electrostatic tubes, and 9" and 12" magnetic tubes. Some notes are given on using 14" and 15" tubes, together with a short guide on operating and fault finding.

The photographs show that the units are pleasing in appearance and compact. But Mr. Bradley's designs and articles usually are pleasing!

TRANSISTORS AND CRYSTAL DIODES, by B. R. Bettridge, A.M.BRIT.I.R.E. 72 pages, 47 diagrams and illustrations. Price 5s. Published by Norman Price (Publishers) Ltd., 283 City Road, London, E.C.1.

The author of this book is associated with one of the leading electronics laboratories in the country; it is therefore understandable that this treatise on semi-conductors impresses the reader with its clarity and purpose from the beginning.

Within its covers the reader finds a surprising amount of information on the properties and uses of germanium diodes and transistors. The history of the development of semi-conductors is traced from earliest times. After describing how they work, the author gives several chapters of practical uses for germanium crystals, point-contact transistors and junction transistors.

This is the sort of book that really deserves the attention of anyone interested in semi-conductors. It is exceptionally good value at 5s.

VALVES FOR A.F. AMPLIFIERS, by E. Rodenhuis. 147 pages, 95 diagrams and illustrations. Price 10*s*. 6*d*. Distributed in the U.K. and Eire by Cleaver Hume Press Ltd., 31 Wright's Lane, Kensington, London, W.8.

This is a further addition to the Popular Series of the Philips Technical Library. It is a paper-covered book dealing with the use of EF40, EF86, ECC40, EL34, EL84 and GZ34 valves in audio amplifiers.

General hints on amplifier construction are given. Several pages are devoted to characteristic curves and technical data of the valves, and provide a wealth of information about them. One has come to expect this from the Philips Library.

A few short chapters deal with output transformer design and features of microphones, pick-ups, speakers, etc. About half the book is devoted to detailed descriptions of eight amplifiers which range from a 3-watt single-ended output stage to a 100-watt push-pull output using Class B.

One is surprised to find a very serious technical error on pages 85 and 86, concerning the windings on the primary of an output transformer. To wind two sections in opposite directions and then connect them in parallel as stated must obviously produce a non-inductive winding—hardly conducive to obtaining an output from the secondary!

THE INVENTOR OF THE VALVE, by J. T. MacGregor-Morris, D.Sc. (Eng.), M.I.E.E. 134 pages, 22 illustrations. Price 10*s*. Published by The Television Society, 164 Shaftesbury Avenue, London, W.C.2.

Collectors of unique volumes will need to obtain their copy of this interesting book without delay, for only one issue of 1,000 copies is being made. It is produced to commemorate the 50th anniversary of Prof. Fleming's filing of his patent for his "oscillating valve," from which original design has grown the enormous number of valves we know today.

It is well that such a notable pioneer should be immortalized, lest we forget the debt that is owed to him. This biography makes particularly interesting reading and gives the reader a clear conception of the amazing abilities of Fleming, both as physicist and lecturer.

FUNDAMENTALS OF RADAR, by S. A. Knight, F.R.S.A. 150 pages, 113 diagrams. Price 15*s*. Published by Sir Isaac Pitman & Sons, Ltd., Pitman House, Parker Street, Kingsway, London, W.C.2.

In this second edition the author has taken the opportunity to revise parts of the original work, and to introduce additional material. The present work has a new chapter on waveguides.

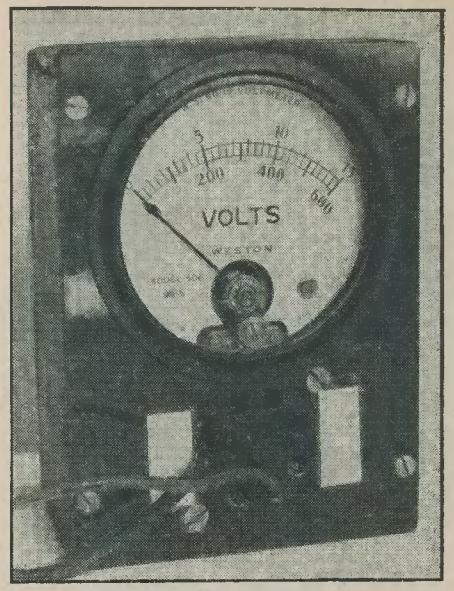
After describing how radar works, the author introduces the fundamentals of trigger and pulse circuits, saw-tooth generators, cathode-ray indicators, pulse transmitters and receivers, range determination, resonant lines and directional arrays.

This book is intended as an introduction to the wide and complicated field of radar technique; it certainly achieves its object. W. E. THOMPSON

MAKING MULTI-RANGE METERS

By

F. G. RAYER



FOR SOME YEARS EXCELLENT EX-SERVICE meter movements have been obtainable at prices which make them genuine bargains, and one of these can easily be used as the basis for a test instrument for general use, or as a stand-by to the service meter. It is, therefore, proposed to describe how voltage and current ranges may be obtained with such meters, and also to give constructional details of a particular multi-range instrument which was made up in this way. In the latter, dimensions were kept down as far as possible, but this is a matter for personal preference, and a larger instrument could be constructed.

The Meter Movement

As so many different types are available it is best to consider which is most suitable for the present purpose. A flush-mounting meter is most convenient, and it will probably be about 2-in. in diameter, and contained in a circular bakelite case. It can be mounted flush on the panel by cutting a hole of suitable size in the latter.

The meter should be of the moving-coil type. That illustrated had a full-scale deflection of 0.5 mA. Meters with other full-scale deflections can be used, but the lower the full-scale deflection, the less current the meter will take. As a result, higher accuracy will be obtained in receiver testing, when external components such as resistors, choke windings, etc., are present in the circuit being tested. (Incidentally, the performance of the instrument, in this direction, will be vastly superior to the cheaper-type test instruments manufactured commercially).

Voltage Ranges

These are obtained by adding a resistor for each range required, as in Fig. 1a. If the meter is a 1mA model, a voltage range of 10 will be obtained with a 10,000 ohm resistor. A 15V range would require a 15,000 ohm resistor, a 60V range a 60,000 ohm resistor, and so on. If the meter has a full-scale deflection of 0.5 mA, the resistors will need to be of twice this value—20,000 ohms for 10V, and so on. Should the meter be a 5mA model, 2,000 ohms will be required for 10V, 3,000 ohms for 15V, and so on. The resistance for any range, with any meter, can be found from Ohm's law.

The resistors may be brought into circuit by means of a rotary switch. In the instrument illustrated, an octal valveholder is used, to keep size down, a plug being inserted in the appropriate socket.

As many voltage ranges as desired can be provided, but each will require a socket, or a

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separate way on the rotary switch. Ranges of 0–15V, 0–150V and 0–600V were provided on the meter shown. If battery-driven receivers only are dealt with, the constructor could omit the 600V range. If the meter used is already calibrated from 0 to 10, convenient multiples of this may be provided for (e.g. 0–10V, 0–100V and 0–500V). The meter illustrated was marked 0–15 and 0–600. This was adapted to the ranges mentioned. Ranges of 0–6V and 0–60V could also be provided, if desired.

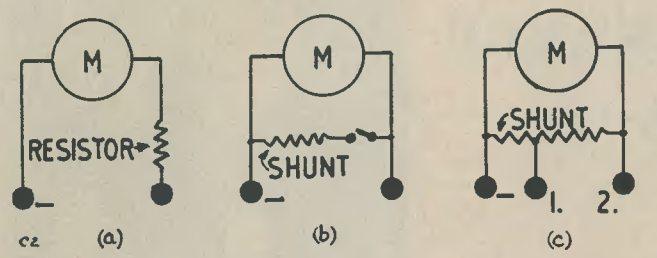


Fig. 1 a, b and c. Circuits for voltage and current readings.

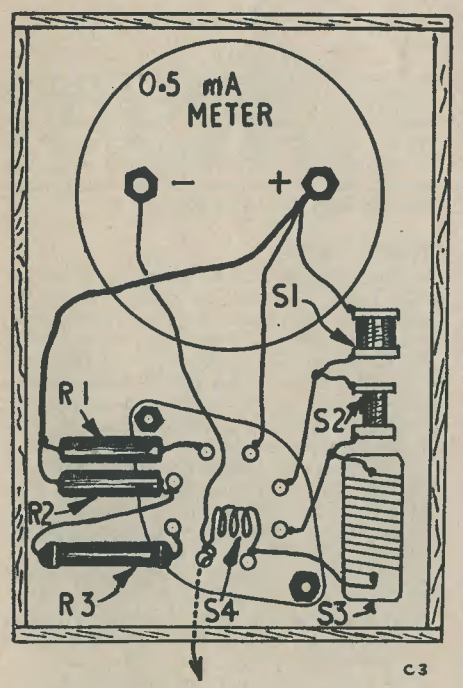


Fig. 2. Wiring plan of the meter

Having decided upon the ranges, resistors of appropriate value need to be obtained. Resistors accurate to 1 per cent are available; if resistors with a gold tolerance band are used, these are accurate to within 5 per cent. Resistors with no tolerance band should be avoided, since they are accurate to only 20 per cent. As a result any reading could be as much as 20 per cent out, if they were used.

It is also possible to select resistors from stock, measuring these with a second meter. Resistors with carbon bodies may easily be filed slightly, to increase their value, if necessary. If 1 per cent tolerance resistors are purchased, then the ranges will be correct to approximately this figure.

Current Ranges

As it stands, the meter can only read currents up to its maximum deflection. But the range can be increased by adding a shunt resistor in parallel; this may be brought into circuit by means of a switch, as in Fig. 1b. Again, as many shunts as desired may be employed, each being selected by a rotary switch or other means.

The circuit in Fig. 1c can also be used. This is employed in the instrument illustrated. The total value of the shunt is such that the 0.5mA meter reads 1mA, when connecting to negative and No. 2 points in Fig. 1c. When the one lead is transferred to point 1, more current must flow to move the meter pointer to its full-scale position. Again, such ranges as are desired can be provided—ranges of 0–1mA, 0–15mA, 0–60mA and 0–600mA, in the present instance. (If the meter were marked 0–10, ranges of 0–1, 0–10, 0–100, and so on would be more convenient to read).

Completed Meter

Fig. 2 shows a complete wiring plan of the 7-range instrument. The case was made from ply, with a paxolin panel. Dimensions are not given since these will, to some extent, depend upon the size of the meter movement. If it is intended to provide rotary switches for selecting the ranges, then a larger case would be necessary.

R1 is 15,000 ohms, providing the 15V range. (The 0.5mA meter being permanently shunted to 1mA, as mentioned). R2 provides the 150V range, and is 150,000 ohms. R3 is added in series, being 450,000 ohms (600,000 less the 150,000 of R2). This is for the 600V range.

The shunts are best made by experiment. S1 and S2 are wound on small spools. S3 consists of a shorter length of wire, and is wound on a flat strip of paxolin. As S4 consists of only an inch or so of wire it is wound in a self-supporting spiral. If a multi-range meter is available, the resistance of the shunts may rapidly be adjusted to obtain the required ranges.

If no second meter is available, quite accurate results can be obtained by working down from the lowest full-scale range. To do this, wire a variable resistor and battery of fairly high voltage in series with the meter (taking care not to pass more than full-scale current through the latter). Adjust the resistance until the pointer indicates exactly full-scale; e.g. 0.5mA in the present case. Now connect a length of resistance wire in parallel with the meter. Adjust the length until the pointer shows exactly 0.25mA. The range of the meter has now been doubled, and this length of wire will provide the 1mA range. Other ranges can be obtained in a similar way. E.g., if a 1mA meter is shunted to reduce its reading from 1mA to 0.1mA, then the full-scale deflection is 10mA. Similarly, a full-scale reading of 10mA can be shunted down to indicate 1mA; the full-scale deflection obtained with the latter shunt will then be 100mA.

In Fig. 2 all the shunts are in series; this avoids having to use a separate plug or switch to bring them into circuit. Instead, the plug may be inserted in any socket and the appropriate voltage or current range immediately obtained. *All* shunts together are of a value to reduce the meter range from 0.5mA to 1mA. S2, 3 and 4 together reduce the sensitivity from 0.5mA to 15mA. S3 and S4 together provide the 60mA range; and S4 alone, the 600mA range.

A plywood back is screwed on the meter, and red and black test-leads provided.

TRADE REVIEWS

NEW MULLARD SPECIAL QUALITY VOLTAGE STABILISERS AND REFERENCE TUBES

Almost every piece of industrial, military, and commercial electronic equipment incorporates a source of stable voltage. Mullard gas-filled stabilisers and voltage reference tubes such as the 90C1 and 85A2 are widely used in such equipments because of their extremely long life, freedom from voltage "jumps," and close tolerance burning voltages. Samples of Special Quality versions of these tubes are now being made available by the Communications and Industrial Valve Department of Mullard Ltd. These combine the good qualities of normal types with the ability to operate satisfactorily under severe conditions of shock and vibration such as are encountered in aircraft, ships, vehicles, and in industry. They are tested to withstand impacts of 500g and vibrations of 6g at 175 cycles per second.

The new tubes are electrically equivalent to the 85A2, the 90C1, and the 150B2. They are available in two forms, one with pins and one with flying leads. Flying leads are desirable because, since they can be soldered firmly in place, variations in contact resistance such as are encountered when plug-in types are subjected to vibration are eliminated. Such variations give rise to noise and minute voltage fluctuations which degrade the high performance of a voltage reference tube. The fact that replacement is more difficult mechanically than with plug-in types is of little importance in view of the long life of these tubes.

The type numbers of the new Special Quality stabilisers are as follows.

The M8098 and M8142 are electrical equivalents of the Mullard 85A2 voltage reference tube (CV449). M8098 has a pin base and M8142 a flying lead base.

The M8206 and M8207 are pin base and flying lead base equivalents respectively of the Mullard 90C1 voltage stabiliser.

The M8163 and M8208 are pin base and flying lead base equivalents of the Mullard 150B2 voltage stabiliser (CV2225). (*Continued at foot of next column*)

MULLARD JUNCTION TRANSISTORS TYPES OC70 AND OC71

Although the properties and advantages in certain applications of transistors are well-known, a limiting factor to their more widespread utilisation has to date been the difficulty of obtaining uniformity of performance and properties in the quantity production of such items.

Mullard have devoted very considerable research to the solution of this specific problem and two junction type transistors (types OC70 and OC71) are the successful outcome of this work. These two transistors are now being made available in large quantities and maintain a degree of consistency hitherto unobtained.

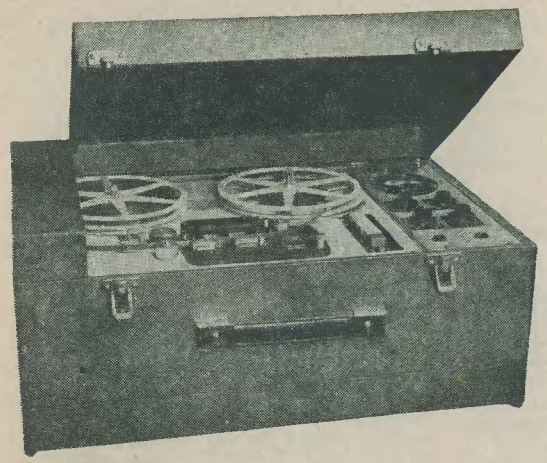
Junction transistors have definite inherent advantages over the earlier point-contact types. They have improved stability and reliability and, in addition, two other advantages enabling them to be used for all stages of audio frequency work; namely, their low circuit noise and complete freedom from microphony. One of their earliest successes in fact has been their application to hearing aids, in which they are widely used.

Amongst the many other applications of Mullard junction transistors on which investigations are being actively progressed are those in telephone circuits and computers.

The OC70 and OC71 are low-power transistors. Whilst the OC70 is intended for use in microphone input and amplifying stages, the OC71 can also be used as an output stage for telephone earpieces and hearing aids.

A special process of fusion sealing provides an all-glass fully hermetically sealed envelope. These envelopes measure about 0.6 in. long and 0.25 in. in diameter for both types.

Full scale production of these important new additions to the Mullard special quality range will commence early in the New Year.



THE *Paragon* TAPE RECORDER

By **J. W. WALKER**

ONE OF THE MOST INTERESTING AND fascinating hobbies available to the radio enthusiast at the present moment is that provided by the construction and operation of tape recording equipment in the home. It is, of course, possible to purchase tape recorders as completely manufactured units; but these suffer from the disadvantages that they are liable to be more expensive than the home-constructed version, and that they offer none of the satisfaction which is obtainable from equipment which has been built entirely by the user.

The Paragon has been designed expressly for the home-constructor. It incorporates a home-built amplifier and power-pack, these being used in conjunction with the popular and well-tried Truvox tape-deck. Although the circuit of the amplifier is fairly simple, it has not been skimped in any way; and it is capable of giving more than adequate gain for the purposes for which it is required, with excellent quality of reproduction. A comprehensive tone control is incorporated, and especial attention has been paid to stability. The result of these points of design is that, provided a reasonable amount of care is observed during its construction, the amplifier should give no trouble in use whatsoever.

