The RADIO Constructor

FOR THE RADIO AND TELEVISION ENTHUSIAST

VOLUME 9 NUMBER 3 OCTOBER 1955

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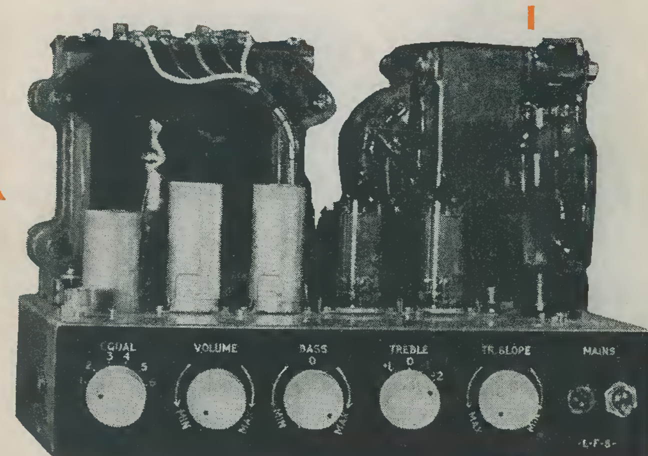

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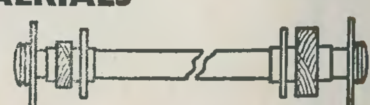

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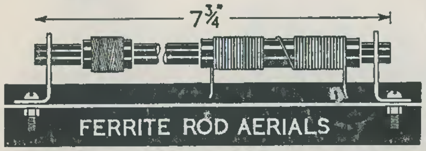

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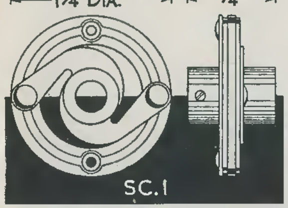

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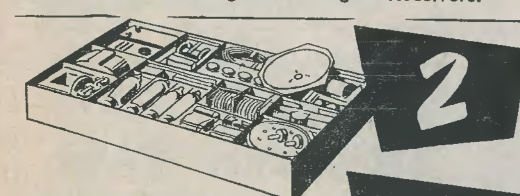

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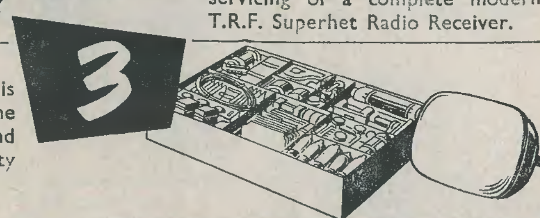

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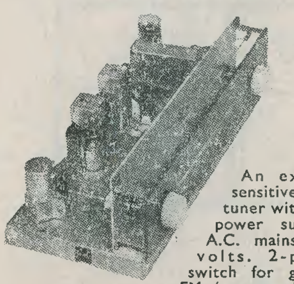

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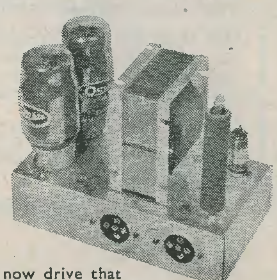

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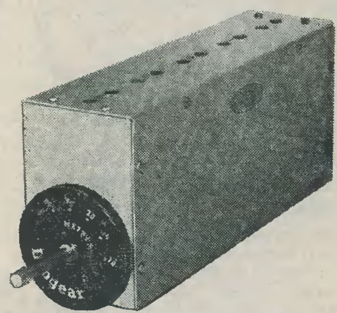

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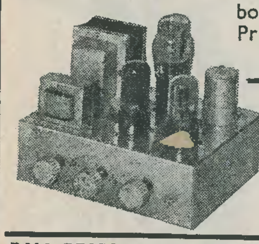

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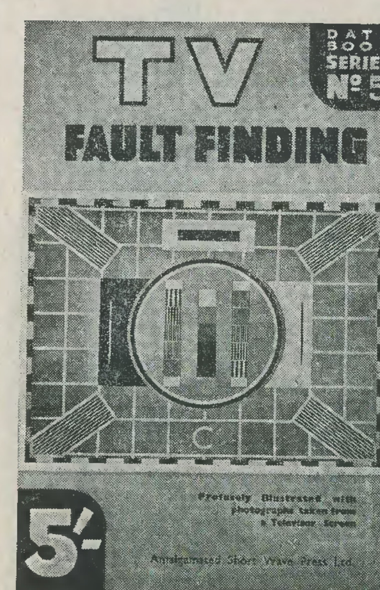

The Radio Constructor

incorporating THE RADIO AMATEUR

CONTENTS FOR OCTOBER

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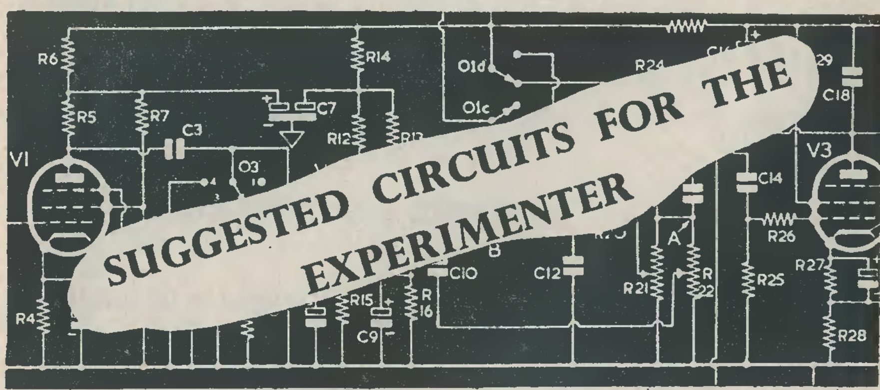
NOTICES

THE EDITOR invites original contributions on construction of radio subjects. All material used will be paid for. Articles should preferably be typewritten, and photographs should be clear and sharp. Diagrams need not be large or perfectly drawn, as our draughtsmen will redraw in most cases, but all relevant information should be included.

All MSS must be accompanied by a stamped addressed envelope for reply or return. Each item must bear the sender's name and address.

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

ALL CORRESPONDENCE should be addressed to THE RADIO CONSTRUCTOR 57 Maida Vale London W9



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. 59. A BOOSTER UNIT FOR BAND III

By the time this month's suggested Circuit appears in print, I.T.A. transmissions in Band III should have commenced. These will mark the culmination of many months of work in the past on the part of the Radio Industry, together with the fulfilment of a considerable amount of preliminary publicity given by the Press and other organs.

It is possible that some viewers will be slightly disappointed with the strength of the signals received when they finally appear, and that others may have the quality of their pictures degraded by interference. In the first instance, the viewer who suffers from poor signal strength will almost certainly be one of those residing in a fringe area, or in an area which is "screened" from the transmitter by local land formations or buildings. The alternative instance of viewers suffering from interference would be given mainly by cases where this is caused by alternative services.

In both of these instances, the use of a booster unit tuned to Band III appears to be very attractive. Such a unit should, for example, be capable of providing just the extra gain which is required to bring fringe area signals to satisfactory picture strength. In cases of interference, the unit could also increase the strength of the Band III signa such that the effect of the interference was noticeably reduced, or was made negligible in comparison.

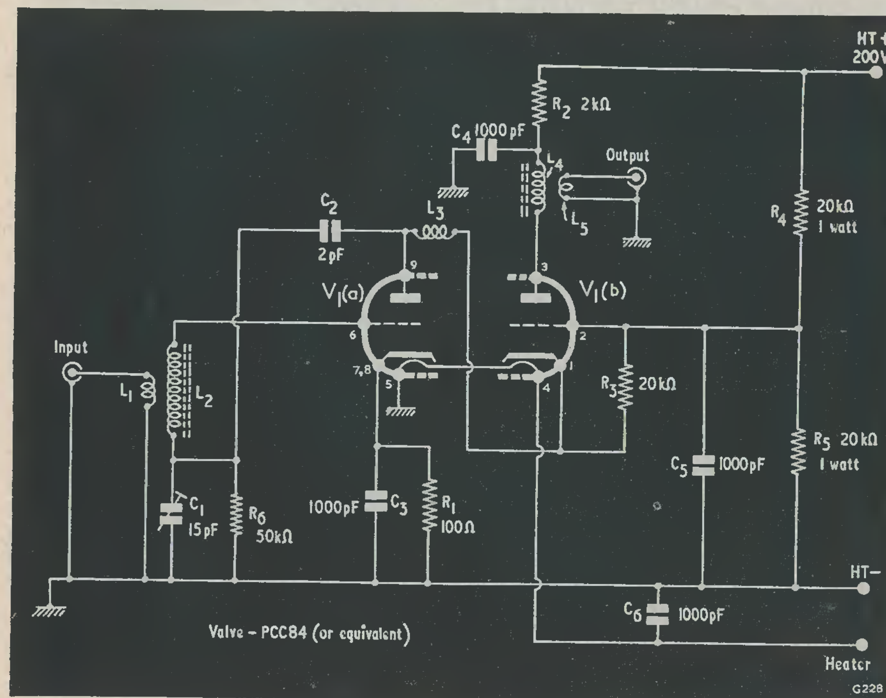
It may finally be argued that a Band III booster, being tuned to a single frequency, would possess the additional advantage of having an input tuned circuit which could be relied upon to give optimum results with the particular aerial being employed, especially insofar as neutralisation was concerned. Such a point cannot be guaranteed in a turret tuner, which has to function as best it may with whatever set of coils is selected by the user.

The Circuit

The circuit of the booster unit is illustrated in the diagram accompanying this article. As may be seen, it is extremely simple in design. It consists of a single cascode acting as a straightforward v.h.f. amplifier, its output feeding into the aerial socket of the associated receiver (or Band III converter).

The aerial input socket of the booster connects directly to the coupling coil, L_1, of the first tuned coil, L_2. L_2 is tuned by the grid-cathode capacity of V_{1a} plus other capacities existing in the circuit. V_{1a} is the first part of a double triode v.h.f. cascode, and its anode connects to the cathode of V_{1b} via a small "peaking" coil. V_{1b} then feeds into the anode tuned circuit formed by L_4 and stray capacities to chassis. A second coupling coil, L_5, next connects to a co axial feeder; this terminating at the input socket of the associated televisor.

A neutralising arrangement is employed in the first tuned circuit, this helping to increase the signal/noise ratio given at the grid of V_{1a}. Neutralising is carried out via the small condenser C_2, this feeding out-of-phase voltage to the lower end of the grid coil L_2. The degr[illegible] of neutralisation obtained is controlled by the trimmer C_1.



Circuit of Band III Booster Unit

Components

Apart from the coils, the components for this circuit should be readily available through the normal retail channels. All condensers should be ceramic as, also, should the valveholder for the cascode. To attain the full gain possible, all component leads should be made extremely short, and all earth returns soldered direct to the chassis. The neutralising trimmer, C_1, is available from several well-known manufacturers. The type required is that which is, in effect, a variable feed-through condenser, and whose earthy connection is soldered direct to the chassis.

The series peaking coil should be self-supporting and may be wound quite simply. It should consist of approximately four turns on a diameter of three-sixteenths of an inch. Normal tinned copper (around 22 to 26 s.w.g.) could be employed here, and the coil may be soldered directly across the appropriate pins of the valveholder. The peaking coil is intended to resonate just above Band III frequencies. If its inductance is made too large, and its resonant frequency consequently approaches the operating frequency of the booster unit, it is liable to introduce regeneration and consequent instability. There is an interesting field of experiment here for those who wish to obtain the maximum amount of gain from the cascode.

The Tuned Coils

The tuned coils will require a certain amount of experiment to find the final optimum number of turns. Assuming an unscreened Aladdin former, some three turns of 18 to 22 s.w.g. enamelled wire will probably cope for L_2, and some four turns for L_4. The turns should be close-wound. The coupling coils, L_1 and L_5, should consist of one to two turns of thinner enamelled wire (from 32 to 36 s.w.g.), interleaved at the earthy end of the tuned coil. (The earthy end of L_2 is that connecting to C_1). Iron-dust or brass cores (preferably brass) will be required to finally set the inductance of L_2 and L_5. To prevent the risk of an h.t. short-circuit between L_4 and L_5, the wire for the latter may be covered by thin-wall sleeving before it is interwound with L_4.

The two coils should be mounted as close as possible to the valveholder and should be screened from each other to prevent instability. Extensive screening is not required.

Setting Up

If the televisor with which the booster is to be employed is capable of receiving the Band III signal faintly, setting up is reasonably simple. If not, a reliable signal generator will be initially required.

The first coil to bring into correct operation is L_4. After the optimum number of turns for this coil has been decided, the coupling coil, L_5, should be adjusted for optimum transfer of energy to the televisor.

L_2 is the next coil, followed by L_1. The number of turns required on L_1 will probably be a compromise between maximum transfer of energy and minimum damping of L_2. L_1 should be adjusted using the Band III signal and the aerial which will finally be employed.

The trimmer C_1 is then adjusted for maximum signal/noise ratio. The optimum setting of this condenser may be difficult to determine accurately if a strong signal is being received. In consequence, this component could be finally set when the Band III transmitter is off the air, it being adjusted for minimum "noise" on the screen. (This may necessitate also the removal of the aerial plug, and its substitution by a 75 ohm fixed carbon resistor).

Can Anyone Help?

D. B. Collins, of 286 Heckmondwike Road, Dewsbury Moor, Dewsbury, Yorks, who needs the circuit, power requirements, plug connections and other data on the Transmitter 1154.

* * *

R. A. Smith, 253 Fir Tree Road, Epsom Downs, Surrey, who needs circuit diagrams and constructional data on an electronic densitometer, capable of reading densities of 0 to 4 in 0.1 steps. A wider range would be even more acceptable.

* * *

R. S. Langdon, 11 Boyson Road, Walworth, S.E.17, would like to know of any modifications to enable the Bendix R.A.10.F.B., R.A.F. Serial No. 1100/159, to be used on normal mains supply. The loop aerial, relay and 28V band-change motor have been removed. He would also like to know if the crystal is required. Is willing to pay reasonably for such information.

* * *

S. Dingwall, 12 Llewelyn Road, Colwyn Bay, N. Wales, has tried in vain to obtain data for his MCR1 receiver, which is giving trouble. Can anyone supply service instructions on the receiver and power pack?

* * *

H. R. Fry, of 108 Glenfield Road, Longbenton Estate, Newcastle-on-Tyne 12, would like to obtain a copy of the May 1952 iss e of *The Radio Constructor*. He is interested in obtaining a circuit for a bridge which will measure inductance of iron-cored l.f. chokes with a heavy d.c. load.

* * *

W. J. Ellesmere, 23 Rawlings Road, Bearwood, Smethwick, Staffs, would like to obtain information regarding the circuit and conversion of the ex-R.A.F. v.h.f. transmitter/receiver type T.R.3171, ref. no. 10DB913, serial no. G1123.

* * *

J. Moss, 4a Kent Street, Upper Gornal, near Dudley, Worcs, asks if anyone can supply the circuit diagram or preferably the service sheet of the Alba a.c./d.c. table model 3-band receiver No. 462. Expenses gladly refunded.

* * *

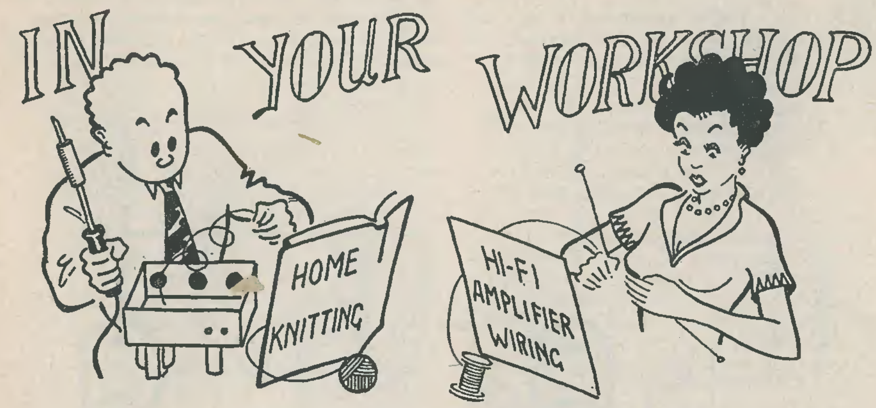
J. W. Barnett, 77 The Crescent, Dunscroft, near Doncaster, needs information on the P.O. Receiver W31/3T (RL127) (PL Receiver)—all these markings on panel—and the R.A.F. Wavemeter W1310. All letters answered and costs covered.

* * *

R. K. Saxena, 70 James Street, Rugby, Warwicks, would like to buy or borrow the circuits of the BC348 and DST100. He would also like to know where to obtain a 3-gang $(3\times(130+360))$ pF.

* * *

H. W. Bonfield, 73 Grove Road, Hitchin, Herts, wishes to buy or borrow the circuit or any information on the R1120 battery t.r.f. receiver, AM reference No. 10D/10472.



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

Now that v.h.f. transmissions are with us in the London area, and will shortly be available over most of the country, it follows that a certain amount of re-orientation of mind becomes necessary to absorb the new techniques which are necessary at these higher frequencies. The v.h.f. transmissions referred to are, of course, those in Band II from Wrotham and the I.T.A. signals in Band III. The latter are not in existence at the time of writing, except as a low power test signal, but should be by the time this appears in print.

Frequency-Changers

Readers may remember that as long as a year ago I contributed some notes concerning the cascode and triode-pentode combination which is now accepted as "standard" for Band III manufactured television "front ends." At that time I paid especial attention to the cascode, but did not devote a great deal of space to the triode-pentode; and some readers have asked me to give further details concerning the working of this second valve.

From the theoretical point of view there is, of course, nothing very complicated in the functioning of the additive mixers (such as the triode-pentode) that are nowadays so commonly used for v.h.f. work. In practice, however, things may not be quite so easy. (They seldom are!) I have been in a position to carry out some v.h.f. experimental work recently, and so I may be able to pass on some useful tips concerning those valves which will be of interest and help to constructors.

Let us start at the beginning and ask ourselves why we employ additive mixers for v.h.f. reception in the first place. (Additive mixers are those in which the signal and oscillator voltages are applied to the same grid, usually via a condenser and leak). Why not carry on with the normal well-known frequency-changers, such as the 6K8, 6SA7, 12AH8, etc., etc., in which frequency conversion takes place in the electron stream? The answer to this question is that the electrode assemblies used in the types of frequency-changer employed for broadcast band and short-wave reception do not permit of satisfactory mixing at v.h.f. The main difficulty is caused by transit time. This is the time taken by the electron stream to travel from one modulating grid to the next; and at v.h.f. it becomes an appreciable fraction of the time occupied by one cycle of the signal or oscillator frequency. The transit time could be reduced by mounting the grids very closely together, of course; but the best answer consists of applying both signal and oscillator frequencies to a single grid. This is done in the additive mixers intended for v.h.f. operation.

The Oscillator

Practically all v.h.f. frequency-changers employ two valves in the one envelope. Typical types are the 12AT7 double-triode, or the PCF80 triode-pentode. One of the two valves functions as an oscillator, the other as the mixer.

Since the oscillator plays a very important rôle in the functioning of the valve as a whole, it might be as well to consider next this section of the v.h.f. frequency-changing circuit.

Most v.h.f. oscillators employ a form of the Colpitts circuit, a typical example of which is shown in Fig. 1(*a*). The frequency at which this circuit oscillates is that given by the coil L_1 and the two condensers C_2 and C_3 in series. Thus, if each of these

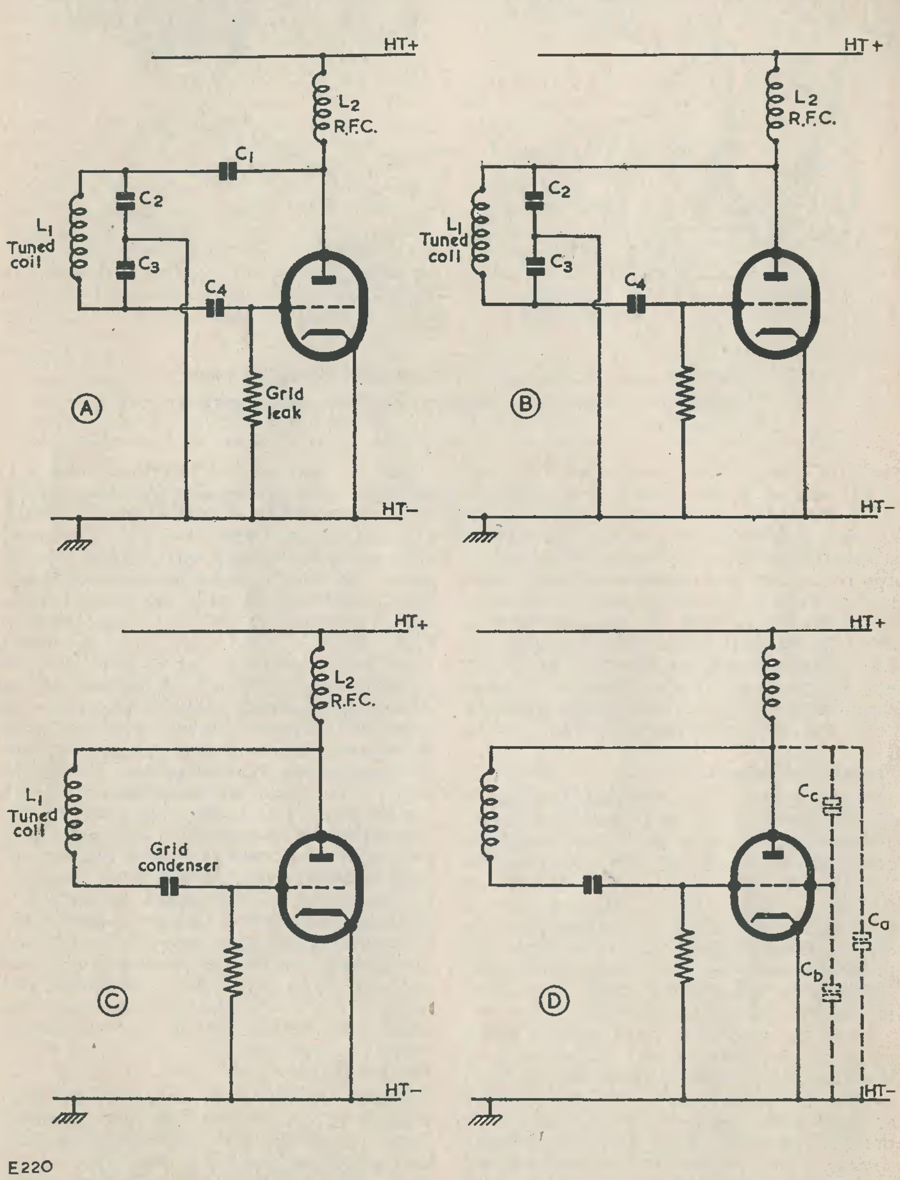


Fig. 1 (a) A typical Colpitts oscillator. (b) An economy in components may often be effected by cutting out the anode coupling condenser, as shown here. (c) A typical v.h.f. oscillator. (d) When the stray capacities are taken into account, circuit (c) is similar to circuit (b).

condensers had a value of 200pF, the resonant circuit of the oscillator would be given by the coil paralleled by an effective 100pF condenser. To keep an oscillator of this type running, it is necessary to ensure that the r.f. at the grid of the valve is of opposite phase to that at the anode. To ensure this relationship, an earthy tap has to be made into some point in the tuned circuit. This tap could be made into the coil. Or it could be made into the capacitive half of the tuned circuit, as is done in Fig. 1(*a*).