The erase and bias circuits have been the subject of considerable attention also. It appears that some constructors have had difficulty in the past in obtaining satisfactory erase and bias components or circuits. The Paragon recorder utilises the newly-released Allen Tape Deck Oscillator Coil (type TD031), and this component is especially suitable for working with the Truvox tape-deck.

The Circuit

The circuit of the amplifier and oscillator is shown in Fig. 1. As may be seen from this diagram, the amplifier proper consists of three pentodes in cascade.

The first of these, V1, is the low-hum, low-microphony, EF86. This valve represents an excellent choice for this position since it enables a high degree of gain to be obtained at low signal levels. In the Record position of switch S1 (a) the grid of V1 is connected to Input Jack A, thereby offering a high-impedance input for low-level programme sources. This input jack is intended for direct connection to a crystal microphone or to a moving coil microphone fitted with its own step-up microphone transformer. In the Neutral position of S1 (a) the grid of V1 is earthed; whilst, in the Playback position, it is taken, via S1 (b), directly to the high impedance Record/Playback head of the tape-deck.

The output of V1 is applied, via the "break" contact of Input Jack B, to the grid of V2. Input Jack B is intended for high level recording inputs, such as would be provided by a radio tuner unit, etc. (It is hoped to describe a simple crystal diode

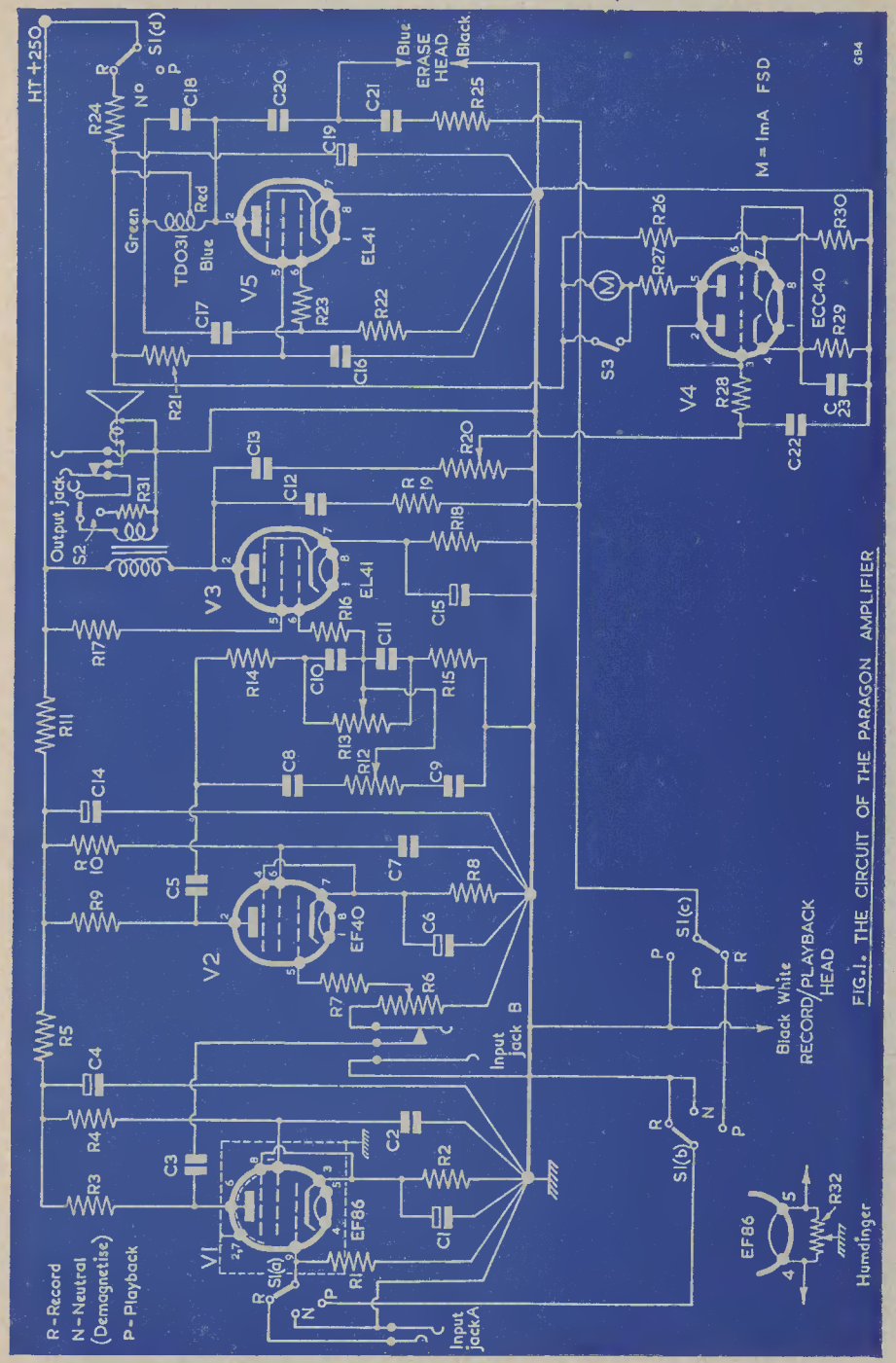


FIG. 1. THE CIRCUIT OF THE PARAGON AMPLIFIER

tuner at the end of the articles devoted to this recorder). It will be noted that, when a plug is inserted into Input Jack B, V1 is disconnected from the amplifier.

The output of V2 feeds into a comprehensive tone correction circuit, the controls for which are provided by R12 and R13. These two potentiometers are brought out to the front panel and, by suitable combinations of their settings, are capable of offering a considerable degree of tone control. R12 provides an adjustment of top level response, whilst R13 provides a similar adjustment of bass level. It is recommended that these two controls be fitted with calibrated scales (such as Panel-Signs) to ensure that previous settings can be repeated at any time. It should be noted that they are in circuit both during recording and during playback.

The output of the tone control network connects to the grid of the output valve, V3. This valve feeds into the speaker switching network and, when S1 (c) is in the Record position, to the Record/Playback head as well. The speaker switching is provided by S2 and Output Jack C. The function of S2 is to switch the output transformer secondary either to the loudspeaker or to a load resistor, R31. This facility is essential as, otherwise, it would be impossible to operate the recorder with a microphone in the same room without experiencing acoustic feedback. Further switching is provided by Output Jack C, this allowing headphones, an alternative speaker, or monitoring equipment to be connected to the output circuits in place of the internal loudspeaker. The impedance of whatever equipment is plugged into Output Jack C should be approximately 3 ohms. If headphones are used, this impedance may be obtained by connecting a suitable resistor across the contacts of the plug. When a plug is fitted to Output Jack C, the internal loudspeaker is, of course, automatically taken out of circuit.

Volume Level Indicator

Volume level indication is provided by the double triode, V4, this being employed in conjunction with a 1mA FSD moving-coil meter. V4 and its circuit function in the following manner.

A proportion of the AF voltages appearing at the anode of V3 are passed, via the preset potentiometer R20, to C22. This condenser acts partly to provide top-cut; but its primary purpose is to partially short-circuit the steady high frequency bias voltage present at the Record/Playback head. This steady voltage would otherwise upset the functioning of the volume level circuit.

The filtered AF is then passed to the effective diode formed by strapping the grid and anode of the left hand triode of V4. This diode conducts on positive half-cycles, causing C23 to charge to peak voltage. Further attenuation of the high-frequency bias voltage is offered by C23 as well, this working in conjunction with the series resistor R28.

The condenser C23 is shunted by the high-value resistor R29. This resistor allows C23 to charge up to peak AF voltages quickly; and ensures that it discharges slowly. The rectified AF voltage obtained across C23, therefore, is proportional to the peaks provided by the programme source. If not allowed for, such peaks could overload the Record/Playback head.

The varying rectified voltage appearing across C23 (which is positive with respect to chassis), is next applied to the grid of the right hand triode of V4. This triode functions as a simple valve voltmeter. In the absence of voltage across C23, the grid of the right hand triode is at chassis potential. Its cathode, however, is kept at positive potential with respect to chassis by the fixed potentiometer provided by R26 and R30 in series across the HT supply. The positive cathode potential thus obtained is sufficient to keep the triode at cut-off point or slightly beyond. On the arrival of AF to the left hand "diode" of V4, C23 charges, causing a positive voltage to be applied to the right hand grid. The right hand triode now conducts and its anode current, measured by the meter, gives an indication of the voltage built up across C23.

In use, the milliameter should be given an arbitrary marking (say, at the 0.8mA reading), after which R20 should be adjusted such that this level corresponds to the optimum output voltage which may be applied to the tape without distortion or overloading.

The volume indicator arrangement functions only when S1 is in the Record position. In the other two positions of this switch, the HT supply to the indicator is cut off.

A further facility is provided by S3. This short-circuits the meter for instances in which external monitoring equipment provides a means of checking volume level.

The Oscillator Circuit

The oscillator portion of the recorder incorporates an EL41 valve, this working with the Allen TDO31 oscillator coil. The Allen coil is a high-grade, screened, component; and it provides an RF voltage of excellent waveform. It may be noted that the screen-grid dropping resistor, R21, has a fairly high value. This value is quite permissible, since the screen-grid current taken

Components List—Set out for Easy Reference to Fig. 1.

Resistors
(All ¼ watt unless otherwise stated.)

R1	4.7 MΩ
R2	1.7 kΩ
R3	200 kΩ
R4	1 MΩ
R5	22 kΩ
R6	2 MΩ Pot'meter
R7	22 kΩ
R8	1.7 kΩ
R9	100 kΩ
R10	270 kΩ
R11	22 kΩ
R12	100 kΩ Pot'meter
R13	1 MΩ Pot'meter
R14	100 kΩ
R15	10 kΩ
R16	22 kΩ
R17	680 Ω 1 watt
R18	180 Ω
R19	100 kΩ
R20	50 kΩ Pot'meter
R21	47 kΩ 1 watt
R22	47 kΩ
R23	20 kΩ
R24	100 Ω 1 watt
R25	20 kΩ
R26	500 kΩ 1 watt
R27	82 kΩ
R28	82 kΩ
R29	10 MΩ
R30	27 kΩ
R31	3 Ω ½ watt
R32	50 Ω (Miniature humdinger)
R33	500 Ω 10 watt

Condensers
(All TCC. Type number in brackets.)

C1	50 μF 12V (CE77B)
C2	0.1 μF 350V (343)
C3	0.1 μF 350V (343)
C4	32 μF 350V (CE19LE)
C5	0.1 μF 350V (343)
C6	50 μF 12V (CE77B)
C7	0.1 μF 350V (343)
C8	0.005 μF 350V (383)
C9	0.02 μF 350V (346)
C10	0.005 μF 350V (383)
C11	0.005 μF 350V (383)
C12	0.1 μF 350V (343)
C13	0.01 μF 350V (343)
C14	8 μF 350V (CE17LE)
C15	25 μF 25V (CE77C)
C16	0.5 μF 350V (343)
C17	0.002 μF 350V (383)
C18	0.002 μF 350V (M2N)
C19	16 μF 350V (CE19L)
C20	0.1 μF 350V (343)
C21	0.002 μF 350V (383)
C22	0.001 μF 350V (383)
C23	0.1 μF 350V (343)
C24, C25	16 + 16 μF 450V (CE35PE)

Inductors

Smoothing Choke	Electrovoice 101C
Mains Transformer	Electrovoice 104B
Speaker Transformer	Allen Components OP1215
Tape Deck Oscillator	Allen Components TD031

Jacks and Plugs, etc.
Jacks (with break contacts), miniature, bakelite, 3—H. L. Smith, Edgware Rd.
3-way plugs and sockets, Miniature, 2 of each—H. L. Smith, Edgware Rd.
Mains 2-way socket, flush-fitting, and plug for same, 1 of each—Bulgin
(Also 2-way speaker plug and socket and 2-way terminal block, if required).

Meter
1 mA moving coil.

Cabinet
"Paragon" cabinet—H. L. Smith, Edgware Rd.

Switches
S1, 4-pole, 3-way wafer (see text)—H. L. Smith, Edgware Rd.
S2, SPDT, toggle
S3, SPST, toggle
S4, DPST, toggle (with recessed panel if required)

Speaker
Truvox, "Wafer," 6 inch. (see text of Article 2)

Tape Deck
Truvox, Mk III U

Sundries
¼ in. knobs (pointer type)—4
¼ in. spindle couplers, plain—3
¼ in. spindle, 6 ins.—3 lengths

Valves (All Mullard)

EF86	1
EF40	1
EL41	2
ECC40	1
GZ32	1

Valveholders
All McMurdo (type nos. in brackets)
Rimlock (BM8/E)—4
Noval (BM9/UD1)—1
Screening can (8/105)—1
Int. Octal (B8/U)—2
Int. Octal Plug (L8/USP)—1
(1 octal plug and socket are used for power connections)

Transfers
Panel-Signs Set No. 1

by the EL41 is not high. There is, in other words, no necessity to drive the valve to its limits in order to obtain satisfactory bias and erase voltages.

It will be noticed that the HT supply to the oscillator is taken via a 100 ohm resistor, R24, this being connected to a 16μF electrolytic condenser, C19. The purpose of this circuit arrangement is to allow oscillations to die away gradually after the HT supply to the oscillator has been switched off. Thus, at the instant when S1 (d) is moved from the Record position, C19 holds a charge from the HT supply. As the condenser discharges the HT voltage applied to the oscillator valve drops, thus allowing a gradual fall in oscillator voltage. If this procedure were not adopted it could be possible to switch off the oscillator in mid-cycle; whereupon the head it supplies might retain the magnetic field induced at that moment. The purpose of R24 is to limit the heavy current surge which would otherwise flow when C19 is connected by S1 (d) to the HT supply.

The RF supply to the Erase head is obtained direct from the anode of V5 via C20. This head receives the full RF output. Only a small amount of RF is needed at the Record/Playback head, however, and the necessary attenuation is provided by C21 and R25.

It was stated above that the HT supply to the volume level indicator is broken when S1 (d) is moved from the Record position. This is achieved by the simple process of obtaining the volume level indicator HT from the oscillator HT condenser C19.

Switch S1

As will have been gathered, switch S1 performs a most important function in the tape recorder. This switch has three positions: Record, Neutral, and Playback.

In the Record position, S1 (a) connects the grid of V1 to Input Jack A, thus allowing a microphone, or other programme source, to be connected to this valve. Switch arm S1 (b) earths the lead from S1 (a) which, on Playback, would connect to the grid of V1; and switch arm S1 (c) connects the output of V3 (via C12 and R19), to the Record/Playback head. S1 (d) applies HT to the erase oscillator and volume level indicator.

In the Neutral position, S1 (a) earths the grid of V1, and S1 (b) makes the same earthing connection as was provided in the Record position. S1 (c) still keeps the Record/Playback head in circuit, however; this being done to prevent the abrupt cessation of bias RF voltages to this head. Switch arm S1 (d) removes the HT supply to the erase oscillator, etc., as has been described above.

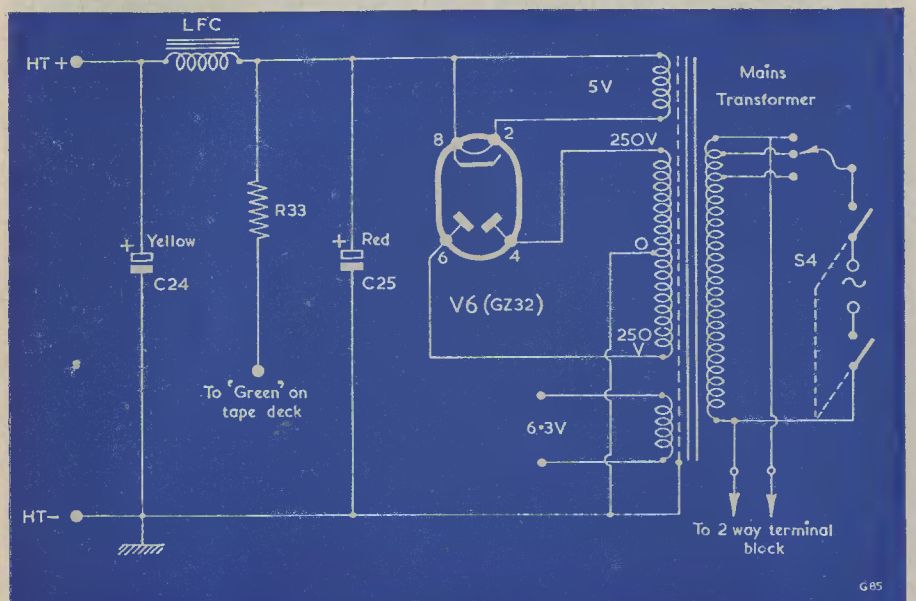


FIG. 2. THE POWER PACK EMPLOYED WITH THE PARAGON TAPE RECORDER

The third position, that of Playback, sets up the amplifier for its reverse function. S1 (a) and S1 (b) connect the grid of V1 to the Record/Playback head. S1 (c) earths the AF feed previously applied to this head, whilst S1 (d) still prevents the application of HT to the erase oscillator.