It will be realised that the ratio between the capacities of C_2 and C_3 in Fig. 1(*a*) determines the ratio between the r.f. voltage appearing at the anode and the grid. This is quite an important point. In practice, if we wish to obtain optimum working conditions in the oscillator circuit we have to choose the relative values of C_2 and C_3 with some care.

It will be noticed that the circuit of Fig. 1(*a*) is shunt fed; i.e., the anode does not receive an h.t. supply through the windings of the coil. C_1 is merely a coupling condenser and prevents h.t. being applied to the coil. The r.f. choke, L_2, in the anode circuit may be replaced by a resistor if desired, provided that the latter does not introduce too many losses into the tuned circuit or drop too many h.t. volts.

Two Condensers for One

If we wanted to save ourselves the price of a condenser in the circuit shown in Fig. 1(*a*), we could do this by re-drawing it so that it resembles Fig. 1(*b*). In Fig. 1(*b*) we have cut out C_1, and the coil is now at the same d.c. potential as the anode. No trouble will result from this, however, because there is no d.c. connection between the coil and chassis: it is still isolated by the condensers C_2, C_3 and C_4.

There is an important point about v.h.f. working with which we should next deal. Due to the high frequencies involved, the resonant circuits used for frequency-changer oscillators must employ components having very low values of inductance and capacity. Also, to keep losses low, we want to ensure that the L/C ratio of the tuned circuit is high; i.e., that the inductance is large compared to the capacity. Indeed, the tuning capacity should be of the order of a small number of picafarads only.

Because of this requirement, v.h.f. oscillators usually appear in a form similar to that shown in Fig. 1(*c*). This circuit looks a little "bereft" at first, but it is quite a workable proposition in practice. Fig. 1(*d*) may help to make it clearer. As may be seen, the coil in Fig. 1(*d*) is tuned by the stray capacities existing in the circuit. Of these, C_a is the capacity existing between the anode and cathode of the oscillator, this being in parallel with the stray capacities between the anode wiring and chassis. C_b is the capacity between grid and cathode, and is also in parallel with stray wiring capacities. C_c is the capacity between grid and anode, plus stray wiring capacities, plus the self-capacity of the coil. Apart from the additional tuning capacity given by C_c, Fig. 1(*d*) is identical to Fig. 1(*b*).

As was mentioned earlier, the values of the two capacities tuning the coil should have a particular ratio if optimum working is to be obtained. It is desirable, therefore, to ensure that C_a and C_b of Fig. 1(*d*) possess this optimum ratio or, at least, approach it. Usually, this state of affairs happens adequately enough with the normal stray capacities existing in the circuit, but it is sometimes necessary to add small-value fixed condensers between one end of the coil and chassis in order to achieve maximum efficiency.

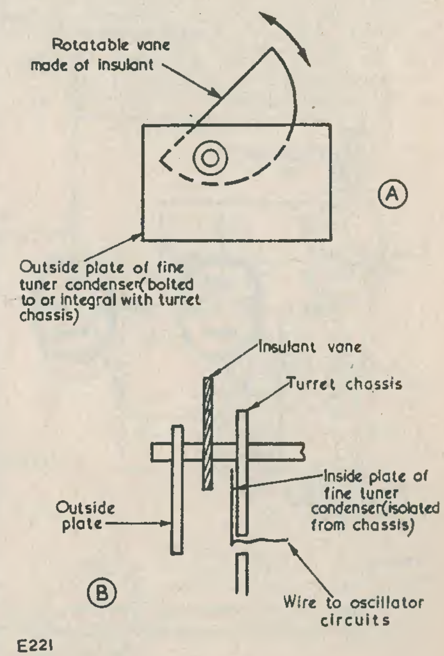


Fig. 2. End view (a), and side view (b), showing the construction of the fine-tuning condensers fitted to turret tuners

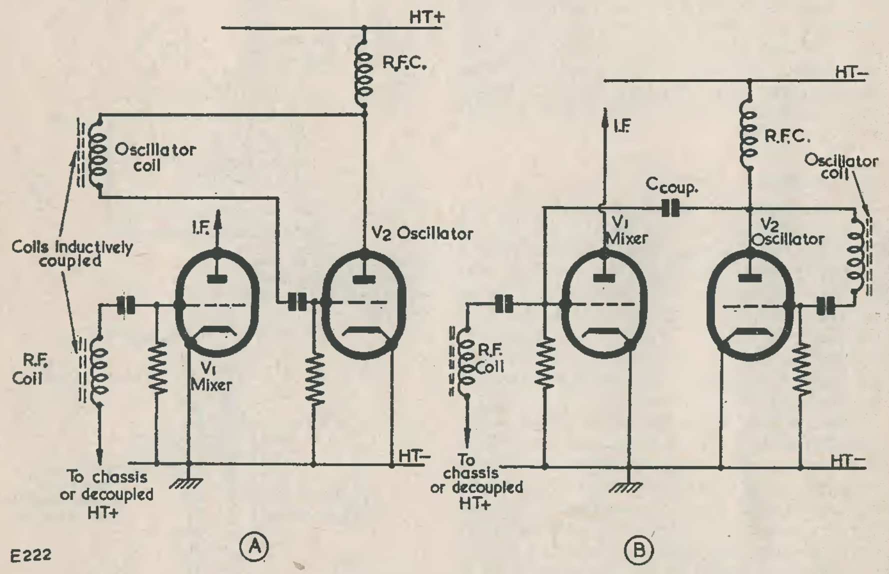
It will almost certainly be necessary to tune the oscillator circuits of Figs. 1(*c*) and (*d*), even if only over a small range. The best way of doing this consists of fitting the coil with an adjustable iron-dust or brass core. Should capacitive fine tuning also be desired this can be achieved by connecting a small-value variable condenser between one end or other of the coil and chassis. If one is going in for really superior design, the middle setting of the variable condenser should give just the capacity needed for the best ratio between the two capacities tuning the coil. In practice, things are not so critical as this unless the variable fine tuning condenser has a higher maximum value than normal design would warrant.

Incidentally, an important advantage of using the Colpitts circuit for v.h.f. operation is the fact that only two connections are needed to the coil. Because of this the design of Band III turrets can be considerably simplified, since only two contacts are needed to connect to the oscillator section of the coils for each channel.

The dielectric constant of the vane material differs from that of air, with the result that the capacity of the condenser varies as the vane is rotated. Capacity variation is of the order of a few pF only.

Application to the Mixer

Having obtained an oscillatory voltage, it is necessary to apply this to the grid of the mixer. This may be done either inductively or capacitively. Inductive coupling is given when the signal frequency coil is mounted close enough to the oscillator coil to enable r.f. currents at oscillator frequency to be induced in it. This arrangement is illustrated in Fig. 3(*a*). (A rejector r.f. tuned circuit is assumed here and in Fig. 3(*b*)). What occurs in Fig. 3(*a*) is that the oscillatory voltage induced into the r.f. signal coil is applied, together with the r.f. signal, to the single grid of the mixer valve.



E222

Fig. 3 (a) Illustrating inductive coupling in a v.h.f. frequency-changer stage. (b) Showing how capacitive coupling may be obtained at v.h.f. C_{coup} *usually has a value between 1 and 4pF.*

As we are dealing with practical points, the type of condenser employed for fine tuning with almost all Band III turret tuners is also worthy of mention here. This condenser consists of two fixed plates, as in Fig. 2, between which rotates a specially shaped vane made of insulating material.

Capacitive coupling is shown in Fig. 3(*b*). In this case the oscillator and r.f. coils are mounted some distance away from each other (being also screened, if desired), and the oscillatory voltage is applied to the mixer grid via C_{coup}.

When using these circuits in practice, one is sometimes liable to forget the stray capacities which are continually in existence. Thus, whilst the coupling employed in the circuit of Fig. 3(*a*) may appear to be wholly inductive on paper it can, in practice, be quite largely capacitive as well.

In Fig. 3(*b*) the nominal coupling capacity C_{coup} may, in fact, be accompanied by stray capacities as well. It should be remembered also that some of these stray capacities may tend to reduce the transfer of energy between the oscillator and mixer grids instead of assisting it. As an example, any stray capacity existing between the two control grids in Fig. 3 (*b*) will actually oppose the coupling given by C_{coup}.

To make things more complicated, there is the question of stray inductive coupling as well. This is usually caused if the oscillator and mixer share a common inductive impedance. Since a straight piece of wire an inch long has an appreciable amount of inductance at v.h.f., care has to be taken to prevent both valves sharing a single connection, such as a common cathode lead. Normally, fortunately, the valve pin layout automatically prevents stray inductive coupling if care is taken with the layout.

This picture of stray inductances and capacities may appear to be rather gloomy to the constructor who is just about to embark on Band III experiments. However, they do not, in practice, cause any insurmountable obstacles; so long, that is, as the normal commonsense rules of wiring layout are observed. Nevertheless, the existence of strays should not be ignored. What may sometimes appear to be quite unexpected results are frequently due to the presence of these "unseen components."

Conversion Conductance

To obtain maximum conversion conductance from a v.h.f. mixer, the oscillatory voltage applied to the mixer grid should be kept within the bounds recommended by the valve manufacturer. The limits set are, frequently, fairly critical.

The usual, and simplest, method of measuring the voltage applied to the mixer grid consists of reading the current (d.c.) flowing through its grid leak. This method has the advantage of causing minimum circuit disturbance, and it takes into account practically all the stray couplings which are in existence. Manufacturers sometimes state the value of grid leak recommended for a particular valve, and give a figure also for optimum grid current. Usually, however, a voltage is quoted; in which case the requisite current has to be worked out. For instance, if a grid leak of 47kΩ and an oscillatory voltage of 4 volts are recommended, the resultant grid current should be 85μA.

The grid current-reading meter may be inserted into the oscillator grid circuit as shown in Fig. 4. In this diagram, the connection between the lower end of the grid leak and chassis is broken, and the meter inserted in between. As the meter will almost certainly have to be connected via fairly long leads it is worth while to decouple these by a condenser mounted very close to the grid leak and chassis. No other wiring in the mixer circuit should be altered.

The best way of getting the frequency changing stage into top condition consists first of making the oscillator work at its highest efficiency. This can be done by experimentally finding the value of capacity required between either end of the coil and chassis which gives greatest oscillator output. This point was explained above. It may happen in some cases that, when additional capacity is needed at the grid end of the coil, this can with advantage be connected from chassis to the grid itself and not directly to the coil. This capacity is then applied to the coil in series with the grid condenser. Experiment is the best way of determining these points. (Optimum oscillator operation will be shown by connecting a milliameter in the oscillator grid leak circuit in the same manner as shown in Fig. 4 for the mixer).

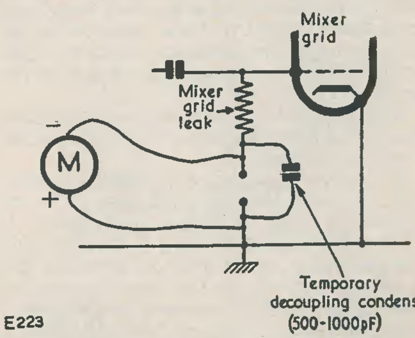


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Fig. 4. The oscillator volts at the mixer grid can be measured as shown here. A similar circuit may be employed for checking oscillator grid current as well.