It should be mentioned at this point that it is advisable to use a wafer switch, or a combination of wafers, to provide the functions of S1. This course is recommended as the capacity between contacts of such switches is low and the risk of feedback between the output and input of the amplifier consequently reduced. "Miniature" switches, whose self-capacity is high, should not be used.

The Power Pack

The circuit of the power pack is shown in Fig. 2. As may be seen, this is conventional, consisting quite simply of a mains transformer, a full-wave rectifier, and two smoothing condensers. A 6.3 volt supply is also provided. The 6.3 volt supply, incidentally, is not earthed in any way at the power pack chassis. Instead, it is connected to a hum-dinger, (R32 of Fig. 1) on the amplifier chassis.

An unusual feature of the power pack is the high-wattage resistor, R33. Braking on the Truvox tape-deck is achieved by applying a direct current to the motor windings for a short period. This current is obtained from the power pack via R33. The immediate braking current is rather high, around 150 mA, but the power pack components specified will cope with this short-time load. Nevertheless, this does not infer that the brake button should be kept depressed for over-long periods whilst the tape-deck is in use.

Next Month

In next month's article, constructional details of the Paragon will be commenced.

CLUB NEWS

CLIFTON AMATEUR RADIO SOCIETY

January Programme

7th, Junk Sale; 21st, Discussion; 14th and 28th, Constructional Evenings. Meetings commence at 7.30 p.m. and are held at the clubrooms, 225 New Cross Road, S.E.14. Hon. Sec.: C. H. Bullivant, G3DIC, 25 St. Fillans Road, Ca ford, S.E.6.

SOUTHEND AND DISTRICT RADIO SOCIETY

Forthcoming Events

7th January, Probable subject "Tape Recording"; 21st January, A.G.M.; 4th February, Visit to Barking Power Station; 1st April, Judging for Pocock and Hudson Cups; 9th April, Hamfest at a London Hotel; 1st May, D/F National qualifying event organised by Southend. Hon. Secretary: J. H. Barrance, 49 Swanage Road, Southend-on-Sea.

THE TELEVISION SOCIETY

Programme for January as follows:

Thurs.–Sat. Jan. 6–8, Annual Exhibition; Wed. Jan. 19, The Fleming Memorial Lecture, "The Perception of Colour," to be held at the Royal Institution, Albermarle Street, W.1, commencing at 7 p.m. Tickets may be obtained from the office of the Society, 164 Shaftesbury Avenue, W.C.2.

WEST LANCASHIRE RADIO SOCIETY

The club meets every Tuesday evening at 8.15 p.m. over Gordons' Sweet Shop, corner of St. John's Road, Waterloo. The winter programme includes: Morse classes, Radio Amateur Exam. classes, lectures and Junk Sales. Details from the Hon. Secretary, S. Turner, 5 Balfe Street, Seaforth, Liverpool, 21.

The Editor and Staff would like to thank the many Readers who so kindly sent us Christmas Greetings from all parts of the world.

SUPERHETS WITH REACTION

By **G3XT**

THE IDEA OF ADDING A REACTION WINDING to an IF transformer in a superhet seems to be becoming increasingly popular. No wonder—for reaction is one of the few things in radio that really gives you something for nothing! It gives a great increase in signal strength and a marked improvement in selectivity, without adding to the number of valves required or increasing the current consumption of the set.

In fact, it may actually reduce the number of valves needed, by enabling one to dispense with an IF amplifying valve and all its associated components, thus effecting a considerable saving in cost. The reaction may not give quite such good results as an IF valve would, but if one does not mind sacrificing a little volume this is justified by the saving of expense.

Two typical circuit arrangements for adding reaction to a superhet are shown in Figs. 1a and 1b. In both of these it is necessary to add a reaction winding close to the secondary of the IFT (on the opposite side to the primary) and the purpose of this article is to show how this can be done with a minimum of trouble.

Fifty turns of 36 swg enamelled wire will probably be found just right for the additional winding. If you get no reaction, or unstable reaction, you will need to reverse the connections to the reaction coil, just as you would in dealing with an ordinary straight set.

With the older and bulkier types of IFT, such as those found in certain ex-Government units, the primary and secondary windings are arranged side by side and a little distance apart, as shown in Fig. 2. The secondary is perfectly accessible, there is plenty of room in which to add the supplementary winding, and no detailed instructions are necessary.

But if (as is more probable) you are using an up-to-date type of midget IFT, having a tiny screening can (smaller than the lower half of your thumb) containing the two windings, two silver mica condensers and an iron-cored former, the job becomes extremely tricky and difficult.

The secondary winding is located at the bottom, is surrounded on two sides by the condensers, and the fine-stranded Litz wire ends of the two windings are soldered to thicker wires rising from the corners of the bakelite base. The secondary is therefore completely inaccessible, and it seems as if the only way to put on the new winding is to dismantle the whole transformer.

If you succeed in dismantling, re-assembling and soldering *properly* the Litz wire (the individual wires of which are finer than a hair) without doing any damage, you will be very lucky. Personally, I found it a difficult job, even with a large magnifying glass fixed over the work; and on two occasions I ruined a brand-new IFT through the fine wire end breaking off at the point where it emerges from the inner end of the winding.

After these two disasters, I decided in future to adopt an easy way out of the problem, and in spite of any theoretical objections the experts may think up I found that it worked quite all right in practice!

All I did was to call the primary the secondary, and the secondary the primary! By "swopping over" the windings in this way, the secondary becomes the upper one, which is easily accessible *without* dismantling the whole assembly. All you have to do is to wind, as neatly as possible, the requisite number of turns on the protruding end of the bakelite former, insert two pieces of 18 swg connecting wire as a tight fit through two holes drilled in the bakelite base, and solder the ends of the reaction windings to these. Replace the screening can, and the job is done. Fig. 3 shows the finished arrangement before replacing the screening can.

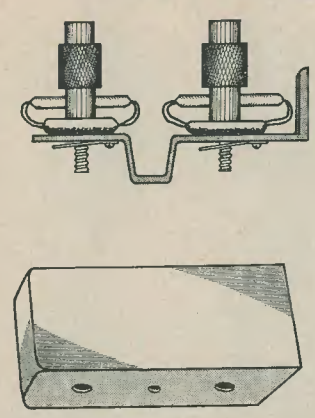


FIG. 2. The older bulkier types of IFT such as this, are easy to provide with a reaction winding as both primary and secondary are accessible

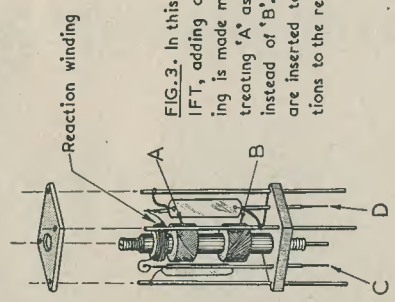


FIG. 3. In this typical midget IFT, adding a reaction winding is made much easier by treating 'A' as the secondary instead of 'B'. Wires 'C' & 'D' are inserted to make connections to the reaction coil

G86

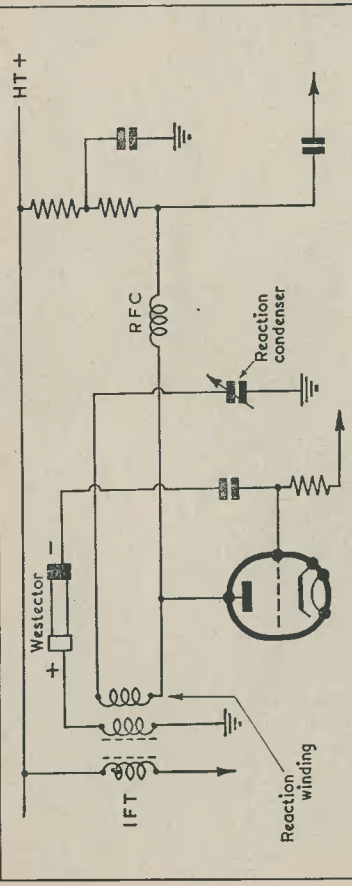


FIG. 1 (a) A typical circuit arrangement incorporating a reaction winding added to the IFT secondary

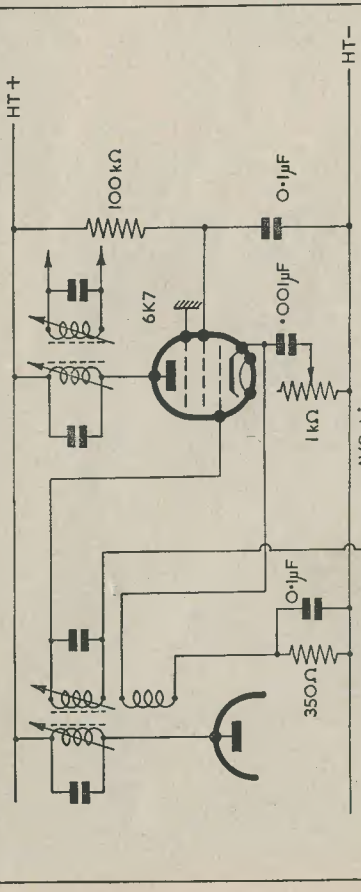


FIG. 1 (b) Typical circuit arrangement showing reaction applied to an IF stage

FREQUENCY MODULATION TUNER UNIT FOR FRINGE AREAS

By **W. GORDON**

MANY READERS HAVE BUILT THE Frequency Modulation Tuner Unit which was featured in the July and September issues of *The Radio Constructor*. Some weird and wonderful versions were produced, the favourite valve employed being the EF50. The circuit, however, proved to be very tame and so good results were achieved. Other constructors driven by the amateur spirit were not daunted by the fact that they were on the edge of the service area, and now many tuners are in use at more than 60 miles from Wrotham. Indeed, one at 80 miles distance, near Portsmouth, although shielded by hills from the station, is working well; and what is more important, is giving better reception than is achieved on the Medium wave programme. All this gives promise of good reception at greater distances.

An extra IF stage has been added in the Tuner Unit described in this article, to increase the sensitivity, and it is expected that good results will be obtained up to perhaps 150 miles under favourable conditions.

In order to help other constructors, readers who build this tuner unit are invited to report the results. *The Radio Constructor* is offering prizes for the best and most useful reports received; full details can be found on page 366. The best reports will be published in later issues of this Magazine, and will undoubtedly prove very useful in establishing the practical limits of the Wrotham service area.

The Circuit

The circuit is very similar to that shown in the September issue. The RF valve has been changed to an Osram Z719 to increase the gain before the frequency changer. An extra IF stage with a bias resistor of 1,000Ω in its cathode has been added after the frequency changer. Despite the considerable increase in IF gain, the circuit has proved very stable providing the layout shown in the photograph is carefully followed. It is very important to keep the bypass condenser leads short—not more than $\frac{3}{8}$″ long. Make all earth connections to the chassis as short as possible, using solder tags under the valveholder mounting nuts.

One side of the heater connections nearest the anode terminal of the Z77 must be grounded. This is to prevent harmonic feedback from the limiter and ratio detector into the aerial circuit. This is likely to be the biggest problem to be encountered, due to the very high end-to-end gain. The shield across the chassis is also necessary for the same reason, as is the filter circuit R19–C32 in the AVC line.

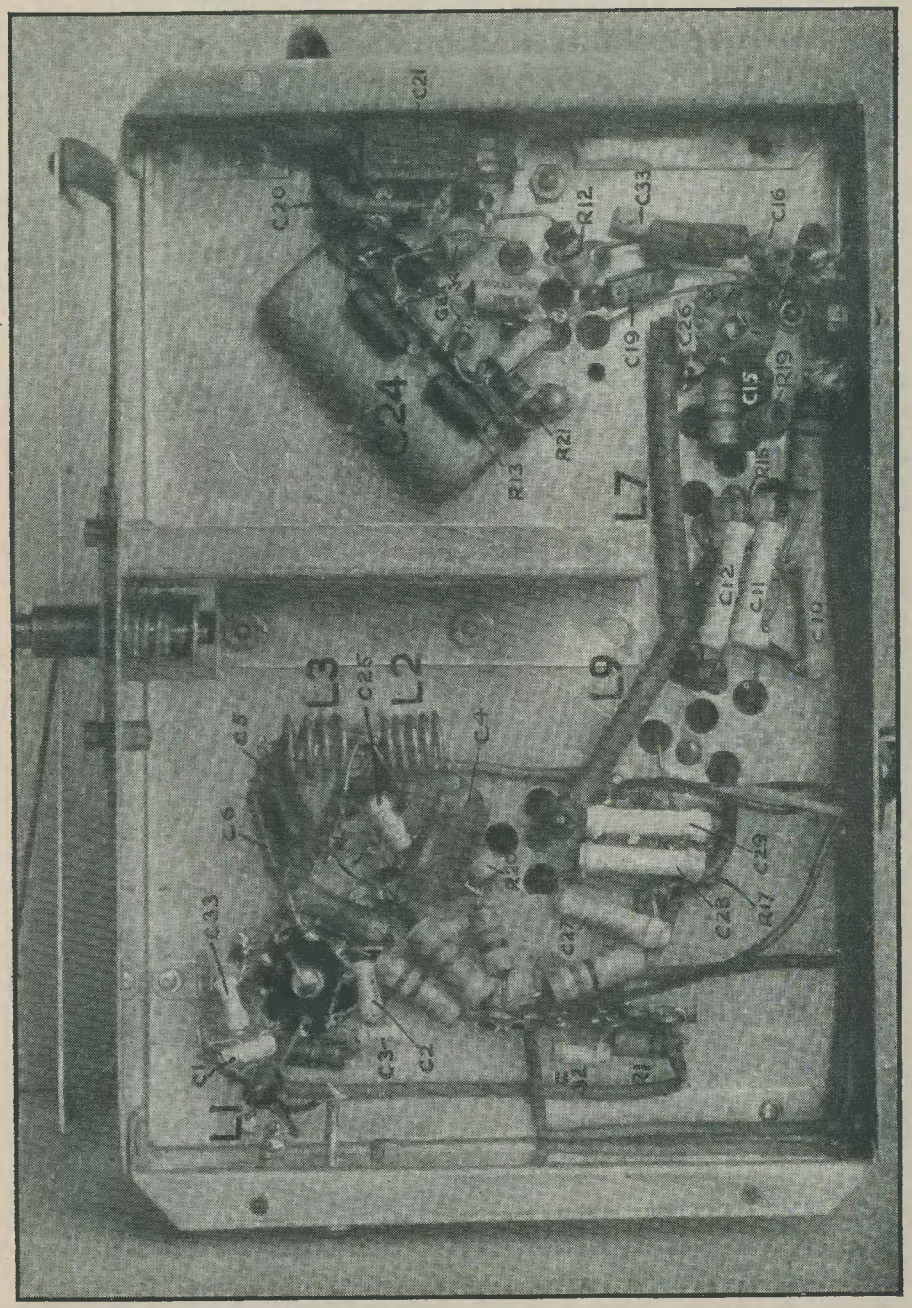
The coil details are exactly as shown in the July issue, except that L3 has 4 turns only and no tap, as explained in the September issue. Note carefully that it is the IF coil L5 which has the smallest spacing ($\frac{1}{8}$″), while L4 and the new IF L8 have $\frac{3}{16}$″ spacing.

Two heater chokes are required. L7 is, as before, $1\frac{7}{8}$″ long wound on a $\frac{1}{8}$″ former with as many turns as possible in this length, whilst L9 is shorter ($1\frac{3}{8}$″) to improve the layout.

Note the use of the two cathode pins of V1 with two separate bypass condensers, the grid bypass being taken to one and g_2 bypass to the other to minimise negative feedback in the valve. This results in an extra gain of 2x approx. in this stage.

The heater supply is fed in at V3. It should not be fed in at V4 as there is likely to be a considerable amount of IF harmonic which will be radiated into the aerial by the heater leads. Also, the shield of the audio lead should be connected direct to chassis immediately on entering, since it was found that this lead also acted as a harmonic radiator if connected further in.

The actual values of the bypass condensers are not important, size being the



Underneath layout of the FM Tuner Unit, fringe area version, with identification of the main components.

main criterion. For instance, C1, C2, C3 etc. should be not more than ⅜" long and ¼" diam., but the value in this size may be between 1,000 and 3,900pF. The larger condensers should be not more than ⅞" long and ¼" diam., the value being between 5,000 and 10,000pF. Indeed, many of these condensers have a tolerance of –0 +100%! They are specified this way because if the bypassing is not adequate instability may result, but no harm can come of having too great a capacity.

The Aerial

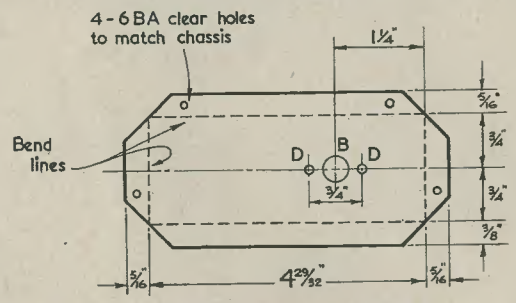
This may be constructed from ¼" diam. dural rod with the dimensions shown in the table. "T" section dural may be used to hold the elements together; 1" approx. section is suitable. A rectangular piece of bakelite may be used to insulate the dipole; the size can be approx. 2" square and ¼" thick, and it should be mounted diagonally on the arm. If mounted outdoors, all the parts should be covered with thick paint, including the joint to the coaxial cable.

Variations of Layout of Standard Set

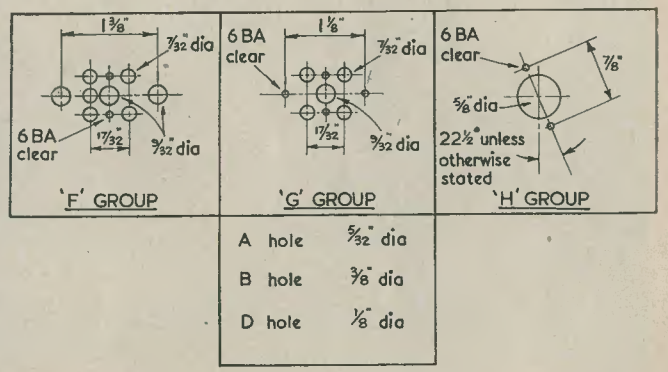
EF50's have been used successfully, and also the Z719 may be used in the RF stage as in the fringe area version described above. The aerial coil as described previously is suitable for these valves. If a 6AK5 is employed in the RF stage, this coil is not suitable because the grid capacity is lower. As the input impedance is higher, a looser coupling of the aerial coil may be used. The same former as for the IF coils may be used, but cut off to about ½" long. 5 turns of 26 swg DSC wire are required, with 1 turn on the aerial coil.

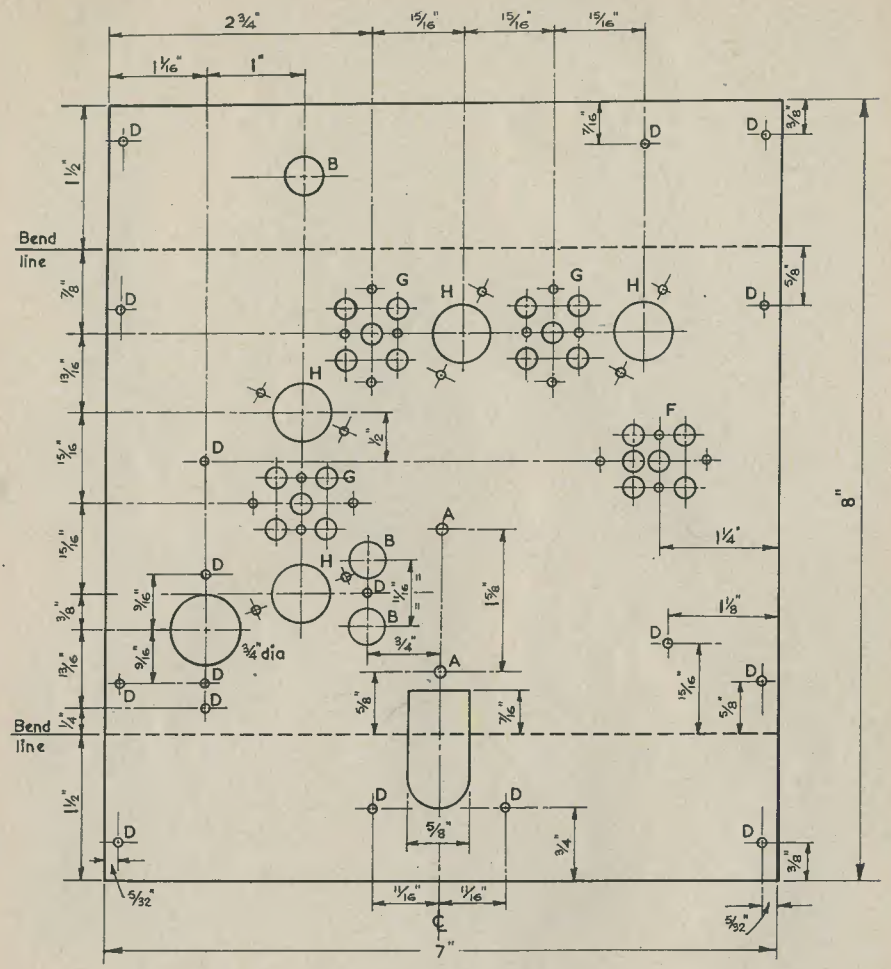
One important point about the layout—the resistor R1 must be mounted close to the IF coil and condenser C15. If this is not done, the connecting lead will act as a radiating aerial using bottom capacity coupling from the limiter grid circuit. This will be picked up at the frequency changer grid and cause IF instability. This circuit is normally very stable except for this point, and one other; the decoupling condensers C11 and C12 must make a total value of 10,000pF, and one condenser may be used. Either a ceramic or a non-inductive metallised paper condenser of small physical size is suitable. A mica condenser is usually too large, and normal paper condensers are inductive. The use of either of these two latter types will certainly produce instability.

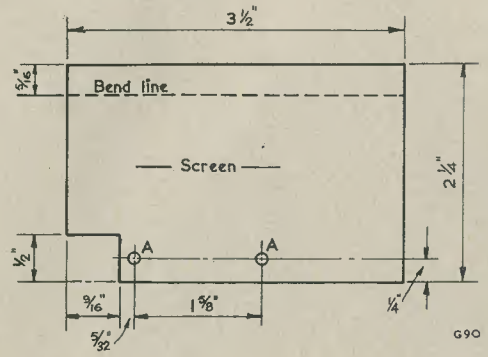
When mounting the IF coils it is unimportant whether the anode coil is at the top or bottom, because the coil is perfectly symmetrical. What is more important is that the coils and valveholders should be mounted as shown in the drawings and photographs so that the lead from the coil goes direct to the appropriate contact of the valveholder.



END BRACKETS - OUTSIDE VIEW







CHASSIS & SCREEN
Dimensional details

If the coil connections are made long by wrong mounting, instability may result because these leads radiate the IF signal and this will be picked up in the early stages.

AERIAL DETAILS

Dipole: 5′ total length, ¼″ spacing in the centre.
Reflector: 5′ 4″ long. **Director:** 4′ 4½″ long.
Dipole to Reflector Spacing: 2′ 8″.
Dipole to Director Spacing: 1′ 7″.

COMPONENT LIST

Set out for Easy Reference to Circuit Diagram on Facing Page.

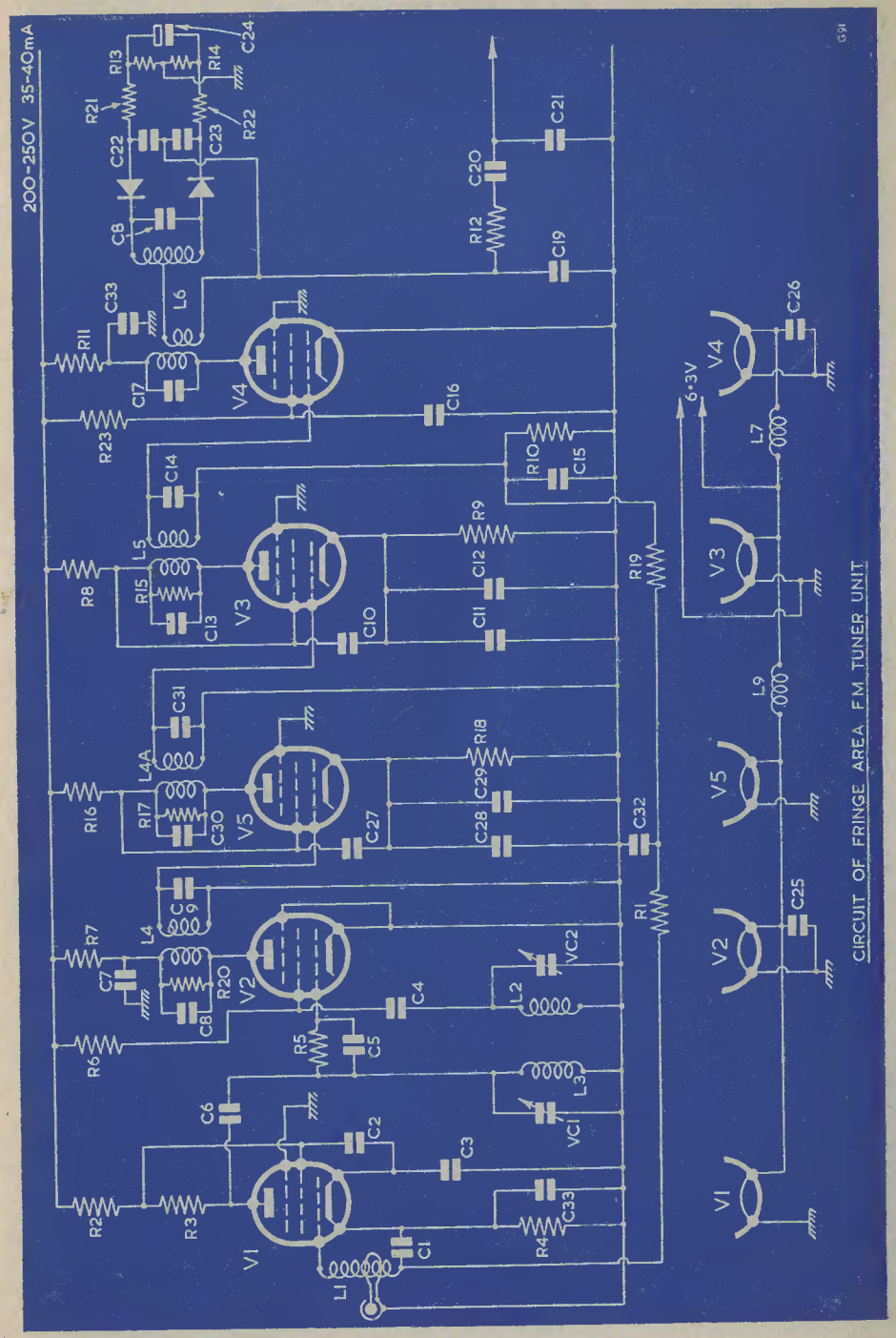
R1	100kΩ	C13	15pF silvered mica
R2	4.7kΩ ½W	C14	15pF silvered mica
R3	6.8kΩ ½W	C15	47pF silvered mica
R4	270Ω	C16	5,000pF ceramic
R5	100kΩ	C17	15pF silvered mica
R6	47kΩ ½W	C18	47pF silvered mica
R7	4.7kΩ ½W	C19	200–300pF mica or ceramic
R8	4.7kΩ ½W	C20	0.05 paper 350V wkg
R9	150Ω	C21	500pF mica or ceramic
R10	47kΩ	C22	200–300pF mica or ceramic
R11	47kΩ ½W	C23	200–300pF mica or ceramic
R12	100kΩ	C24	8μF electrolytic 150V wkg
R13	10kΩ	C25	1,000pF ceramic
R14	10kΩ	C26	1,000pF ceramic
R15	47kΩ	C27	5,000pF ceramic
R16	4.7kΩ ½W	C28	5,000pF ceramic
R17	47kΩ	C29	5,000pF ceramic
R18	1,000Ω	C30	15pF silvered mica
R19	100kΩ	C31	15pF silvered mica
R20	47kΩ	C32	1,000pF ceramic
R21	1,000Ω	C33	5,000pF ceramic
R22	1,000Ω	VC1–2	Split Stator 25pF+25pF Jackson Bros. type U101.
R23	100kΩ		
Resistors all ¼W unless otherwise stated.		Dial	Jackson Bros. full vision drive type 2154 fitted with scale type 4838.
C1	1,000pF ceramic	Valves	V1 Osram Z719
C2	1,000pF ceramic		V2 Osram Z77
C3	1,000pF ceramic		V3 Osram Z77
C4	47pF silvered mica		V4 Osram Z77
C5	27 or 33pF silvered mica		V5 Osram Z77
C6	27 or 33pF silvered mica	Crystal diodes G.E.C. GEX34.	
C7	5,000pF ceramic	Chassis Coils complete with silvered mica condensers: alignment service,—The Jason Motor and Electronic Company, 328 Cricklewood Lane, London, N.W.2.	
C8	15pF silvered mica		
C9	15pF silvered mica		
C10	5,000pF ceramic		
C11	5,000pF ceramic		
C12	5,000pF ceramic		

BIB RECORDING TAPE SPLICER

Retail Price 18/6. Marketed by Multicore Solders Ltd., Multicore Works, Hemel Hempstead, Herts.

The Splicer, which is most attractively packed, is made from nickel plated brass and is mounted on a flock sprayed base-board. A razor cutter is included and this fits conveniently underneath the Splicer. If desired, the Splicer can be removed from the base-board and mounted directly on the deck of a tape recorder so that the cutter can also be kept underneath the Splicer in its permanent position. A comprehensive instruction leaflet is included with each Splicer and this leaflet includes some useful information on how to edit recorded tape somewhat in the same way as cine film enthusiasts edit their films.

The body of the Splicer has 2 pivoted clamps which lock into position to hold the lengths of tape firmly in a channel which is of the exact width to accommodate the standard size of recording tape. After the 2 tapes have been put in position and locked, the razor cutter is drawn across a diagonal slit which is provided in the channel so that both pieces of tape are cut simultaneously. A piece of ¼″ cellulose tape is then placed across the cut tapes and pressed down firmly on to the Splicer each side of the recording tape. The cutter is then applied to lateral slits on each side of the recording tape and the surplus tape removed. After the 2 clamps have been lifted up it will be found that a perfect joint has been made.



Radio Miscellany

MORE NEWS FROM THE VETERANS, AND my thanks to those of them who have sent along bits and pieces presented as free gifts with radio periodicals in bygone years. Our old friend, Mr. Charles Brewer of Blackpool, who was responsible for the revival of this theme, has also dug deep and sent along more bits of history.

The collection now includes an enamelled 6" rule, also in centimetres, with a conversion scale on the back reading in kc/s and metres. It only goes down to 125 kc/s, as short waves were thought to have little practical value in those days. Given with *Wireless and TV Review*.

A metal drill gauge for 14 drill point sizes, with a 5-pin drilling template (memories of ebonite panels!) and a "V" cut for wire stripping.

Another, a *Popular Wireless* cardboard World-clock and lightning calculator.

Two open-ended spanners (BA sizes).

Several sheets of transfers from *Radio News Bureau* and from *Wireless*, a 40-page booklet "1,001 Radio Hints and Tips" presented with *Popular Wireless*, 21st February, 1931, and something comparatively modern—"Better Reception," given with *Wireless World* (then a weekly) in the issue for 2nd March, 1939.

Several readers have been good enough to say they do not want their museum pieces returned, and are willing for them to be passed on to any readers of Clubs who collect and preserve relics of the earlier days of our hobby.

Eclectic

News also comes to hand regarding the "Wireless" cigarette cards. It seems there are more series than I thought. Those I wrote of as recalling most clearly are apparently *Wireless Explained* issued in 1923, which are getting rare nowadays. I am indebted to the London Cigarette Card Co. for this information, and they, incidentally, offer a special quotation of 30/- for the set of twenty-five to any interested readers.

There are two other series of 1923 vintage, each of 25 cards—"How To Make Your Own Wireless Set" and "How To Make A Valve Amplifier." These are less rare, and can be obtained at 22/6, for either set.

Still less rare, and obtainable for a mere 15/-, is "How To Build A 2-Valve Set," issued in 1929. Dirt cheap, when only the other day a set of cigarette cards changed hands for over a couple of hundred pounds. No one can complain that Radio is an expensive hobby after that!

Irons in the Fire

Among the letters I was surprised to find two correspondents who ranked the electric soldering iron high in the developments that have come the way of the home constructor. I had never thought seriously about it before, but the very wide difference in constructional practice before and after its introduction confirms that it was quite a major event. How would those who find difficulty in making neat and electrically sound joints nowadays, fare with a pre-heated solid bit? Yet they are still widely used, and recently I witnessed an R.A.C. Patrolman by the roadside make a beautiful joint on to the end of a dirty-looking cable.

In the good old days, Editors were continually bombarded with requests for articles on the real secrets of successful soldering. Beginners either complained that (a) the solder dripped off the iron like water, (b) that it turned into a pasty mass, (c) that it couldn't be made to "take," or (d) that the joint came apart at the first touch.

It was not easy to instruct anyone to judge when the iron was at the right temperature, and many of the failures were due to the beginner allowing the bit to oxidise before it was properly tinned. Insufficient cleaning after removal from the heat or lack of preparation of the surfaces to be soldered were also sources of trouble. In those days, pre-tinned tags were unheard of. No wonder the majority of constructors preferred terminal joints and there was a very steady demand for "spaghetti" resistors. Some of the youngsters may be unfamiliar with spaghetti resistors, but they went out when the electric soldering iron came in. They consisted of asbestos string around which fine resistance wire was spirally wound. This was then inserted in a suitable length of sleeving, and brass eyelets were fitted to the ends. They were held in high esteem among the non-solderers as they not only enabled simple terminal connections, but at the same time formed the wiring. High values were often a foot long and low values were rarely less than five inches.