Having got the oscillator working correctly, the coupling to the mixer grid should then be adjusted. This is done either by varying the relative position of the r.f. and oscillator coils if inductive coupling is employed; or the value of the coupling condenser when capacitive coupling is employed. The signal frequency circuits should be set to their correct frequency during this process. If all goes well, the entire frequency-changer stage should then be working as efficiently as it possibly can be under the limitations imposed by its components and layout.

It should be mentioned, before concluding, that some additive mixers are recommended to work with a cathode bias resistor and condenser. A useful solution to the consequent problem of measuring grid voltage consists of short-circuiting the cathode to chassis by a short piece of wire during the tests, and assuming that only slight errors will be introduced when it is later removed. This assumption appears to be well justified by practical experience.

BAND III INTERFERENCE FROM BAND I

RE-ALIGNING THE MAGNA-VIEW AND UNIVERSAL TELEVISORS

by **A. S. TORRANCE**

(By kind permission of Ikopatents Ltd)

It is regrettable that when these excellent sets made their bow some three years ago, alternative television was a mere pipe-dream—and there was no indication of the likely wavelength to be used for commercial T.V. In consequence the intermediate-frequency chosen for the "Magnaview" and "Universal" Televisors, although free at that time of adjacent channel difficulties, has now revealed itself as the unfortunate victim of the chosen wavelength for the I.T.A. transmitter in the London or Channel 9 areas.

It should also be noted that the presence of a converter, pre-amplifier or other subsidiary apparatus attached to these receivers in no way diminishes the nuisance, which remains constant from the harmonic generated in the oscillator circuit.

Any apparatus embodying an oscillator may have a harmonic either on or close to the new Band III signals.

The power from the oscillator is usually high and will interfere with any T.V. set adjusted to Band III in the near vicinity. It is the third harmonic which is troublesome. The conditions which must be remedied are graphically shown by the following figures taken from the T.V. receivers in question.

Vision I.F.	19.75 Mc/s
Channel I vision R.F. ..	45.00 Mc/s
Osc. frequency, the sum of:	64.75 Mc/s
	3
The third harmonic.. ..	194.25 Mc/s

This offending radiation is only half a megacycle from the London I.T.A. transmitter and would produce a most objectionable "patterning" on the screen of any receiver nearby tuned to the London commercial station. It is therefore imperative that any apparatus operating under these conditions should be re-aligned.

Further to this, as stations make their appearance elsewhere equipment other than the special cases dealt with here may need attention.

Substitution of the above figures with those to be found locally will quickly establish if action is necessary.

Modifications to "Universal" and "Magnaview"

(For the purpose of identifying either receiver, the initial "M" or "U" is used)

It will be remembered that the entire lining-up procedure was based on the sound I.F. being pre-set to 23.25 Mc/s and achieved by the makers setting L12A and L12B accordingly.

This frequency must now be changed to 24.8 Mc/s, whether either set is tuned to Channel I. Readers possessing a signal-generator may inject a signal of this order into the control grid of V6 (M) or V9 (U).

The following procedure can be adopted with confidence if a generator is not available.

(1) Secure screening can for V2. This may be placed over valve and held down by adhesive tape.

(2) Turn anti-clockwise, the cores of L12A and L12B—2½ times.

(3) Adjust core L2B (thick wire) for max. sound.

(4) Re-adjust top core of L12A–L12B again for max. sound.

(5) Adjust core L5 for max. sound.

(6) Adjust cores of L8, L6, L4 and L3 for max. vision definition. Approximately withdrawing each core one turn will be found to be correct.

(7) L2A may need slight adjustment, but always retune L2B for max. sound.

(8) Withdraw core of L7 about 1 turn. If sound on vision is noticeable, adjust L7 carefully until this effect disappears.

(9) Should the wave-trap appear ineffectual the condenser across L7 may be reduced to 82 pF.

NOTES ON RADIO CONTROL

An Automatic Switch

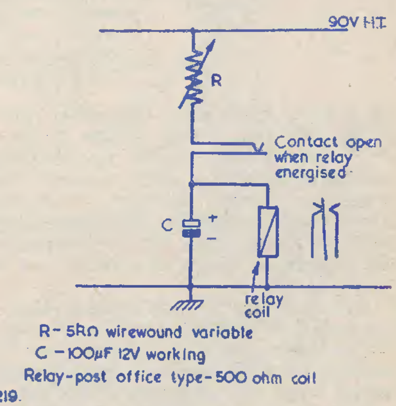
by **C. GRANT DIXON**

When experimenting recently with radio control circuits for the control of a model boat, the writer was faced with the problem of generating pulsed r.f. signals with variable mark/space ratio. Long experience of pulse techniques led to the consideration of the multivibrator, but it soon became evident that with battery valves and a 90V h.t. supply this was going to be quite a problem, especially as a low repetition rate was desired. As a result of a different approach to the problem, the following automatic switch was evolved; this appears to have uses in other directions as well.

Referring to the diagram, it will be seen that the condenser C charges up through the variable resistance R, and when a suitable voltage has built up, the relay is energised, thus breaking the charging circuit. The relay remains energised until the charge on the condenser has leaked away, then it ceases to hold, and the contact with the charging circuit is restored and the whole process starts all over again. The values given in the diagram refer to a repetition rate of about 2 or 3 per second, and it may be noted that the low working voltage of the condenser is possible because it only charges up to a few volts before the relay disconnects it from the supply. With a given relay, the repetition rate is governed by the value of condenser chosen. The variable resistor is used to control the mark/space ratio. With a low value of charging resistance the condenser charges quickly, but its time of discharge is already fixed by the resistance of the relay coil, hence the relay is held closed for a longer time than it is released.

The relay actually used had a set of SPCO contacts, and if a similar one is available these contacts can be used for a variety of switching purposes. In addition to its original function of switching the h.t. to an r.f. oscillator, this automatic switch can be used for the production of accurate, very low frequency, square waves by switching a battery or other d.c. supply. Such square waves can be used for testing the l.f. response of amplifiers, but care should be taken to check the Y amplifier of the oscilloscope before investigating any other amplifiers.

Another possible use for the device is the beam-switching of an oscilloscope by using two Y amplifiers and switching them alternately to the deflector plates. D.C. shift of one trace may be added by additional relay contacts, or else incorporated in the amplifiers by d.c. coupling. For very low frequency switching of this type it is advisable to use a cathode ray tube with a long persistence screen.

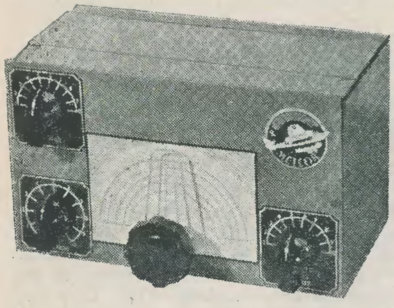


Everything has its disadvantages, and the clicking noise may be somewhat irritating to some people, but this is compensated by the saving of valves and their associated components. A more serious disadvantage is that there is a limit to the mark/space ratio in the "short on—long off" direction, as this means a large value of charging resistance, and because of the potential divider effect across the h.t. supply an insufficient voltage is built up across the condenser to pull the relay.

To sum up—the circuit appears to offer scope for further development, particularly with regard to its applications, and will certainly appeal to those who are fond of the unusual.

The "METEOR" MINI-RECEIVER

for the Beginner



PART 2. by **F. A. BALDWIN**, *A.M.I.P.R.E.*

(A receiver using modern miniature components, specially designed for, and directed at, our beginner readers. In this issue the wiring details and power unit circuit are given).

Having previously described the circuit and drilling details in the last issue of the magazine, we now proceed to outline the wiring of the receiver. Before going any further, however, a few words about tools for the job, and soldering itself, may not come amiss to the beginner—for the benefit of whom this article has been prepared.

Obviously, as a first consideration, the possession of a good quality soldering iron—preferably of the electric type—is of paramount importance. Although this involves some capital outlay at the outset, it will last for many years—being virtually a necessity in the workshop, and without which it is not possible to construct even the most simple modern receiver. Before operations commence, the bit, preferably one of the so-called pencil types, must be "tinned," i.e., cleaned with flux and covered with a thin layer of solder; the latter being then shaken off so that no blobs of solder are left adhering to the iron.

Apart from the iron already mentioned, the other tools required are a pair of side-cutters pliers, fairly small ones, and a "Bib" wire stripper. For materials, lengths of various coloured PVC wire (in effect, plastic covered wire), a length of systoflex (flexible insulating material for covering bare wire ends of components), and last but not least, something not often mentioned in radio periodicals—the humble piece of rag. This latter item is very necessary for wiping the iron from time to time thus removing old solder and accumulated dirt etc. A further point worth mentioning to the beginner is the provision of a suitable iron stand on which the heated bit can be placed, both for safety and convenience. It must, of course, be of metal, and a small length of aluminium bent into the shape of a letter L (viewed sideways), bolted onto the bench and with a cut-away notch in the centre (see Fig. 10), would serve admirably.

Wiring the Receiver—The First Stage (V_1)

Although only the wiring of the first valve is dealt with in this section, the heater wiring should be completed for both valves at the outset. The two valveholder pins (No. 1), should therefore be connected together via a suitable length of PVC wire. From pin 1 of V_1, a nine inch length of wire shouid be taken out through the grommet. This lead will constitute the l.t.+ input when connected to the power unit later. Pins 8 of both valves should now be soldered to the nearest soldering tags which are fastened under the respective holding bolts of the valveholders. The same length of wire should also be soldered to the central metal spigot of the holder. This latter operation ensures that an earthed screen is between the grid and anode pins of the valve. This completes the heater wiring.

Pin 7 should now be soldered to pin 8. To pin 2, solder one end of the r.f. choke, the other end of which goes to the tag on the 3-way strip nearest the chassis (see photograph). Having done this, return to pin 2 and solder both C_2 and C_4 to it. The other end of C_2 is now connected to the coil (see Fig. 3). C_4 is then taken to pin 8 of the valveholder. No. 3 pin is left blank. No. 4 is connected to the earthing tag. Next, pin 5 is taken, via a suitable length of PVC wire, to the centre tag of the potentiometer (R_4). Pin No. 6 is soldered to R_1, the other end of which is taken to pin No. 8, and C_3 connected from pin 6 to the coil (again see Fig. 3). This completes the actual valveholder soldering operations.

instance. This being so, the wire ends of this condenser must not only be cut to length but must also be covered with a length of systoflex in order to provide some measure of insulation. For connections to the phone jack see Fig. 8, where it will be seen that C_5 is wired to the tag furthest from the chassis wall, while the other tag is taken to chassis (to pin 8 of V_2). There are four tags on the phone jack altogether, but the two we are concerned with are those comprising the long spring-metal portions which extend through the cut-away portion of the bakelite body. The remaining two tags are not required in this circuit. The resistor R_2 is taken to the other outer tag of the strip (again see Fig. 9). To this same tag connect a nine-inch length of wire, taking the other end of this through the rubber grommet. This will constitute the h.t.+ input to the receiver. Also to this tag solder R_3, the other end of which is then taken to the right-hand tag on the potentiometer (R_4), for which see Fig. 6.

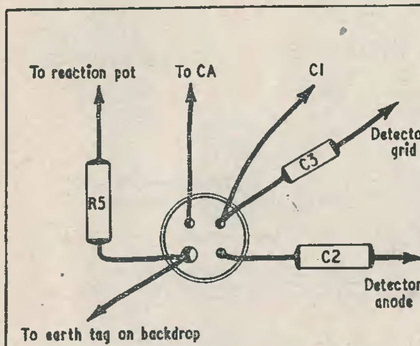


FIG.3. COIL CONNECTIONS

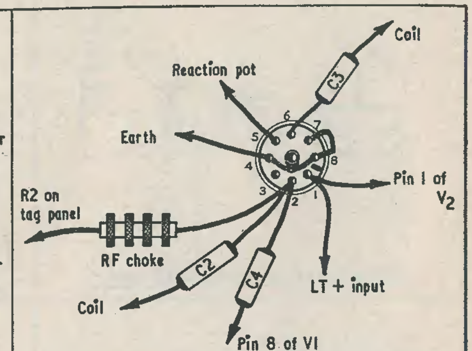


FIG.4. DETECTOR BASE WIRING

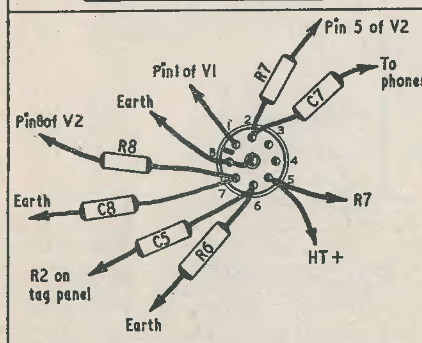


FIG.5 BASE WIRING OF V2

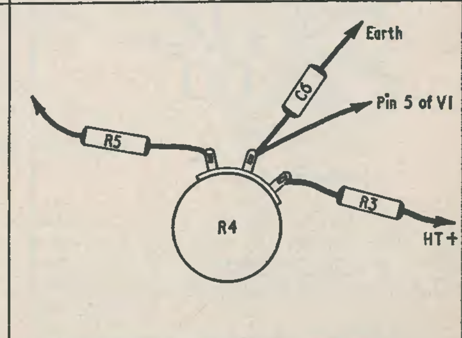


FIG.6. REAR VIEW OF R4 (POTENTIOMETER) CONNECTIONS

G217

The next step is to wire up the tag strip (see Fig. 9). On the same tag holding the r.f. choke, solder both C_5 and R_2. Now C_5 has to be connected at the other end to the phone jack—assuming that the receiver is being built as a one-valver in the first

Still dealing with R_4, to the centre tag, on which we already have a wire from pin 5 connected, also solder C_6—the other end of which is connected to the earth tag contained on the aerial/earth strip bolted to the chassis rear wall. To the left-hand tag on R_4 (Fig. 6), solder the resistor R_5, the other end of which is then taken to the coil (see Fig. 3).

Dealing with coil connections next, most of which are already done in the foregoing instructions, a study of Fig. 3 will show the photograph. From the other side of this condenser solder a further length to C_1, the larger variable condenser. A study of the illustrations will show how this has been done. The only remaining coil connection should then be wired to PVC wire which is taken through a hole drilled in the chassis deck and soldered to the tag fitted to the stator plates (i.e., those that do not rotate), on C_a. From the rotor plate (i.e., those that rotate with the spindle) connection, solder a further length of wire through the

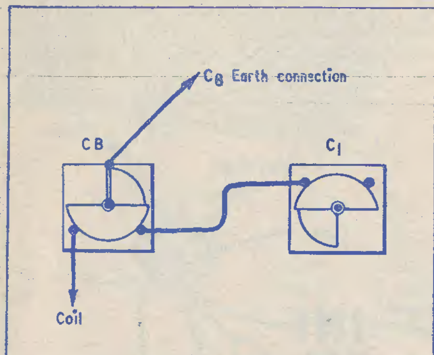


FIG.7.VARIABLE CONDENSER WIRING

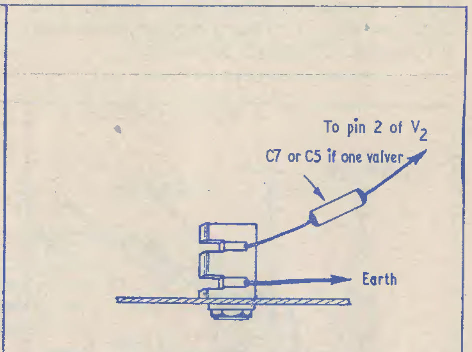


FIG 8 PHONE CONNECTIONS

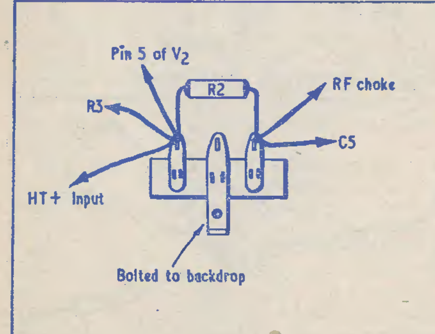


FIG.9.TAG WIRING

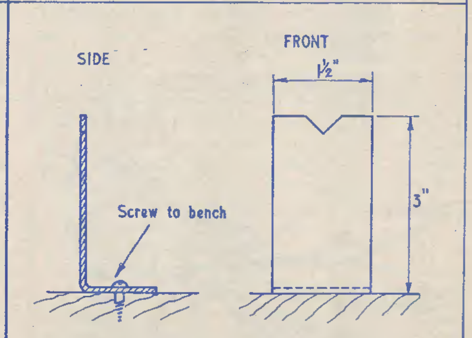


FIG.10.SIMPLE SOLDERING IRON STAND

G218

that the key to these is that pin larger than the remaining three. Base details of this are given when the coils are purchased. (See component list). To the same connection as R_5 (the thick pin), take a wire direct to the earth tag on the aerial/earth strip. From the same pin to which C_3 has been connected, solder a length of PVC wire to the variable condenser C_b; this latter is the small condenser occupying the central position in chassis and thence to the aerial tag on the aerial/earth strip.

Lastly, to the earthing tag of V_2, solder a nine-inch length of wire and take this through the rubber grommet. This is both the l.t.– and h.t.– connection to the receiver.

This completes the first stage of the receiver, and we may now try it out on the air in order to ascertain that this part of the set is working before wiring up the second stage.

Putting the One-Valver on the Air

First, insert the valve (EF41) into the valveholder. Next, insert the phone plug into the jack and connect the aerial and earth to the appropriate terminals on the aerial/earth strip (crocodile clips would be an advantage here). Plug in one of the coils —the medium wave one would do— although it is not important which one is finally chosen, except that the signals received on MW are of course stronger in comparison than those on the short waves. Lastly, connect the power unit to the three leads protruding through the rubber grommet. (It is assumed here that the power unit has been purchased already made up. In any event, this was fully described in the heard. Adjust C_a for the loudest signal and follow this by slowly advancing R_4 until the receiver oscillates, i.e., a loud breathing sound is heard and the signal becomes distorted. Slowly retard R_4 to a point just below oscillation level. Then, with C_b, fine-tune the station. For this latter control to be used effectively, always commence operations with this set at a reading of 10. (Details of the perspex pointer and dial are given next month). By slowly turning C_b from 10 to 100 on the dial, the various signals will appear as they are tuned in. To read C.W. (Morse) signals, R_4 should be advanced slightly into oscillation, when these transmissions will be thrown into relief, as it were, enabling them to be read

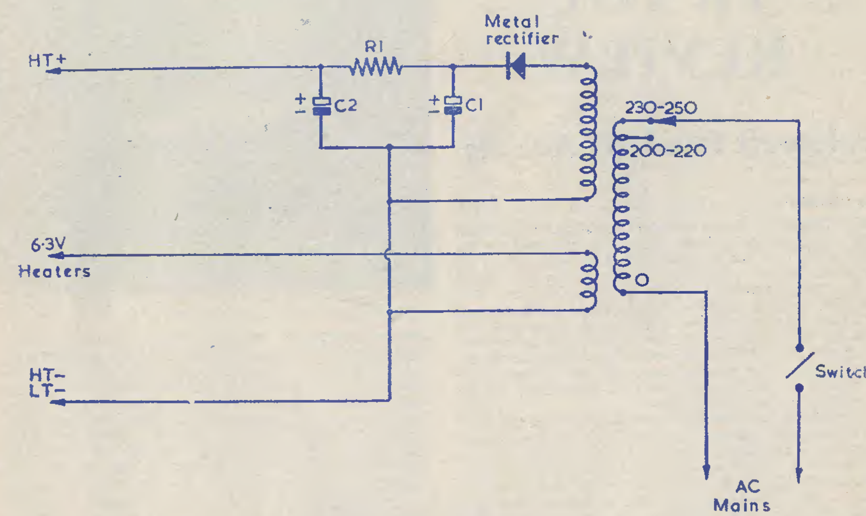


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Fig.11

Circuit of RCS power unit type PU1

October, 1954 issue of this magazine, copies of which are still available. Alternatively, the company supplying these units will forward full constructional details with the component parts). The leads coming from the power unit are:—Red (h.t.+)—join to tag strip, see Fig. 9; orange (l.t.+)—connect to the wire from pin 1 of V_1 valveholder; black and blue (h.t.– and l.t.–) —join to wire going to soldered earth tag of V_2. Connect power unit to the mains and switch on.

Operation of the One-Valver

With C_a and R_4 at approximately half mesh, slowly rotate C_1 until a signal is —always assuming, of course, that the constructor has a knowledge of the code. Further operating details are given in Part 3 next month.

Power Unit Type PU1

For those who require the circuit of this unit, it is presented herewith. It is capable of delivering some 120 volts at 20mA for the h.t.+ supply, and 6.3 volts at 1.5 amps for the valve heaters. This rating is adequate for the Mini-Receiver and the power unit will be found to run cool at all times—a sure sign that it is not being overworked.

(To be continued)

TRADE REVIEW

Telecraft Band III Aerials

The "Bandit"

The "Bandit" is a 3-element Yagi-type aerial with special mountings enabling it to be strapped to an existing "H" or single dipole, thus allowing Band III signals to be fed into the receiver without the use of further lead-in co-ax or cross-over units.

It is of unusual design in that the spacing differs from orthodox principles, the director being ⅛-wave spaced from the driven dipole and the reflector ¼-wave spaced. The aerial is constructed of specially treated aluminium alloy giving great strength, yet the unit weighs only 12 ounces approx. All elements are insulated from the boom by polythene insulators.

A specially designed mounting enables the "Bandit" to be rotated through a full 360° irrespective of direction of the Band I aerial. This facility is of great assistance in obtaining maximum signal strength, and also the reduction of "ghosting" where this is experienced. The "Bandit" is, in fact, a complete fringe area assembly, the characteristics being approximately similar to an array of this type designed for these areas.

When attached to a standard 1/7th wave "H" type aerial, the forward gain is 6 db, front to back ratio 8 db, and the acceptance angle at half power points is better than 40°.

Some readers may require to know how it is possible to connect a Band III to a Band I aerial without loss of signal to either arrays. The answer is that it is merely a question of relative impedances—or what the value of impedance at the centre of one array looks like to the other. A half-wave driven element, at its resonant frequency, has an impedance which rises from 70 Ω at the centre to a figure of several thousand ohms at the ends. A full-wave element, assuming one was used, would therefore have a high centre impedance with two low impedance points a quarter wave from each end. A Band I dipole is practically four times the length of an element cut for Band III, therefore its centre impedance looks like several thousand ohms to the centre of a Band III aerial, connected in parallel, hence the loss to the latter is negligible. Conversely, the short element of the "Bandit" array looks like a high impedance to the Band I aerial, hence they can both be connected to the same feeder and no cross-over unit is required. Thoroughly recommended to our readers, the "Bandit" Band III array is modestly priced at £1 10s., free delivery in London area. It is available to readers direct from the manufacturers: Telecraft Ltd., Quadrant Works, Wortley Road, Croydon, Surrey. Telephone THOrnton Heath 1191/2/3, or from retailers.

The "Bandit" Band III array has been tested and used by us at a distance of some 35 miles from the experimental transmitter with excellent results. Added to a normal "H" type aerial the results achieved fully justify the manufacturer's claims. With the added advantages and consequent saving of having no additional lead-in and cross-over unit, we feel the "Bandit" will become very popular with our readers.