I used to try to encourage the non-solderers by regaling them with stories of how the village handyman of my childhood days used to run perfect soldered seams along sheet metal, with nothing more than a hot poker and bottle of spirits. Even when I swore it was true, they either disbelieved me or put it down to my childhood imagination!

Oddly enough, the normal commercial soldering iron rarely has as much as an on/off switch in its handle.

For Men of Letters

T.C.A. of Loughboro' writes, "Some years ago I remember you gave some hints on letter spacing when printing dial scales and control names, but I cannot trace them. Could they be repeated briefly."

He does not say exactly what he intends to print, and it is difficult to imagine anything not covered by *The Radio Constructor* Panel-Signs. Maybe he is going to engrave them. Incidentally, alphabets of single letters (as well as numerals) are supplied with these transfers, so unusual terms can be made up; and with careful letter spacing, the disjointed effect of much amateur printing can be avoided.

The issue concerned is for August, 1950, when attention was drawn to the fact that letters are never arranged equidistantly.

CENTRE TAP *talks about* FREE GIFTS OF THE PAST SOLDERING IRONS—HAND LETTERING

Have A Go

Readers must not be too scornful of the terminal-and-pliers old timers. It is easy enough to solder nicely tinned wire on to pre-tinned tags with a sleek electric iron. Let them try to make a good joint of thick untinned wire on to a pillar terminal with a plain copper bit and tinman's solder.

Oddly enough, when the electric domestic soldering iron first appeared it was little different from those we know to-day. Unlike most things it had no evolution worth mentioning. The best makes soon settled to a popular price—7/6—including a generous length of cable. Today, manufacturers seem to think 5 feet or so is ample! Very shortly after, cheap Japanese copies appeared on the market, selling at 2/11 and later at 1/11.

The fact that the modern soldering iron is so little different from the early models makes one wonder if the present pattern couldn't be improved. There have, of course been minor improvements, particularly in the home-made variety. I remember some years ago describing how, in a War-time Army Repair Workshop, the design of "improved" electric irons became the rage. They had bits of all shapes and sizes, interchangeable parts, switched elements for varying the heat, pistol grips and trigger switches; and many were self-feeding or self-balancing when laid on the work-bench.

If they are, the result looks higgledy-piggledy. The "evenness" is only apparent, and the following rules should be observed whether hand printed or made up from Panel-Signs.

The widest spacing is left between straight stems, such as HE, ND, ME, etc.

A smaller space is left between a straight vertical and a curved letter, such as ON, DE etc.

A still smaller space is left between two curved letters, such as DO, OG, etc.

With combinations of letters such as VO, LT, AY, etc., there need be no spacing at all between the *extreme* points of the letters, but these points should not on any account be allowed to overlap.

Wording which follows these simple rules takes on a harmonious form and looks like a word—not a jumble of letters.

Where the terms to be printed have two words (such as Volume Control) and it is necessary to use two lines, care must again be taken about the line spacing. Too narrow it looks cramped, too wide it looks incoherent. About a quarter or a third of the letter height will usually be about right, depending on the width of the letter spacing.

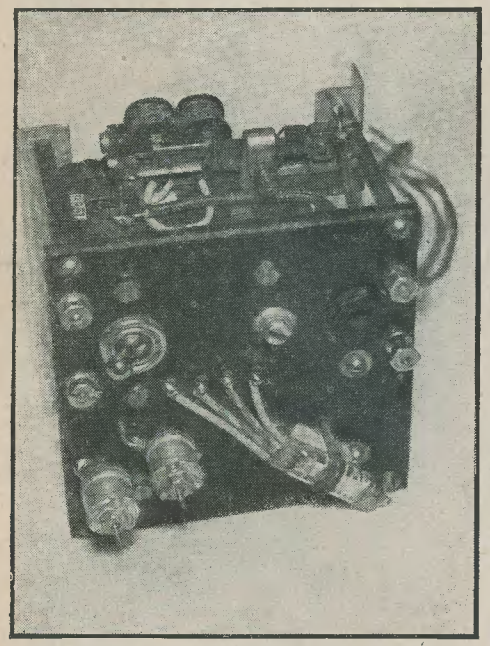
By the way, when making up words with individual letters from Panel-Signs, it is a good plan to first stick the letters on to a piece of tissue paper with thin paste, and then transfer them in position on the panel as a whole.

NOTES ON RADIO CONTROL

3: A 3A4 RECEIVER

By **QUENCH COIL**

LAST MONTH WE DESCRIBED A RADIO control receiver using the Hivac XFG1 gas-filled triode type of valve. The miniature hard valves available nowadays also lend themselves very well to R/C use and the receiver described this month uses a type 3A4 valve. But before we pass on to this circuit, a few words about possible difficulties which may have been experienced with the gas triode circuit.



Another version of the XFG1 Receiver described in the last issue.

Faults in XFG1 Receiver

If no current reading is shown on the meter, check all components and battery voltages. Try another valve and try the effect of fitting higher or lower value fixed resistors.

If an intense blue glow is seen in the valve, switch off at once, and check wiring, etc. This is an indication that the valve is not oscillating. It may be due to faulty tuning or faulty components. Check by means of headphones that the valve is oscillating. A low current reading may be due to the valve quenching too hard. Adjust the variable resistor; check both batteries; adjust length; check trimmers.

If no current drop occurs on receiving a signal from the transmitter, check for bad joints. A new valve may be necessary. Also try shortening the aerial. Try adjusting the trimmers and the effect of disconnecting the aerial trimmer. Erratic meter readings should be checked by making sure there are no intermittent short circuits, dry joints or faulty batteries.

If the current reading cannot be reduced, fit another variable resistor of higher value, check the valve, etc. To check the receiver for proper quenching, connect a pair of high resistance phones in the HT+ lead. If the receiver is quenching, a noise like rushing water will be heard.

If the receiver is generally unstable, dismantle it and rewire, after having checked all the components. Try another coil with one turn more or less. On the whole, the writer has had little trouble with this type of receiver, but these hints are given for the benefit of those who may run into trouble.

The 3A4 Receiver

Turning now to the construction of the 3A4 valve receiver, the first point to make is that it may seem rather complicated to the beginner—but whilst it does need rather more skill to construct, it will prove a most reliable receiver once constructed. The only difficult part is the quench coil and chokes, but a little practice should soon remove any difficulties in this direction. All components must be of high grade quality; the coil and choke formers particularly should be constructed of the highest grade insulating materials. This may increase the cost a little, but it will pay dividends in the long run.

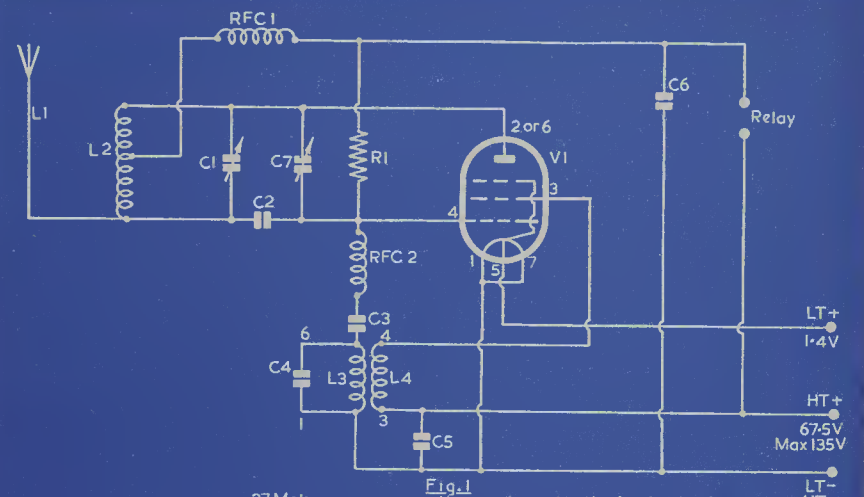
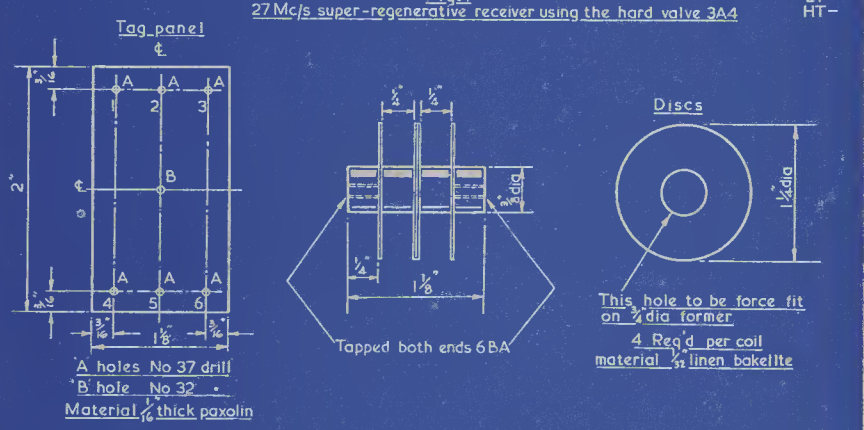


Fig. 1
27 Mc/s super-regenerative receiver using the hard valve 3A4



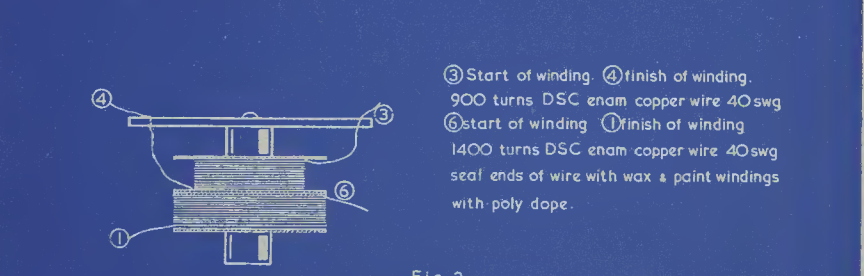


Fig. 2
Details of quench coil for 27 Mc/s receiver

E102

The Circuit

It will be seen that, with this type of receiver, we are able to use much higher HT voltages and, consequently, larger batteries. The 3A4 valve will take up to 135 volts on its anode, but works well with 69 volts HT. The filament supply required is 1.5 volts, so we are able to use the Batrymax B.114 battery which gives a long length of life, thus reducing costs. During range tests with a receiver of this type, using a two valve transmitter, a current change of 3mA was maintained over a range of one mile, the receiver having been in operation for months without any adjustment. This is ample evidence of the efficiency and quality of this receiver.

The circuit diagram is shown in Fig. 1, the values of the components and details of chokes and coils being as follows:—

Components and Key to 3A4 Receiver Circuit

C1, 50pF variable condenser or trimmer, ceramic type if possible.
C2, 100pF Mica condenser.
C3, 100pF Mica condenser.
C4, 750pF Mica condenser.
C5, 1μFcondenser.
C6, 1μF condenser.
C7, 2–8pF variable condenser or trimmer.
R1, 1 megohm fixed resistor.
V1, 3A4 Valve. Use ceramic based holder.
RFC1 and 2, RF choke. Former 1¼″ long ¼″ dia., wind with 38 swg DSC enam. wire, wind close-wound. Length of windings should be about 1″ long when completed. Dope with polystyrene solution.
L1, Aerial 20″ to 36″ long.
L2, Aerial coil 10 turns of 18 swg tinned copper wire wound on a former 1½″ long ¾″ dia. Make tap at centre. Wind as tight as possible and secure on solder tags or pegs (see drawings on same).
L3, 1,400 turns. L4, 900 turns: Quench Coil. Wind with 40 swg DSC enam. wire. See drawings on these coils, Fig. 2.

On testing the receiver it may be found that condenser C7 is not needed. Test for best results. This condenser or trimmer may have some bearing on the current drawn. If one wishes, the aerial coil may be self-supporting but if weight will allow, wind on a former as shown.

Wire with 16 swg tinned copper wire and sleeving, keeping components close and all wires as short as possible. Keep coil clear of other components and metal chassis if used. Twist battery leads together and keep short.

Bench Testing

The procedure is as with the first receiver, with the exception that the standing current reading will be much higher. This should be from 4 to 5mA, but I have found it may vary from receiver to receiver.

On receiving a signal from the transmitter, the current reading should drop 2½ to 3mA but, like the standing current, this may vary. There should be at least 2mA drop; this will be more than enough to operate any of the relays described in these articles.

Should the aerial be too long it will stop the receiver from operating correctly. An indication of this is that the current reading will be low and will not respond to the transmitter signal.

To check for operation, connect a pair of headphones in the HT+ lead (in place of meter). If the receiver is operating correctly, a sound like rushing water will be heard. On receiving a signal this sound will stop (this check applies to the XFG1 receiver as well). Should a valve or battery be changed, it may be necessary to re-tune the receiver. This condition does not always take place, but is a point to remember. It is a wise plan to make a meter test before commencing operations.

Range tests are as before; assemble components and wire with care, the routine being as with the first receiver. Final tests must be made with a full length aerial on the receiver and transmitter.

Batteries

The type of batteries that will be used for the receiver will be governed by the size of model. In the case of model boats, this problem is not a major one.

Before deciding on the ones that will be used, it is a good plan to test various types in order to see which is most suitable. For the LT supply we can use the small type pocket lamp batteries. These are light in weight and their size makes them ideal for the purpose. These are the types U11, U2, and U12. There are a number of hearing aid batteries on the market that can be used for the HT supply. These range from 22½ to 45 volts. It is a wise plan never to use a battery for operations after it has been used for testing.

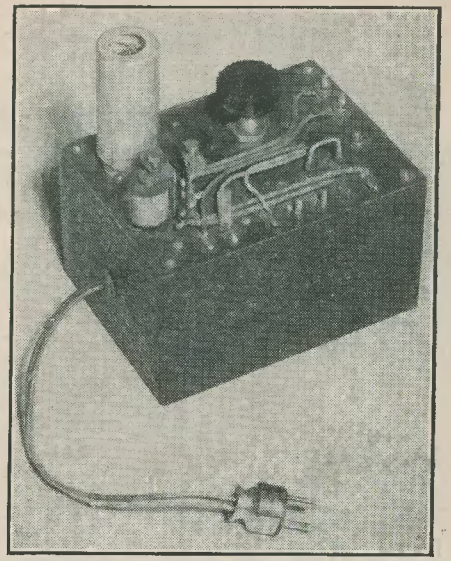
Having a large model, the writer is able to use the Batrymax No. B.114. This gives a voltage of 1.5 LT and 69 volts HT, and has a long life, thus being ideal for the writer's purpose. Hearing aid batteries for LT are also available, their weight range being from 1½ to 6 ounces.

The latest addition to the really small accumulator is the Venner lightweight Silver-Zinc accumulator. They range from ¾ozs upwards in weight, and are ideal for the receiver LT supply. Full details can be obtained from the Venner Accumulators Ltd., New Malden, Surrey, mentioning this magazine.

The transmitter will require much heavier batteries. This again will be governed by the size of transmitter case, but if we wish to make a really portable one, we can use the Batrymax, B.114. HT and LT batteries as used for broadcast radios are suitable, the HT battery range required being from 90 to 135 volts.

For long life LT batteries, we can use the AD4 or AD35. The batteries should be housed in a separate compartment in the transmitter case, and held secure by some form of clips. A faulty LT supply can be the cause of many troubles in both receiver and transmitter, so check them regularly. A falling LT voltage will be accompanied by a lower current reading and a change in frequency of the transmitter. For the larger types of transmitters, we can use a Vibrator unit or Rotary transformer which are operated from a six- or twelve-volt car battery. Brand new vibrator units can be purchased from ex-service stores at very low prices. This type of power supply has many advantages; at the same time one must have the means to charge batteries and have some form of transport for this extra equipment.

In the next instalment we shall deal with the fitting of the receiver and its associated equipment into the model.

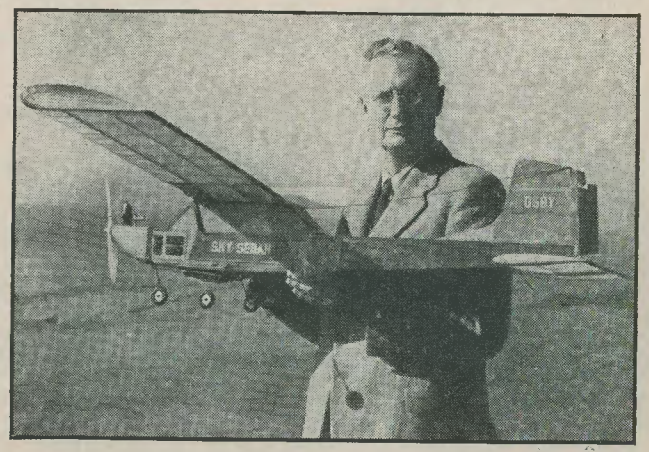


The 3A4 Receiver described in this article.

RECORD FLIGHT BY RADIO-CONTROLLED MODEL

The present world's record duration flight of 1 hour 40 minutes for a radio-controlled model aircraft has been well and truly beaten by Mr. H. L. O'Heffernan, who on October 7th, 1954, flew his model for 2 hours 31 minutes. This new record is subject to official confirmation for which a claim has been submitted.

Two Venner H 105 Silver-Zinc lightweight accumulators, each weighing only 1⅛ ounces, supplied power to the electric motor used to actuate the rudder and one H 105 supplied current for the valve filament in the receiver. All three cells showed 1.45 volts on load at the end of the flight.



Query Corner

A *Radio Constructor* Service for Readers

Response Curves

Having read with much interest recent articles on high fidelity amplifiers, many of which contained some very impressive response curves, I would like to check the response of my own amplifier. Would you advise me as to the best method of plotting the frequency characteristic of an amplifier?

G. Glover, Staines

It is possible that other readers, inspired by the publicity which quality sound reproduction has recently received, would wish to examine their own equipment with a view to seeing how it compares with the latest designs. There are several different methods of plotting the frequency characteristic of an audio amplifier; each requires a calibrated audio oscillator which is complete with an output level indicator. If this refinement is not fitted, then a valve voltmeter will be required; although for the method to be described it is not necessary for this to be calibrated.

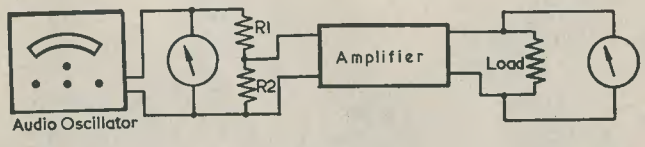


Fig. 1
Method of plotting amplifier response curve

E111

The method consists of plotting the output power relative to a fixed level against frequency, the input or signal voltage to the amplifier being kept constant during the test. It is first necessary to provide some means of indicating the output power which is fed into a dummy load. It is not possible to examine the frequency response of the amplifier whilst the loudspeaker is connected to it, as the characteristic of the speaker will give a false impression of the capabilities of the amplifier. This is because the effective load of a speaker varies as the frequency changes. A load in the form of a non-inductive resistor having a value equal to the impedance of the speaker is connected across the secondary terminals of the output transformer. The power dissipated in the resistor (R) will be proportional to the square of the voltage across it, and may be simply calculated by the formula:

$$W = \frac{V^2}{R},$$

where V is the RMS value of the voltage. This voltage is most accurately measured by means of a valve voltmeter or a high impedance moving coil meter such as the model 8 AVO. It is important that the meter is capable of giving an accurate voltage reading over the range of frequencies to be covered. If there is any doubt on this point the meter may be compared with the valve voltmeter, or if the latter is accurately calibrated it may be employed to measure both the input and output voltages.

Fig. 1 shows the general connections for the equipment. It will be noted that a potential divider is connected across the output terminals of the oscillator. This is required because the input level will probably be below that at which the meter gives a reading. The reduction in voltage can be calculated by multiplying the output voltage of the oscillator by the fraction:

$$\frac{R2}{R1+R2}$$

The frequency response of an amplifier is normally plotted at its rated output power, but measurements can be made at any lower level as required. The input voltage to the amplifier is thus increased until the selected output level is reached, the output being calculated from the formula already given. A reference frequency of 400 c/s is conveniently taken for this purpose. At this output the input and output voltages are carefully noted. Then, commencing at about 25 c/s, the input frequency is increased in steps up to around 20 kc/s, the input voltage being maintained constant and the output voltage reading noted at each step. The frequency response curve can now be plotted in decibels relative to the selected output level. To convert the output voltage readings to decibels, the following formula is employed.

$$db = \frac{20 \log \text{Output V}}{\text{Output V at 400 c/s}}$$

It is best to plot the response on log-linear graph paper, using the log scale for the frequency coverage. A curve of this type was published for the Mullard Amplifier on p. 22 of the August 1954 issue of *The Radio Constructor*.

Push Pull Amplifier for FM Unit

Can you please recommend a simple 5 watt push-pull amplifier for use with the FM Tuner Unit described in the July and September 1954 *issues of* The Radio Constructor;

J. Groves, Chippenham

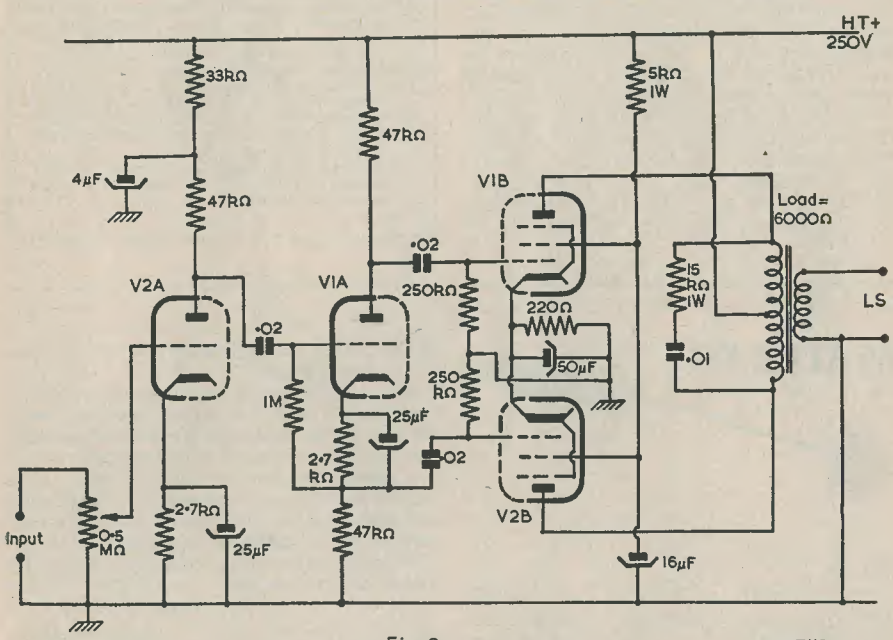


Fig. 2
Push-pull amplifier using 2xLN309(OSRAM) for use with FM tuner

E112

The Osram triode pentode type LN309 is a most suitable valve to employ in a push-pull 5 watt amplifier, as the two triode sections may be used as amplifier and phase splitter. This enables an efficient amplifier to be made, using only two valves and functioning from the power pack which is used to feed the tuning unit.

www.americanradiohistory.com

The design of the circuit follows conventional practice. The first triode is resistance-capacity coupled to the split load phase divider, which in turn drives the grids of the two pentode sections of the valves. All signal-carrying leads must be kept short and the input lead to the first triode must be carefully screened to avoid instability. HT consumption at 250V is in the region of 60mA, which together with the 30mA required by the tuner enables the complete set to operate from a 120 mA power pack. The LN309 has a 12.6V heater, so it is necessary to add an additional 6.3V winding in series with the one used to feed the tuner valves. If this extra winding is not already on the transformer, it is usually possible to add it on the outside of the coil. The exact number of extra turns which are required will depend upon the size of the transformer, but it will most possibly be in the region of 30. The wire gauge should not be greater than 26 swg enamelled copper.

The output transformer must present an anode-to-anode load to the valves of 6,000Ω. Thus, using a 3Ω speaker a turns ratio of 45:1 is required, whilst for a 15Ω speaker this is reduced to 20:1. The transformer must, of course, be capable of handling at least 5 watts. The harmonic distortion of the complete amplifier at this output is better than 2%.

Query Corner

RULES

(1) A nominal fee of 2/6 will be made for each query.
(2) Queries on any subject relating to technical radio matters will be accepted, though it will not be possible to provide complete circuit diagrams for the more complex receivers, transmitters and the like. Queries relating to ex-W.D. surplus or commercial equipment cannot be accepted.
(3) Complete circuits of equipment may be submitted to us before construction is commenced. This will ensure that component values are correct and that the circuit is theoretically sound.
(4) All queries will receive critical scrutiny and replies will be as comprehensive as possible.
(5) Correspondence to be addressed to "Query Corner," Radio Constructor, 57 Maida Vale, Paddington, London, W.9.
(6) A selection of those queries with a more general interest will be reproduced in these pages each month.

MAILBAG

Dear Sir,

In September we started some special classes dealing with Band III Television and F.M. broadcasting for the benefit of service engineers.

Two groups of classes started: (*a*) one full day per week, and (*b*) evening classes. The one day per week group will finish their course at Christmas, whereas the evening class will terminate at Easter.

I wish to acknowledge most sincerely the great assistance rendered by the technical and trade Press, and the R.T.R.A. in making these classes known through their editorial columns. I feel that in view of the interest in these classes we should commence a second, one day per week course as from the 10th January next. The class will take place each Monday from 9.30 a.m. — 4.30 p.m., and prospective students can obtain full details of the course on application to the Secretary of the Department.

Through the generosity of many manufacturers of TV and FM sets and aerial systems, we are able to deal with the intricacies of the various systems with working models.

I should be most grateful if you could include a paragraph in your journal regarding this new class, as I am particularly keen that service and installation engineers should be fully prepared for the introduction of Band III and FM broadcasting.

Yours sincerely,

JOHN GILBERT.

Dept. of
Telecommunication Engineering,
Northern Polytechnic,
London, N.7.

* * *

Dear Sir,

. . . I have found that the hand soap marketed under the trade name of "Dirty-paws" is very good for removing Indian ink from Panel-Signs dials. If it is rubbed well in with the finger tips it will not harm the transfer but removes the ink.

Yours faithfully,

J. W. BAGNALL.

EXPERIMENTER'S IDEAL CHASSIS

By **W. SCHROEDER**

THERE MUST BE MANY EXPERIMENTERS WHO regret every month that they cannot hook-up and try out the many interesting circuits given in every issue of *The Radio Constructor*. Either time does not allow it, or the expense of having another chassis made —to construct that intriguing circuit—is more than the pocket allowance can stand.

The answer to this problem, of course, is an experimental chassis, an idea which is at least thirty years old, but which has lost its popularity lately, mainly because modern components do not easily fit into any kind of experimental chassis if it is of conventional design.

The ideal experimental chassis allows the quick assembly of any circuits, easy exchange of different components, is adaptable to all types of modern components and yet is inexpensive. Rather a tall order?

After using many types of experimental chassis, a rather unconventional design has been found most suitable to the requirements of the experimenter. The main feature is a long slot along the centre over which are easily fitted all types of valveholder, coil-holders, IFT's, smoothing condensers, etc., the fixing screws being passed through slots instead of holes, to allow for different sizes of these components. This also makes them more easily interchangeable.

The chassis, as shown in Fig. 3, is made up of two pieces of sheet aluminium, which are screwed to two wooden endboards, and a detachable front panel. These pieces are cut according to Fig. 1. 14 gauge aluminium should be used to make the chassis sturdy enough to stand up to continuous use, but with this thickness care must be taken to ensure that it does not split when bending it. If no proper bending tool is available, it would be better to use aluminium of 16 or even 18 gauge.

All three pieces of aluminium are 13″ long. The height of the front panel is determined by the size of the speaker which it has to accommodate; for a five-inch speaker it should be 6½″. The width of the front part of the chassis is 5½″, that of the rear 3½″. The two wooden boards, preferably cut from hardwood, measure 7½″ by 2″ by ½″ thick.

Into the front panel are drilled the fixing holes for the loudspeaker. No measurements are given in the diagram, as these have to be determined according to the size used. This also applies to the perforations in front of the speaker, the arrangement of which is clearly shown in the diagram. This method is preferable to cutting one large aperture for the loudspeaker, as the panel is not permanently fixed, and when it is lying about on the workbench, a sharp tool might easily damage the cone or the moving coil. A piece of material should be fitted behind the perforations to prevent small iron particles from falling on to the magnet.

The two holes of ⅜″ clearance take two tuning condensers, and are set sufficiently wide apart to accommodate two large, graduated tuning knobs on the front side.

At the bottom of the front panel three slots are cut, one in the centre and the other two 1″ from either end. These slots are cut with a hacksaw into which two blades have been fitted. Each of these slots is cut to a depth of 5/16″. Finally the bottom ½″ of the panel is bent back, along the dotted line in the diagram, to make a right angle with the rest of the panel.

The other two pieces of the chassis are then clamped together in a vice, and eight slots are cut, 1½″ apart. These, again, are made with a hacksaw into which an additional blade has been fitted. The slots are ½″ deep, and allow the fitting of different sized valveholders, IFT's, etc. The fixing screws need never be removed from these components, as they can easily be slid into position after the chassis has been assembled.

The holes on the shorter edges of these two pieces take woodscrews with which they are fastened to the two wooden end boards. The wider of the two pieces has three holes for fitting the panel, and four holes of ⅜″ clearance for potentiometers, or a reaction condenser, as required. The two outer holes are

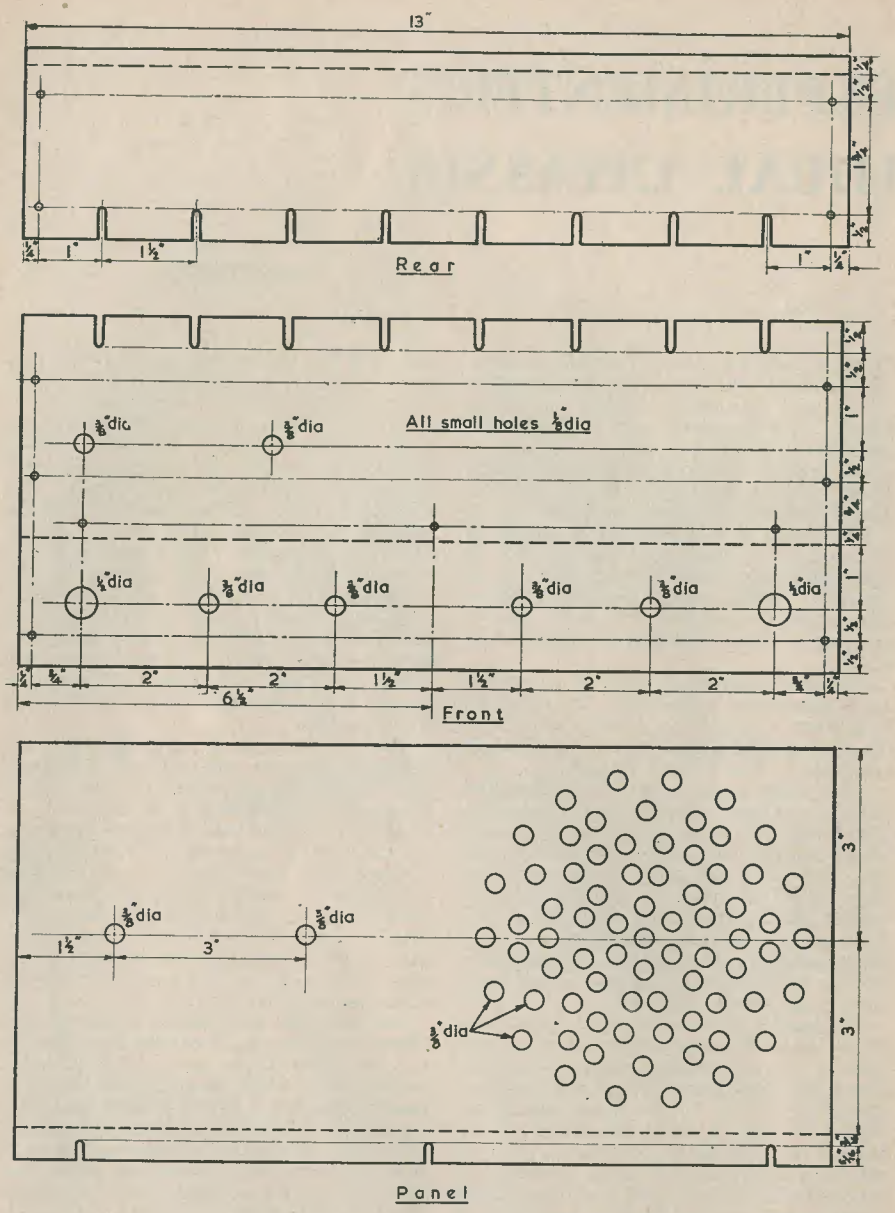


Fig.1

E103

of ½" diameter. The one on the right-hand side is used for a toggle switch, which is permanently fixed, and the other for a co-axial input socket.

In addition to these, a number of other holes are to be drilled on top of the chassis, to take the fixing screws for all the components in the junkbox, fitting them in the

places where they are most likely to be used, and also two holes situated under the tuning condensers, which are to take rubber grommets.

On the left-hand side of the chassis should be the fixing holes for the different tuning coils which might be used, the most convenient being one-hole fixing coils with adjustable iron dust cores, which would most conveniently be situated besides the two rubber grommets. Of course, any other available coils can be used. Plug-in coils are quite handy, but they require additional holders, which take up space in the centre slot. More towards the centre, provision should be made for fixing HF chokes, intervalve transformers, and preset condensers and resistors. The right-hand side is reserved for output transformer, smoothing choke and mains transformer. It is by no means necessary to drill all these holes at once; in fact, it would be wiser to drill them as required when the chassis is in use.