Complete with a Band I "H" aerial and all fittings, the whole assembly is priced at £5 2s. 6d. Complete with a single dipole Band I aerial the cost is £2 10s.

Type 503A—503

The 503A Band III aerial is a 5-element Yagi with folded dipole. The construction and spacing follow orthodox lines except that all elements are insulated from the boom, the whole assembly being fabricated from special heat treated aluminium alloy giving great strength with minimum weight. This is of great importance as it is assumed that the majority of Band III aerials will be required to be fitted to existing masts. The aerial is supplied with a unique fixing plate enabling the aerial to be mounted on an existing mast either in the loft or on a gutter board.

The cable connection consists of a weather-proof polythene box having inlets for either standard or semi-air-spaced cables. Using a ½-in outside diameter tube for the elements enables the utmost efficiency to be obtained at these frequencies, and the gain shown is 8 db with a front to back ratio of 9½ db. The forward acceptance angle at half power points is better than 25°. The type 503A aerial is priced at £2. Complete with cranked arm and chimney lashing or wall brackets it is £3 19s. 6d. (type 503, as shown in heading). As with the "Bandit," it is available to readers direct from the manufacturer. This array is recommended to readers who require a separate Band III aerial. The connecting co-ax should be of the 80Ω impedance type.

A SIGNAL TRACER—PLUS

by **A. SHAW**

THE UNIT DESCRIBED IN THIS ARTICLE AND shown in the accompanying circuit diagram was originally conceived as a signal tracer during a mood of black despair caused by an obscure fault in one of those veteran receivers, the insulation on whose wiring is apt to fall off in generous flakes if it is disturbed. In these receivers and, fortunately, more rarely in some more modern types, it is usually necessary and certainly advantageous to be able to monitor valve bases and other suitable points with a thin probe so that the wiring is disturbed as little as possible. If such a probe is feeding a device capable of reproducing, at a comfortably audible level, either by earphone or loudspeaker, whatever signal is present at the monitored point, then finding those less obvious faults which often occur is much less difficult. Assuming that such a fault does not lie in the first tuned circuit, which is relatively unlikely and, in any case, becomes immediately apparent, it is only necessary to probe the frequency changer or r.f. amplifier grid, tune for maximum output from the tracer and successively to monitor suitable points through the receiver in order to localise the stage on which maximum effort must be concentrated. To achieve impartial reproduction of r.f. or audio signals with one and the same probe unit calls firstly for a probe unit capable of detecting r.f. and passing audio signals and, secondly, for relatively high gain, since tuned circuits cannot conveniently be incorporated in a signal tracer. The probe unit shown in the circuit diagram does all that is required in this respect, while the gain provided by the circuit as shown is sufficient to reproduce all the stronger signals which are present on an indoor aerial in an area notorious for its bad reception, without, of course, any sort of tuning whatever.

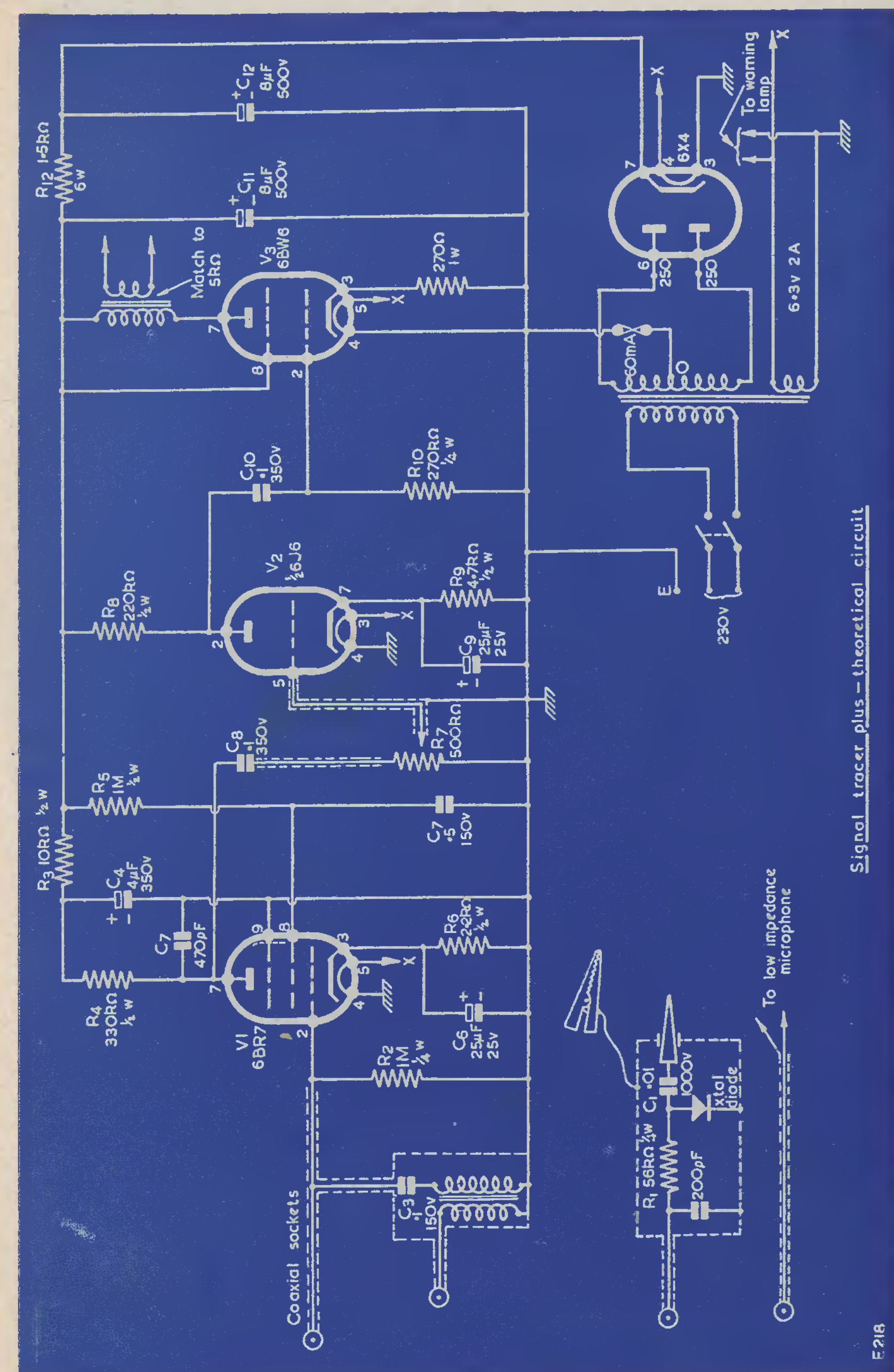
The usefulness of a signal tracer is by no means confined to "awkward" receivers; any receiver having a fault may be investigated as desired. Being of a conveniently portable size, the writer's unit was endowed with a carrying handle and has several times proved a great labour saver, in that *in situ* investi a-tions have sometimes prevented large and heavy receivers having to be humped over quite considerable distances for faults which were trivial but not readily apparent.

After the unit had been in action for some time as a signal tracer, the need arose for a baby alarm and, having a high gain amplifier ready to hand, it was the work of but a moment to insert a second co-axial socket and a microphone transformer, so that now the unit does a double duty, with equal facility in both roles, at the cost of only one amplifier.

No claim is made for originality of design; on the contrary, the circuit will be seen to be depressingly conventional. To avoid undue hum pick-up and any tendency to instability the microphone transformer should be shielded and mounted under the chassis; similarly the input leads to the transformer and to V_1 control grid should be shielded and as short as possible. The decoupling afforded by R_3 and C_4 further reduces the possibility of instability (which may sometimes occur when the probe unit is not connected and a high gain level is set at R_7), while C_5 removes any r.f. which may have passed through the probe unit. The remainder of the circuit follows closely the lines of the audio stages in any receiver and ultimately drives a 3½in speaker, through a transformer to match it to 5,000 ohms.

The valves shown in the circuit diagram were chosen in preference to more orthodox amplifier types partially because two were already available in the spares box, but mainly on account of their physical size. The 6X4 and the 6J6 both mount on B7G bases, while the other two use B9A. If extreme portability is not essential, there is no reason why the more normal I.0-based line-up of 6J7, 6J5, 6V6 and either 6X5 or 5Z4 should not be used, without any circuit value changes at all. In the miniature valve line there are no readily available equivalents to the 6BR7 or 6BW6 that would not require circuit modifications, but the 6J6, of which only one half is used, could, with suitable reconnections at the valveholder, be replaced by an EAC91, which has more modest filament current requirements, 0.3A as opposed to 0.45A.

Experienced constructors will readily realise what component values must be changed in order that they may use their pet valves, or valves they happen to have available, but in general the valves shown, or their I.0-based equivalents, or any combination of the two types, should be used.



Signal tracer plus – theoretical circuit

The wattage rating of resistors and the voltage rating of capacitors are shown on the circuit diagram; particular note should be made of the voltage rating of C_1 in the probe unit. The probe will often be applied to points which are at h.t.+; thus it is very necessary to have a capacitor of adequate voltage rating in that position. 1,000 VDCW may seem somewhat high, but in fact this component is not physically large and it is better to be safe than sorry.

The power supply is derived quite conventionally, with a 6X4 and an R-C filter. The 6X4 happened to be available, but there is no reason why a metal rectifier of adequate voltage and current rating should not be used instead. The unit takes 41 mA at 230V h.t., so a 60mA component, say two RM1's, would be quite satisfactory and would also provide a little extra space. Any mains transformer having a centre-tapped secondary giving an output of the order of 250/275V at 50mA, together with a heater winding giving 6.3V at 2A, for a normal mains input, will suffice. The primary limitation is one of physical size, but of course this is entirely up to the individual. The R-C filter was used mainly in the interests of size, but in the event there turned out to be quite enough room for a midget choke. However, the R-C filter yields a quite acceptable hum level; but if a metal rectifier is used a choke, suitably rated, would probably be a better choice.

The probe unit, which connects to the amplifier unit via a suitable length of screened cable and a co-axial plug, was originally contained within one of the screening cans that in days gone by were used to screen those massive coils, but since reading the article by W. S. Burrows in the March issue, the writer has been given to realise how piteously primitive this arrangement is. Potential constructors are, therefore, recommended unreservedly to Mr. Burrows' proposed probe case.

The microphone is of the low impedance type only because it happened also to be available when the need for it arose. If, however, a high impedance type is available it can of course be used without a transformer, in which case both the microphone and probe leads can be terminated in a co-axial plug and the same socket in the tracer can be used for either. Whether a high or low impedance type is used, the lead-in cable should be screened.

The method of using the tracer has already been mentioned. It should be borne in mind, however, that it is essentially a device for locating faults which have not yielded to normal preliminary tests. The writer once knew a serviceman in America who got steamed up to such a pitch of enthusiasm over how easy fault-finding was with a signal tracer that he always used it as a matter of course, to the exclusion of more basic preliminary investigations. As a result he once spent over 30 minutes looking for a fault which in the event turned out to be a dud fuse in the wall socket. Used as a trouble shooter where normal tests fail to pinpoint the fault, it will more than repay the trouble taken to construct it. In addition, one always has a high gain amplifier to hand, which is sometimes an asset in a workshop; one also possesses a baby alarm and even a standby radio. The writer's unit was once used in conjunction with a coil and a condenser as a sick bed radio for a child. The selectivity was appalling, but the child was very happy. Most of the required components are available in any spares box, and the initial outlay is modest indeed for the service one can reasonably expect to obtain.

NEW LABGEAR TRANSMITTER

Labgear (Cambridge) Ltd. announce a new version of their well-known LG300 Amateur Bands Transmitter, which was reviewed in our March issue. The new version is known as the LG300 Mark II, and embodies many improvements over the original model. The cabinet is even more distinctive, being finished in a dual shade of grey.