Finally, the two pieces are bent into their proper shape. The narrower piece has the back bent down at right angles for a width of ¼" to give it added strength, and 2" are bent down at the front of the other part, also to make a right angle with the remainder. The two are then screwed down on the wooden end boards, so that a space of 1¼" is left between them.

The two end boards carry a terminal strip each, which serve as input and output sockets whenever the loudspeaker and the co-axial input socket are not used.

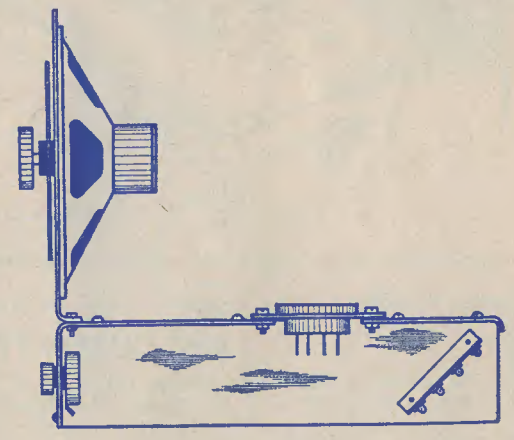
The last item to be fitted is the tagboard underneath the chassis. This should be as long as possible, and preferably stretched over the whole length of the chassis. Tagboards of this size are contained in some items of ex-WD equipment, and these are excellent for this purpose after they have been stripped and cleaned. The tagboard is fixed to two brackets made from aluminium, which are screwed to the end boards in a position indicated in Fig. 2 and Fig. 3; that is, at an angle of 45°, which make its more easily accessible when any soldering is done.

After the loudspeaker and the two tuning condensers have been fitted to the front panel, the chassis is complete, but the panel should not yet be fitted to the chassis.

Assembling circuits on this chassis is extremely simple; one stage follows the next, in a straight line along the slot in the centre of the chassis. This also makes it easy to trace the wiring should a mistake have been made. All connections should be made underneath, and when everything else is completed, the wires leading to the top of the chassis are added, which would be the leads to the top caps of one or two valves and the two wires to the tuning condensers. After all the wiring is done, the three slots in the panel are slipped under the fixing screws on top of the chassis which are then tightened up, after which the last connections can be soldered.

It is simpler to use two tuning condensers, even for superhet circuits, on any experimental chassis, as thus it is possible to do without trimmers and padders, and no alignment is necessary. As the sets built on this chassis are not supposed to be permanent or used for daily listening, this is no disadvantage.

While doing the wiring underneath, the chassis can lie flat on the workbench; everything is then easily accessible. The tagboard makes the fitting of small components extremely easy, and its length makes the disadvantage of rather longer wires than absolutely necessary hardly noticeable, as those components which could give unwanted feedback can be kept sufficiently far apart.



Side view

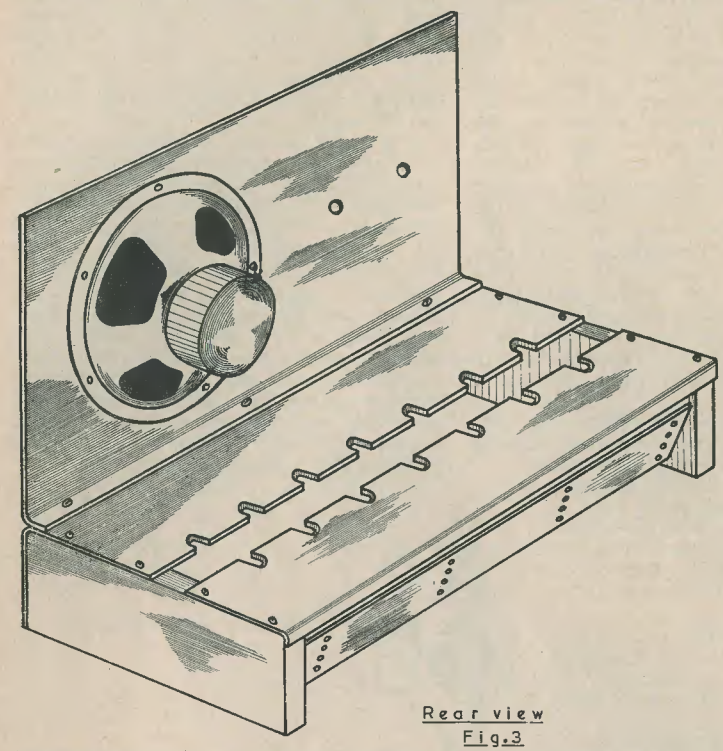
Fig.2

E104

Wires which are to be soldered to tags, valveholders, etc., should never be twisted round the tag first, or unsoldering them later becomes almost impossible, and just breaking the wires off soon makes a mess of the tags, and might even give rise to faulty connections or short circuits.

As described here, the chassis is to be used for assembling receiver circuits which involve

three or four valves. This is just about what the average experimenter should require, but if the chassis is to be used for designing superhets, including power supply and, possibly, with plug-in coils, it will be necessary to add another three or four inches to the length, otherwise it would not be possible to find room to accommodate all the components. The number of the fixing slots should of course, be increased accordingly.



Rear view
Fig.3

Anyone interested in amplifiers only, or other specialized electronic circuits, need make no provision for a front panel and tuning condensers. The length of the chassis can be varied to individual requirements, and many appropriate features can easily be included, thus making this experimental chassis a really versatile and ideal piece of equipment.

The small initial cost of making the chassis will be offset by the pleasure of being able to 'hook-up' all the interesting circuits one comes across, with a minimum of constructional work, time and expense.

FM COMPETITION

The Radio Constructor is offering prizes of (1) 2 guineas, (2) 1 guinea, and two consolations of 10*s* 6*d* to the senders of the most informative report of reception at distances greater than 80 miles from Wrotham. The report should be concise, but should cover the following points:

(1) Type of aerial (1, 2 or 3 elements), and height.
(2) Approx. height of location above sea level, if known, or whether the site is shielded by hills from Wrotham.
(3) Comparison of reception with the local medium wave service.
(4) Details of FM Tuner or Receiver.
(5) Details of other equipment in use, e.g. 8-Watt push-pull output with 10″ speaker in bass reflex cabinet.
(6) Reliability of reception, and any other useful information.

ALL REPORTS SHOULD BE SENT TO ARRIVE AT:

"FM Contest," The Radio Constructor, 57 Maida Vale, London, W.9.,
NOT LATER THAN MARCH 10TH, 1955.

Let's Get Started 19:

MORE — OR LESS? — FEEDBACK

By **A. BLACKBURN**

ON THE WHOLE, LAST MONTH'S ARTICLE presented a rather glowing picture of the effect of negative feedback on amplifier performance. We discovered that it boasted of such advantages as increasing frequency response, decreasing hum occurring in the amplifier, and reducing distortion, all of which result, unfortunately, in loss of gain. We found, further, that the output performance is modified according to whether voltage or current feedback is used.

Our closing paragraph last time, however, hinted darkly that practical application of the system was not without its difficulties. As we shall see when we come to designing an amplifier, indiscriminate application of negative feedback will get us nowhere. Only by judicious handling and with due regard for the performance of the amplifier as it stands will we succeed in getting the utmost use from the system.

Overall Feedback

We already know that feedback may be applied over any number of stages, and frequently is applied from output to input. The important question is, how much feedback should be used? The obvious answer would seem to be—as much as possible without unduly reducing the gain. Unfortunately, it isn't quite as simple as that. In a previous article we dealt with phase shift and its causes at some length, and it is this that throws the spanner in the works as far as feedback is concerned.

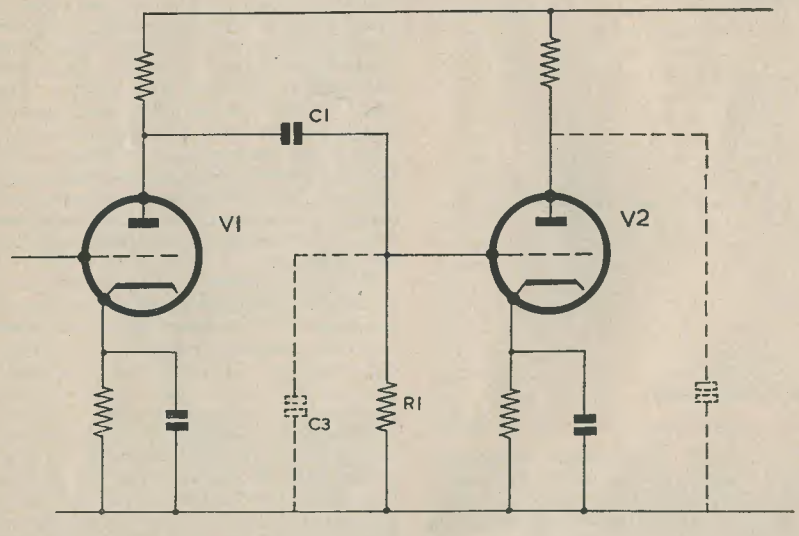


FIG.1.

Fig. 1 shows two stages of an RC coupled amplifier. The dotted capacities are the strays produced by valve inter-electrode

capacities and the wiring. Fig. 2a is typical of the frequency response curve for such an amplifier, and 2b shows what happens to the phase over the frequency range in one of the couplings, say, C_1–R_1–C_3. Don't forget that the voltages at the grid and anode of a valve are 180° out of phase. So in Fig. 1, if there were no strays and the coupling circuit introduced no phase shift, the output of V_2 would be in phase with the input to V_1. However, the phase shift caused by the strays and coupling modify, to an extent dependent upon frequency, this input-output relationship. Fig. 2b shows that the phase shift is zero over the

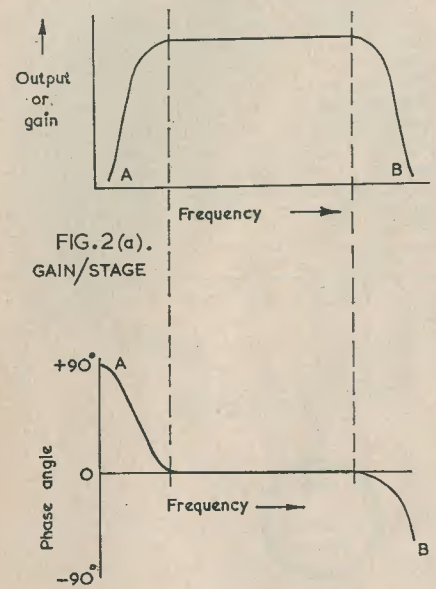


FIG. 2(a). GAIN/STAGE

FIG. 2(b). PHASE ANGLE/STAGE

G97

middle range of frequencies, where the frequency response curve is flat. Try not to confuse the 180° shift produced by the valve with that produced by the components outside the valve.

For the moment we will stick to the idea that the feedback voltage is applied to the cathode of V_1, where the phase conditions are correct to produce negative feedback. Because the feedback voltage would be in phase with the input, connection between input and output of this amplifier would produce positive feedback over the flat portion of the frequency response curve.

But *only* over the flat portion. We can see from Fig. 2b that a phase shift of 90° occurs at points A and B, representing high and low frequencies respectively. Fig. 2b, however, only gives us the phase shift for one coupling circuit. In Fig. 1, though, we have two such couplings. At points A and B, the phase shifts are now doubled, and become 180°. This means that, although over the range of middle frequencies the feedback is negative, at the extreme ends of the band it will become positive. The gain at these frequencies has, however, dropped (Fig. 2a) to a very low level, but if there is sufficient gain left, the amplifier will oscillate. The likelihood of oscillation is also controlled by the amount of the output voltage fed back. If this were very small, the gain would have to be very high to enable oscillation to occur. But in this particular condition the gain happens to be very low.

And therein lies our first conclusion. If the amplifier has a poor frequency response, it will have a poor phase response, and the application of large doses of feedback will cause oscillation. So, before an attempt can be made to improve performance, it has to be pretty reasonable beforehand.

If continuous oscillation does not occur, it may be because there is just that tiny insufficiency of feedback voltage. In this case, if an input voltage of the right frequency were applied, oscillation would occur for the period over which this signal were present. This is quite common in amplifiers and often goes unnoticed, but the quality suffers for it.

With an even smaller feedback voltage, and the phase and frequency responses at either A or B, the positive feedback may cause a rise in the characteristic, as shown in Fig. 3. This again represents deterioration in performance.

With the increase in the number of stages is the increased danger of oscillation, since the phase shift increases as the gain rises.

So far, of course, we have only considered RC couplings. If transformers occur in the circuit, the phase shift is even further increased. A common practice is to derive the feedback voltage from the secondary of the output transformer, which, if it is of good design, may be a very satisfactory scheme, as it includes the transformer in the feedback loop and helps to offset any undesirable effect which it might have upon the performance.

If we use overall feedback, we are going to be faced with two seemingly irreconcilable conditions which it is possible to overcome. From what we have already said, we can see that we must make sure that the gain in the amplifier is too low to allow oscillation, when the phase shift is 180°. We have also seen that, as the gain drops, the phase shift will increase. There doesn't seem to be any way

over this difficulty. It rather looks as though we shall have to put up with such a miserably small amount of feedback as to make it scarcely worth while bothering, anyway.

It has been shown, however, that if the various coupling circuits have different time constants, stage to stage, an improvement to this unhappy state of affairs can be effected. If one stage of the amplifier has a wider band than the others, considerably more feedback may be used than in the case where all stages are equal. To give the stage this extra bandwidth, it is necessary to reduce the anode load. If a transformer is included in the loop, the RC coupled stages should have a wider bandwidth than the stage with the transformer. The same principles apply at the low frequency end of the response also, except that an extended bandwidth at this end calls for larger coupling capacitors or higher grid leaks.

The Volume Control

We said last month that the output impedance of the amplifier was affected by feedback. This applies only in the overall case, when the feedback voltage is derived from, say, the secondary of the output transformer.

It was also explained that the extent of the change in output impedance was dependent upon the gain of the amplifier. If there is a volume control somewhere within that part of the amplifier over which feedback is applied, then operation of the control will change the output impedance. And we don't want that to happen because a large change in the setting of the control may cause considerable mismatching of the loudspeaker to the output valve, accompanied by loss of power, and possible distortion.

In some designs, feedback is applied over one or two stages only, a certain amount of overall feedback being applied and augmented by one or even two small loops within the amplifier itself. It is particularly undesirable to include a volume control within such an amplifier.

Tone Control

Fig. 4 shows a small amplifier with negative feedback applied between output transformer and input. This is not intended to be a particularly practical circuit, but merely as a demonstration. The factor $\frac{1}{1 + \beta A}$ figured largely in last month's article, in showing how nearly everything depends on it. For example, the gain with feedback is:

$$\frac{\text{gain without feedback}}{1 - \beta \times \text{gain without feedback}}$$

Now β is determined by the resistors R1 and R2 in Fig. 4.

$$\beta = \frac{R2}{R1 + R2} = \frac{\text{Voltage fed back}}{\text{output voltage}}$$

Now suppose we insert a capacitor at the point marked C in Fig. 4. If this were a small capacity, the feedback circuit would become frequency sensitive, because the reactance of the capacitor would rise as the frequency dropped. β, therefore, would drop also, and the gain of the amplifier would rise, at the lower frequencies.

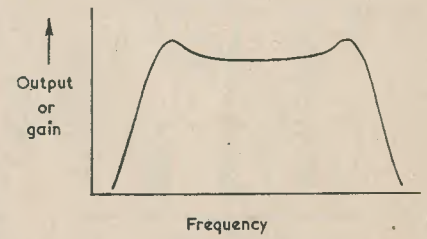


FIG. 3. G96

If, on the other hand, a capacitor were put in parallel with R2, its reactance would drop as the frequency were raised, and it would shunt R2. The potentiometer formed by R1 and R2 would introduce a higher attenuation of the feedback voltage, and β would decrease. The result would be a rise in gain, this time at the high frequency end of the band.

The point of all this is that, if the feedback circuit contains elements which cause it to be frequency sensitive, it may be used as a tone control. The danger lies, of course, in the fact that if the feedback circuit is frequency sensitive, it will also introduce phase shift. It would be particularly harmful to introduce such elements for tone control in overall feedback, although they may be used in the overall case to deliberately introduce phase shift in opposition to that occurring in the amplifier itself, thereby allowing more feedback to be applied without the consequent risk of oscillation.

Circuits

By now you probably feel lost in a maze of ifs and buts. But let's take a look at a few practical circuits, and that might help to clear things up.

No doubt Fig. 5 looks, at first sight, like any innocent stage of amplification, and the un-bypassed screen and cathode resistors have a bearing on the subject.

With a positive going signal at the grid, the current through the valve increases. The voltage drop across the bias resistor also increases, and the cathode moves positive. The resultant change in voltage between the

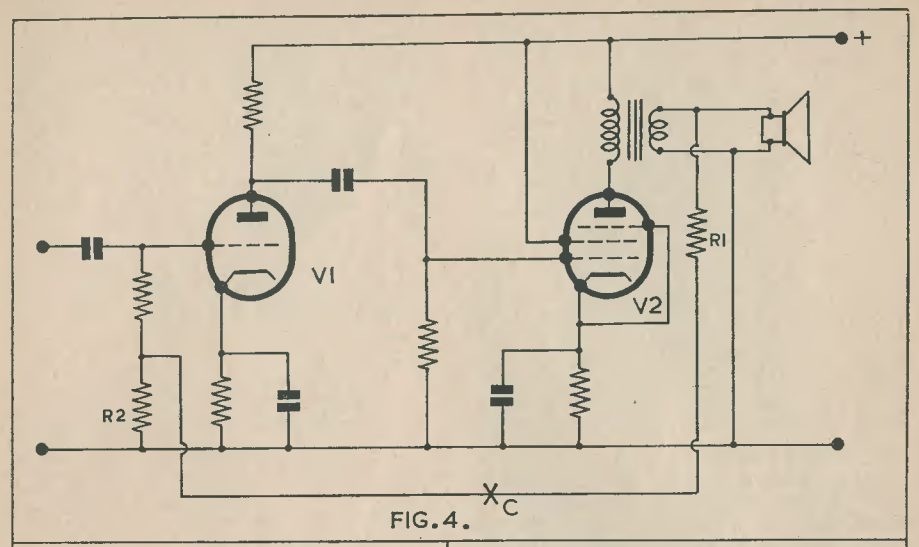


FIG. 4.

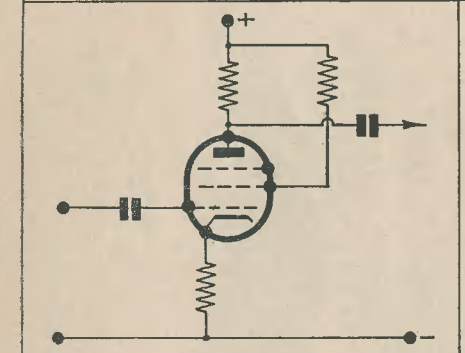


FIG. 5.

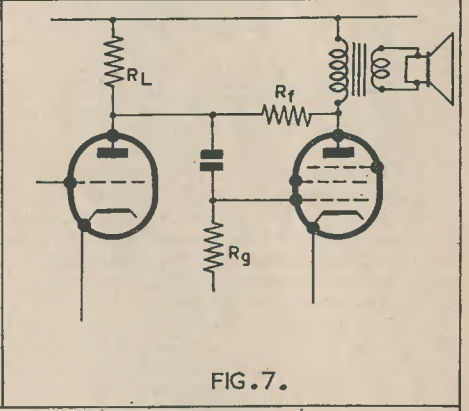


FIG. 7.

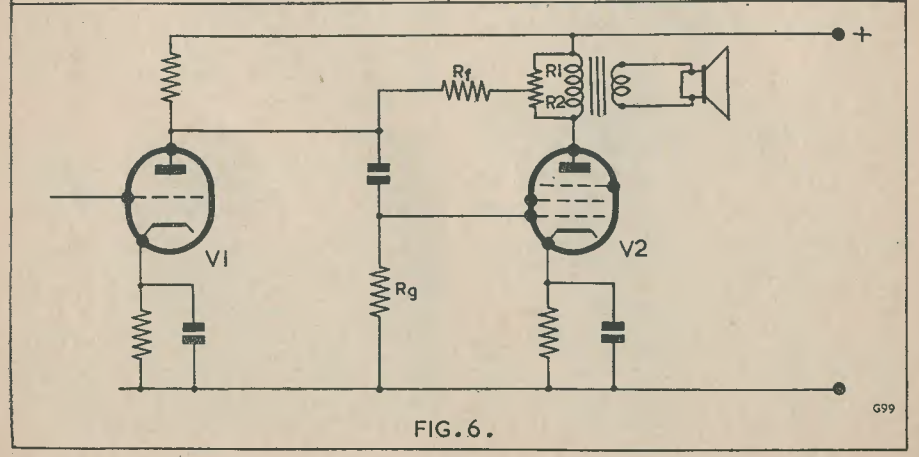


FIG. 6.

grid and cathode is less than the applied change. The anode voltage change is less than if the voltage across the bias resistor had remained constant, that is, if it were bypassed.

The same action occurs at the screen. As the grid goes say, positive, the screen current will increase, the screen voltage will drop, and the current reaching the anode will be less than if the screen voltage had remained fixed. Once again, therefore, the anode voltage change will be less.

Fig. 6 shows a simple method for introducing feedback over one stage, in this case the output stage. If V1 is a pentode, and Rg is of the order mentioned above, the feedback factor β is, very approximately, $\frac{R2}{R1 + R2}$

A more accurate determination of β is

$$\frac{RaR2}{(Ra + Rf)(R1 + R2)}$$

where Ra is the AC anode impedance of V1.

Fig. 7 shows a similar method which only involves one resistor in the feed back circuit.

Here $\beta = \frac{Rf}{Rf + R}$, where R is the parallel combination of Rg, R1 and the Ra of V1.

There are innumerable examples of feedback circuit–too many in fact to deal with here.

I have not, of course, dealt with this subject in detail—that would not be possible in two articles—but I hope I have outlined it sufficiently clearly to enable you to at least avoid the major practical pitfalls and to give you a lead on further research if you find it helpful.

Can Anyone Help?

DEAR SIR,—Can any reader of our magazine please help me by supplying any information on the Admiralty Receiver Pattern W1516B and the Tuner Amplifier B21B. All letters answered. R. Baker, 64 Craner Avenue, Ealing, London, W.13.

DEAR SIR,—Can any reader please supply either on loan or sale, a circuit diagram for the "Hambander" Receiver, Serial No. 767. Yours sincerely, L. G. Burge, 4 Robinia Avenue, Northfleet, Kent.

DEAR SIR,—I have a Romac Television Model 179/T for which I would very much like service data. Can any reader help me with any information and/or diagrams please, either on loan or sale. Yours faithfully, A. E. Ford, 3 High Meadow, Abercary, near Newport, Mon.

DEAR SIR,—Can I, as a regular reader, appeal through your columns for any details or information concerning AM Transmitter Type T1403, Ref. No. 10D/13330 and the power unit for same. I would be glad to purchase circuit or details of this equipment. Yours sincerely, I. Smith, 46 Cow Heys, Dalton, Huddersfield, Yorks.

DEAR SIR,—Can anyone please help with information on VHF Receiver CRI 43044 and the BC312M. Yours faithfully, B. Cutts, 50 Cropton Road, Bricknell Avenue, Hull, Yorks.

DEAR SIR,—Could any of your readers please help me with information or circuit for VHF Receiver No. R-4/ARR-2 (28 volts), particularly regarding the 8 pin plug on the front panel. I would gladly pay for any literature, or defray any expenses. Yours faithfully, L. H. Carter, 17 Fraser House, Britain Street, Portsmouth, Hants.

DEAR SIR,—Having been presented with a small German receiver, I wonder if any reader could help identify the set and may be lend a circuit diagram. The bands are Short, Medium and Long. The valve line up is a bank of three RV12 P2001 plugged into the first 8 pin holder, followed by an RV12 P200 and a further bank of three RV12 P2001 plugged into a further 8 pin holder. A metal rectifier is used. Yours faithfully, T. C. George, 289A Putney Bridge Road, Putney, London, S.W.15.

* * *

ERRATA

Under the Can Anyone Help section of the November issue, R. W. Stewart was inadvertently given the call sign G3ELS. The correct call sign is G3LS, and we apologise to G3ELS for this error.

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EIGHTH ANNUAL R.S.G.B. AMATEUR RADIO EXHIBITION

THE BEST EXHIBITION YET WAS THE GENERAL opinion of most Amateurs visiting the Royal Hotel this year. Many and varied were the exhibits, from the small transistor transmitter to the amateur television station, with its host of valves and apparatus. Live demonstrations were given by various Amateurs on chassis bending, how to solder and other interesting subjects, and the Trade gave talks on their respective products. Not only were they heard, but seen on the monitors and vision receivers around the exhibition. Most of the suggestions submitted by the membership over the past year had been taken care of, including the attendance at their respective stands of the VHF and SSB Editors.

The theme of this year's exhibition was "Transistors and Mobile Equipment." The newly-developed transistor transmitters were on show, including those built by A. Cockle, G3IEE; M. Banks, GC2CNC; J. Francis, G3HGY and M. Horne, G3JRH. Also on the same plinth was the latest RAEN portable and mobile equipment, including 10-metre Walkie-Talkies powered by batteries and with a range of around one mile. These were lent by B. Howlett, G3JAM; G3FKJ, G6HU and F. Wilson, G3ETX. The mobile sets included one by N. Ta'Bois, G3HWG, a 160 metre transmitter and modulator with an input of 5 watts powered by a car battery and rotary converter, and a 160/80 metre transmitter/receiver by C. H. L. Edwards, G8TL, with an input of 1 watt, using internal or external batteries, or mains.

On the main constructors' stand an interesting item was the Personal Receiver built by one of the Society's blind members, W. Griffin, G3IIN; a truly magnificent effort. Also displayed were a "Teapot Detector" by F. H. Lawrence, G2LW; an Oscilloscope by E. G. Styles, G3JSE; a Grid Dip Oscillator by F. Smallwood, BRS 18713; a Precision Valve Voltmeter by W. Thompson, BRS 19773; a Turret Microphone and Pre-Amp by T. Foord, G3HCK; an Electronic Key by F. R. Steckel, G3AVZ; and others no less interesting but too numerous to mention. A Tape Recorder completely home built, including deck, was displayed and operated by J. Hunter, G6HU, and members were able to not only inspect the machine but to have their voices recorded and played back.

In lighter vein was the "Heath Robinson" transmitter by "Seedy," W. Matthews, G2CD, showing how to "link couple the plate" (cuff link and tea plate) to the "ant" (a large ant up which the "soup" (carbon-tetrachloride) was passing.

The VHF/UHF Stand featured the gigantic strides made in the power available on the 70 cms band. Three transmitters were shown, one by C. Newton, G2FKZ; another by S. C. Tucker, G5DT using a 4×150A PA; and one by A. L. Mynett, G3HBW showing the CV25 PA.

Another feature was the equipment used to demonstrate the considerable difficulty of making reliable noise factor and sensitivity measurements at 70 cms. Other items were a novel 2 metre converter by Karl Lickfeld, DL3FM, VHF Editor of DARC; and a 24 cm "Rocket" by J. A. Kliffen, PA⌀KC.

The SSB Stand was well patronised also. The theme was "no TVI," this being made possible by linear amplification and the narrow bandwidth of SSB, thus giving rise to less QRM. A theoretical possible gain of 9db over A_3 makes operation possible where it would otherwise not be when using amplitude modulation during poor conditions. To show that SSB equipment is not expensive, a home-built phasing exciter plus junk box was produced for 30/– by G3JKA. Other equipment shown included a complete 2-band transmitter by C. Savage, G3HRO; a Phasing Exciter by B. Rogers, G3ILI; and items by A. Pegler, G3ENI; C. Bagley, G3FHL and H. Knott, G3CU.

The television station G2WJ/T attracted most attention. The transmitter was operated on 436 Mc/s and for the purposes of the Exhibition was run into a dummy load. A small amount of signal was picked up and fed to a 70 cm converter, the output being on 45 Mc/s, so that a standard receiver could be used. Two cameras were employed, one lent by Ian Walters of Ely and the other by R. Royle, G2WJ. Both cameras were fed into a mixer unit so that pictures from either could be shown on the receivers.

Normal power when used on the air is 20 watts peak white, and it should be possible to obtain a picture from G2WJ/T over an optical path. The signals normally radiated are from a 64-element beam, which is naturally very directional. Anyone wanting to receive these pictures should get into touch with G2WJ/T (address in Call Book) so that the beam can be swung in the correct direction. Signals are radiated each Saturday on 436 Mc/s video and 145 Mc/s sound, beamed to Watford from Great Canfield, near Dunmow, Essex, from 6 to 7.30 p.m.

The most sought-after signal on the air during the week was the Exhibition station GB3RS. Using 10 watts on top band and 120 watts on 80 metres, over 300 stations were worked, QSL cards being made out as each station was contacted. The top band Tx was designed by E. Yeomanson, G3IIR, and used plug-in Tesla oscillators. The receiver, also by G3IIR, was completely home-built from surplus CR100 components. The 80 metre rig was built by D. C. Jardine, G5DJ, and is a rack mounted modified "Elizabethan" covering 3.5 to 28 Mc/s. No trouble was experienced with TVI, the station operating continuously whilst the TV programme was running.

At the Headquarters Stand were displayed several pieces of equipment produced by the Technical Committee. A 150 watt PA for 70 cms by D. N. Corfield, G5CD; the "Reflectometer," a very neatly constructed piece of apparatus by J. Matthews, G6LL, a Band 3 converter by A. H. Koster, G3ECA; a modern Q5'er (using 85 kc/s 2nd IF) by L. Varney, G5RV; and a 2 metre converter by W. H. Allen, G2UJ were included.

A replica of the R.A.F. Amateur Radio Society's HQ station, G8FC, was to be seen on the R.A.F. stand. Amos (Electronics) Ltd. showed samples of their comprehensive range of components, and AVO exhibited their well known range of measuring instruments. Cosmocord, Ltd. displayed their latest microphones and pick-ups. On the English Electric Co. Ltd. stand was a display of electronic equipment manufactured by them, and Enthoven Solders Ltd. demonstrated their "Superspeed" range of solders, and a new low voltage soldering iron. On the G.E.C. stand was a selection of valves, CRT's, germanium diodes and transistors; the FM Tuner Unit described in the July and September issues of *The Radio Constructor* was also on view. Grundig (Great Britain) Ltd. demonstrated their "Reporter" tape recorder. Magnetic Devices Ltd. showed a range of relays, many of which are of interest for radio control purposes. The Minimitter Co. and Panda Radio Co. exhibited TVI-free transmitters; the former also showed aerial filters and tuners, and a 35*ft* steel lattice aerial tower in kit form; the latter also showed aerial filters and tuners.

E. J. Philpott's (Metalworks) Ltd. had samples of their well known metal cabinets on their stand. Pye Telecommunications Ltd. had a comprehensive range of apparatus on show, including VHF two-way radiotelephone equipment. On the Brimar stand was a selection of receiving and transmitting valves, metal rectifiers, germanium diodes, Brimistors, transistors, and TV tubes. Taylor Electrical Instruments Ltd. showed their range of measuring instruments, and a "hear your own Morse" exhibit was one of the features on the War Office stand.

Over 2,500 members attended the Exhibition, as well as representatives from the Trade and "casual" visitors.

Radio Show Dates

London

The next National Radio Show is to be held at Earls Court, London, from August 24 to September 3, 1955, with a preview for Overseas and other special visitors on August 23.

The period chosen is approximately the same as in 1954.

Manchester

Meanwhile planning proceeds for a smaller exhibition, the Northern Radio Show, to be held at the City Hall, Manchester, from May 4 to 14.

Organisers of both exhibitions are the Radio Industry Council, 59 Russell Square, London, W.C.1.

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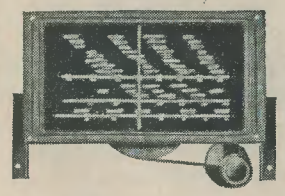

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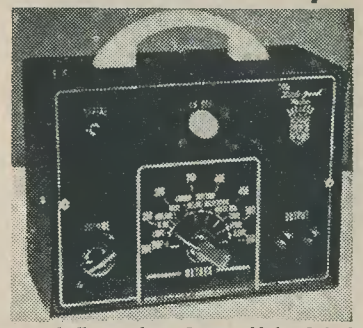

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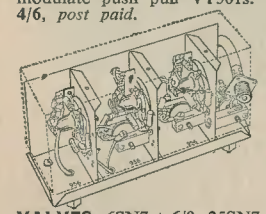

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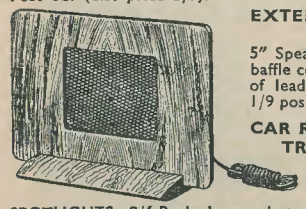

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continued from page 381]

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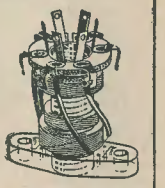

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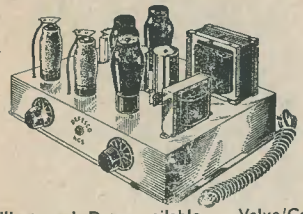

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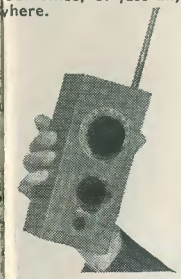

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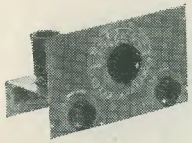

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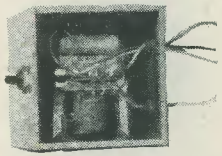

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