As will be remembered, the most noteworthy features of this design are the extensive harmonic filtration combined with tuned harmonic rejector circuits, making TV1 just about as much suppressed as it possibly can be at the transmitter end.

A harmonic check point is provided for test purposes, and reduced power "tune-up" facilities are also incorporated. Thorough shielding is provided, but this has not been carried out at the expense of efficient ventilation. An 813 handles the full 150 watts at A_1 or A_3 without any signs of overheating. The 10, 15, 20, 40 and 80 metres bands are covered, and the calibrated VFO is really stable.

As our readers will know, this unit is designed to provide the Amateur with a transmitter in which all the difficult aspects of transmitter construction to cope with present-day requirements has been carried out. The construction of power supplies and the modulator is still well within the constructional ability of the average amateur. Adequate TVI-proofing, etc., is not so easy for those with limited laboratory facilities. Here is the unit to use with existing power pack and modulator.

At 55 guineas complete except for the 813, or 51 guineas less all valves, it represents a very economical way of acquiring a modern amateur transmitting station.

Full details are available on receipt of an S.A.E. from Labgear (Cambridge) Ltd., Willow Place, Cambridge.

BAND III TELEVISION for the HOME CONSTRUCTOR

PART 4: A HIGH-GAIN BAND III CONVERTER

by S. WELBURN

Following upon last month's double-pentode unit, we now present an up-to-the-minute Band III converter using the latest valves and techniques. The description of this converter represents yet another contribution to our Band III series by that popular writer on television topics—S. Welburn.

IN LAST MONTH'S ISSUE WE DESCRIBED A Band III converter employing the Teletron two-pentode coil-set. This unit was capable of being built upon ready-drilled chassis which were available from advertisers in *The Radio Constructor*; and it was designed to give the especial qualities of simplicity of alignment and construction.

Since that article was written, a considerable amount of research has been carried out with the intention of producing a cascode, triode-pentode converter which not only possessed similar qualities, but which also gave the greater gain associated with these valves. This work has now been completed; and the unit described in this article is the result.

The New Converter

Before proceeding with a description of the circuit and layout, a few general comments on the new converter might be advisable at this point.

To begin with, the new converter employs exactly the same chassis as did the earlier model. Thus, chassis offered by advertisers for the "Teletron Band III Converter" are applicable either to the two-pentode or to the cascode, triode-pentode version.

The new converter can be run from the same heater and h.t. supplies as was the two-pentode unit. However, due to the various different types of cascode and triode-pentode now available, the heaters of the unit may, alternatively, be connected into an 0.1 or 0.3 amp series heater run.

The recommended h.t. voltage should be between 180 and 250 volts. At 200 volts, consumption should normally lie between 20 and 25mA.

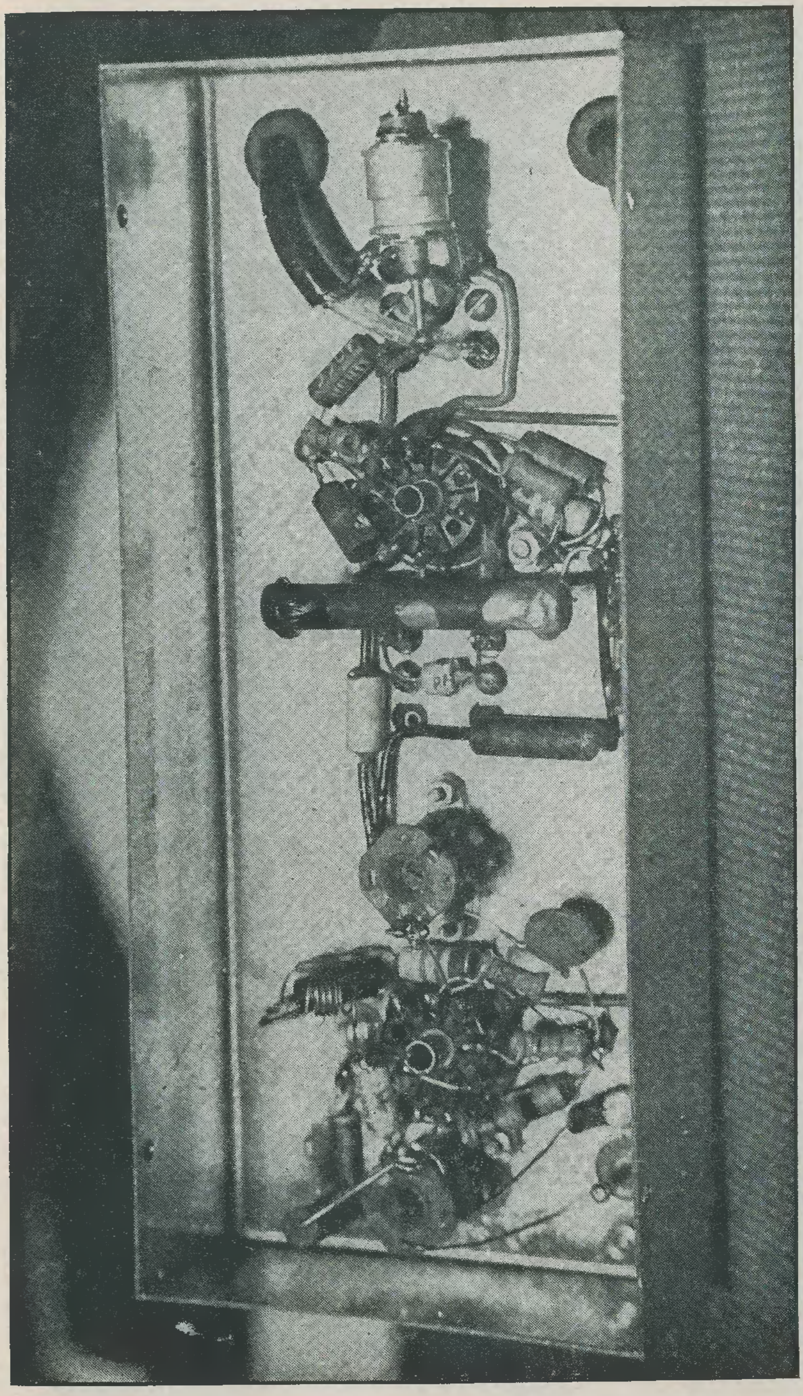
The Circuit

The circuit of the converter is illustrated in Fig. 1.

In this diagram the Band III 75 ohm aerial input connects to the coupling coil L_1. This couples into the tuned coil L_2, and is designed to provide maximum transfer of signal energy from the aerial to the grid-cathode input circuit of V_1 (*a*). A neutralising circuit is provided by the condensers C_1 and C_2, these helping to increase the signal-noise ratio.

The anode of $V_1(a)$ feeds into the cathode of the earthed-grid triode $V_1(b)$ via L_3 and R_3, C_3. The purpose of L_3 is to provide accentuation of frequencies near its own resonant frequency (in conjunction with circuit strays). The tuning circuit of L_3 is, however, slightly damped by R_3 in parallel with C_3; this arrangement causing L_3 to be effective over a greater band of frequencies than would otherwise be the case. R_3 is not, incidentally, intended to act as a cathode bias resistor for $V_1(b)$, and it is quite in order to return R_4 to the upper end of this resistor.

$V_1(b)$ functions as the second half of the double-triode cascode and its anode feeds into the pi-network formed by L_4, together with the capacities to chassis existing at either end of this coil. The input impedance at the grid of $V_2(a)$ is very low at Band III frequencies, and it is possible to obtain an accurate degree of matching for individual converter units by varying the value of C_6. For this reason it has been decided not to specify a particular value for this condenser, but to leave its final capacity to be chosen by the constructor. Out of several prototypes constructed and tested, optimum results were given by values ranging between 2,000 and 4,000pF. The final value of C_6 is not,



Underneath layout of the Teletron Mark 2 Band III Converter incidentally, very critical; and the constructor is advised to commence building with a component at this position whose value is 2,000pF.

It was found that there was no necessity to couple the triode oscillator section, $V_2(b)$ of the triode-pentode to the mixer, $V_2(a)$; more than adequate oscillator transfer occurring through the stray capacities existing in the valve and valveholder. Indeed, the addition of a coupling condenser is liable to cause the appearance of too high a heterodyne voltage on the grid of the pentode, and may even cause a slight loss in conversion conductance.

The i.f. appearing at the anode of $V_2(a)$ is fed to the i.f. transformer, T_1, in conventional manner. T_1 is tuned to Channel 1, and has a response broad enough to pass the video signal without attenuation of higher frequency modulation. A coupling coil in T_1 transfers the i.f. built up across the primary to 75 ohm cable for connection to the aerial input socket of the Band I television receiver.

Heaters

The heater circuit is not shown in Fig. 1. This is due to the fact that this may vary for different types of cascode and triode-pentode.

If the converter unit is to be run from a 6.3 volt heater supply, the valves required will be ECF80 and ECC84. The heaters of these valves should then be wired as shown in Fig. 2 (a). There is little which requires further description here, save that the earthy heater connection to each valve is taken direct to the chassis at an adjacent point.

If a series heater run is decided upon, the circuits of Fig. 2 (b) or (c) may be employed. The valves now required will be UCF8O and UCC84, assuming an 0.1 amp heater supply; or PCF80 and PCC84, assuming an 0.3 amp heater supply. The circuit of Fig. 2 (b) applies to the case when the converter valve heaters are at the "chassis end" of the heater chain; and that of Fig. 2 (c) to the case when the heaters of several valves in the associated television receiver are inserted between those in the converter and chassis. If the series heater arrangement is employed in conjunction with the valves in the television receiver, the chassis of the latter must be bonded by a separate wire to the chassis of the converter. Normally, this bonding will be provided automatically by the h.t. negative lead. On no account, however, should the outer conductor of the co-axial cable joining the converter and the receiver be relied upon alone for this connection; a separate lead is essential.

It cannot be emphasised too strongly that, in the event of the converter unit having a live chassis, the normal precautions against shock must be observed. This applies especially to the aerial, and an aerial isolating arrangement similar to that described in last month's issue should be regarded as essential under live chassis conditions.

Layout

The layout of the converter is illustrated in Fig. 3. This layout applies to the 6.3 volt heater version and shows the wiring applicable to the circuit of Fig. 2 (a). Slight alterations in heater wiring will be required if the circuits shown in Figs. 2 (b) or (c) are used. In the case of Fig. 2 (c) an additional anchoring point will be required for the extra heater connection, and the 3-way tag-strip should be altered to 4-way. The layout of the altered heater wiring is not of considerable importance; and the leads concerned may follow the route of the single heater wire shown in Fig. 3.

In Fig. 3 most of the components have been illustrated as having longer leads than would be the case in practice. This has been done to provide increased clarity in the diagram. When the converter is being constructed, all component leads must be kept as short as possible (see photo). Components carrying r.f., such as C_7, should be spaced away from the underside of the chassis. Decoupling condensers, such as C_4, need not be so spaced.

Alignment

The alignment of the converter requires a little more time than does that of the two-pentode version described last month, but this is only because there are more Band III tuned circuits and, in consequence, more variables to take into account. The instructions which follow apply to the case where the constructor has no signal generator.

The television receiver and converter should be switched on and allowed to warm up. The televisor should then be receiving the Channel 1 signal.

The Band I aerial is next disconnected from the televisor aerial socket and connected (via 0.001 μF isolating condensers of the correct voltage rating in the case of a live chassis) between the grid of $V_1(a)$ and the converter chassis. The converter output is connected to the aerial input socket of the televisor.

The Channel 1 signal should now reappear. If necessary, the receiver contrast may be increased to allow this to occur. The core of T_1 and C_{12} are next adjusted for maximum Channel 1 signal, turning down receiver contrast as alignment proceeds. There will be an optimum combination of settings between the core and the trimmer, and alignment should be carried out bearing this point in mind.

The Band I aerial is next removed, and the Band III aerial connected to the input of the converter. The receiver contrast control is then set to its "maximum" position. The

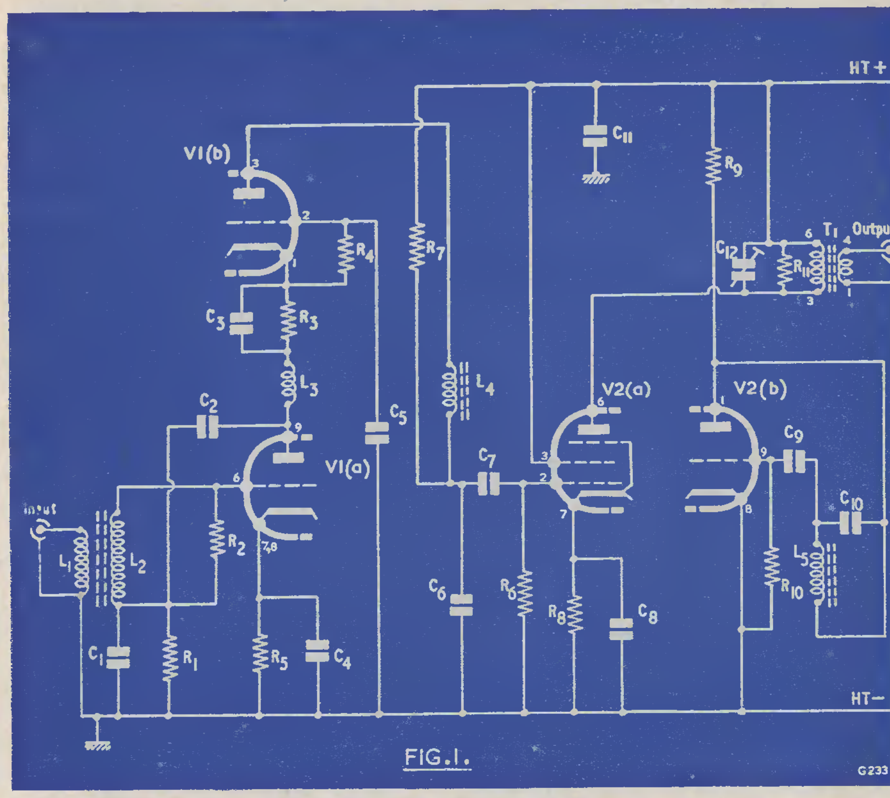


Fig. 1. Circuit diagram of the cascode, triode-pentode converter

COMPONENTS LIST

Resistors (all ¼-watt unless otherwise stated)

R_1	47kΩ
R_2	10kΩ
R_3	100Ω
R_4	22kΩ
R_5	120Ω
R_6	220kΩ
R_7	1kΩ
R_8	680Ω
R_9	10kΩ 1 watt
R_{10}	22kΩ
R_{11}	5.6kΩ

Condensers

C_1	10pF
C_2	2pF
C_3	100pF
C_4	1000pF
C_5	1000pF
C_6	see text
C_7	25pF
C_8	1000pF
C_9	10pF
C_{10}	3pF
C_{11}	1000pF
C_{12}	Trimmer, concentric

Valves

V_1	ECC84 or equivalent (see text)
V_2	ECF80 or equivalent (see text)

Coils

L_1, L_2	Aerial input coil. Green Spot Teletron
L_3	Peaking coil. Teletron
L_4	Coupling coil. Blue Spot Teletron
L_5	Oscillator coil. Red Spot Teletron
T_1	I.F. Transformer. Yellow Spot Teletron

All coils available as Coilset "Mark 2" Teletron.

cores of L_4 and L_2 should be adjusted such that their upper surface is approximately flush with the upper surface of the chassis. (The cores are clearly visible through the polystyrene formers.)

The oscillator core is now very slowly and carefully adjusted until the Band III signal becomes visible upon the screen, or audible from the loudspeaker. L_2 and L_4 are then adjusted for maximum signal, reducing receiver contrast as necessary. Adjusting L_4 may slightly off-set L_5, which should be consequently re-tuned.

In areas of very weak signal strength it is possible that the initial settings of L_2 and L_4 may have to be fairly close to their final settings if the Band III signal is to be primarily picl ed up. In such a case it will be necessary to try several combinations of these cores before tuning L_5 through its range. Alternatively, it may prove helpful to adjust L_2 and L_4 for maximum "noise," and then keep them in step with L_5 as the latter is adjusted.

(To be continued)

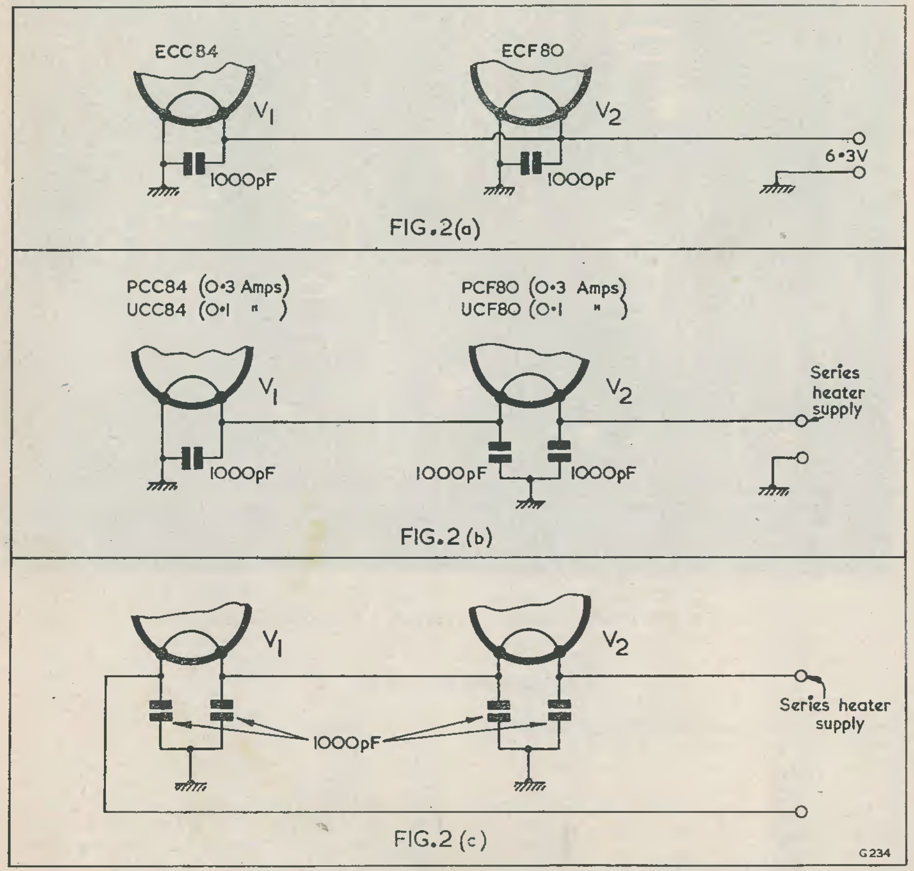


Fig. 2 (a) *Heater circuit required for a 6.3 volt supply*
Fig. 2 (b) *A suitable arrangement when a series heater supply is employed*
Fig. 2 (c) *The circuit used when heaters in the television receiver are connected between those of the converter and chassis*

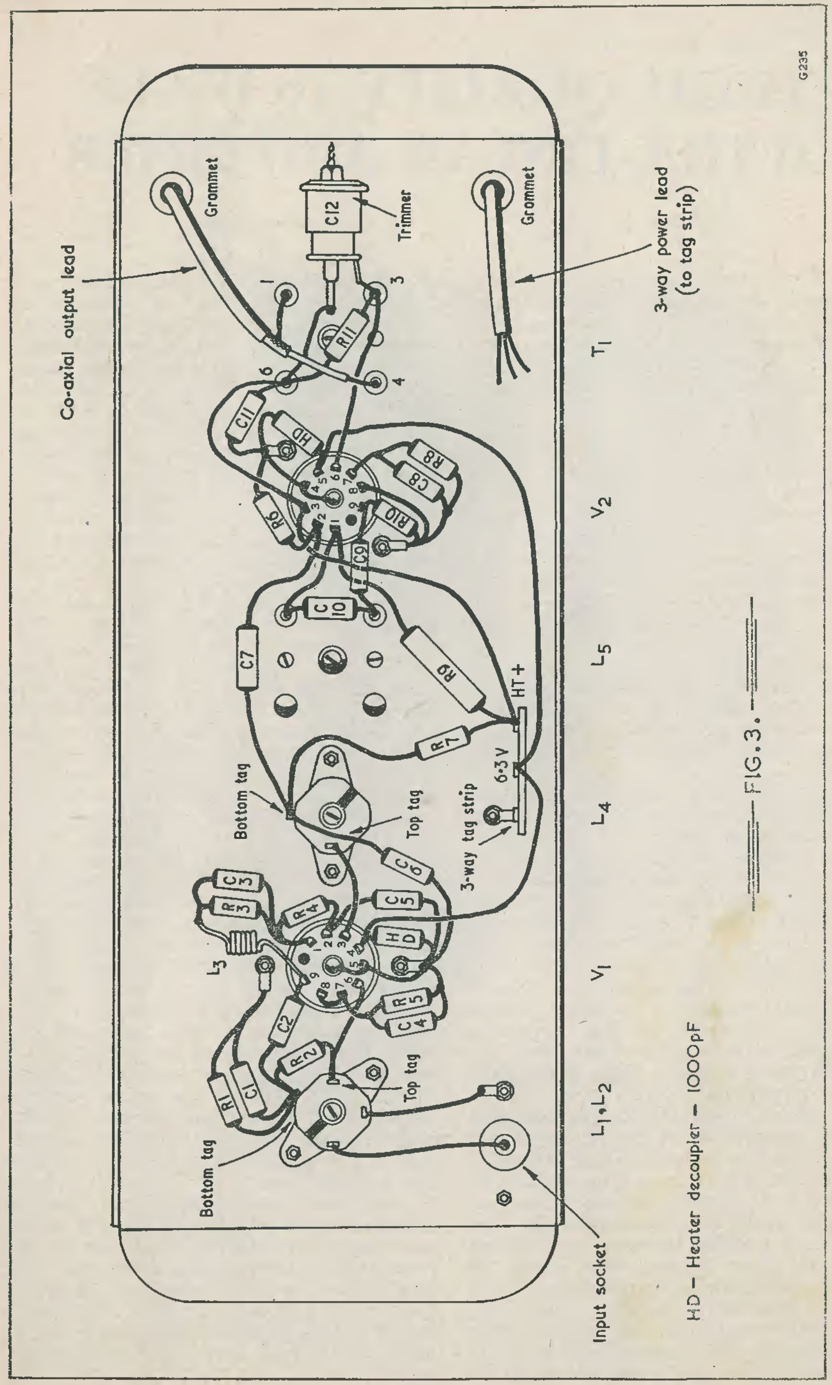


Fig. 3. *The under-chassis layout of the converter shown slightly displaced to give extra clarity to point-to-point wiring—compare with photograph on page 159*

HIGH QUALITY 10 WATT ULTRA-LINEAR AMPLIFIER

PART 1.

by L. F. SINFIELD

With the present availability of high quality recordings and increasing use of lightweight high fidelity pick-ups and wide range speakers, there is an understandable enthusiasm for suitable high fidelity amplifiers. Much of this originates from the very popular "Williamson" design, which set an extremely high standard and was very widely copied in home-construction form and also commercially.

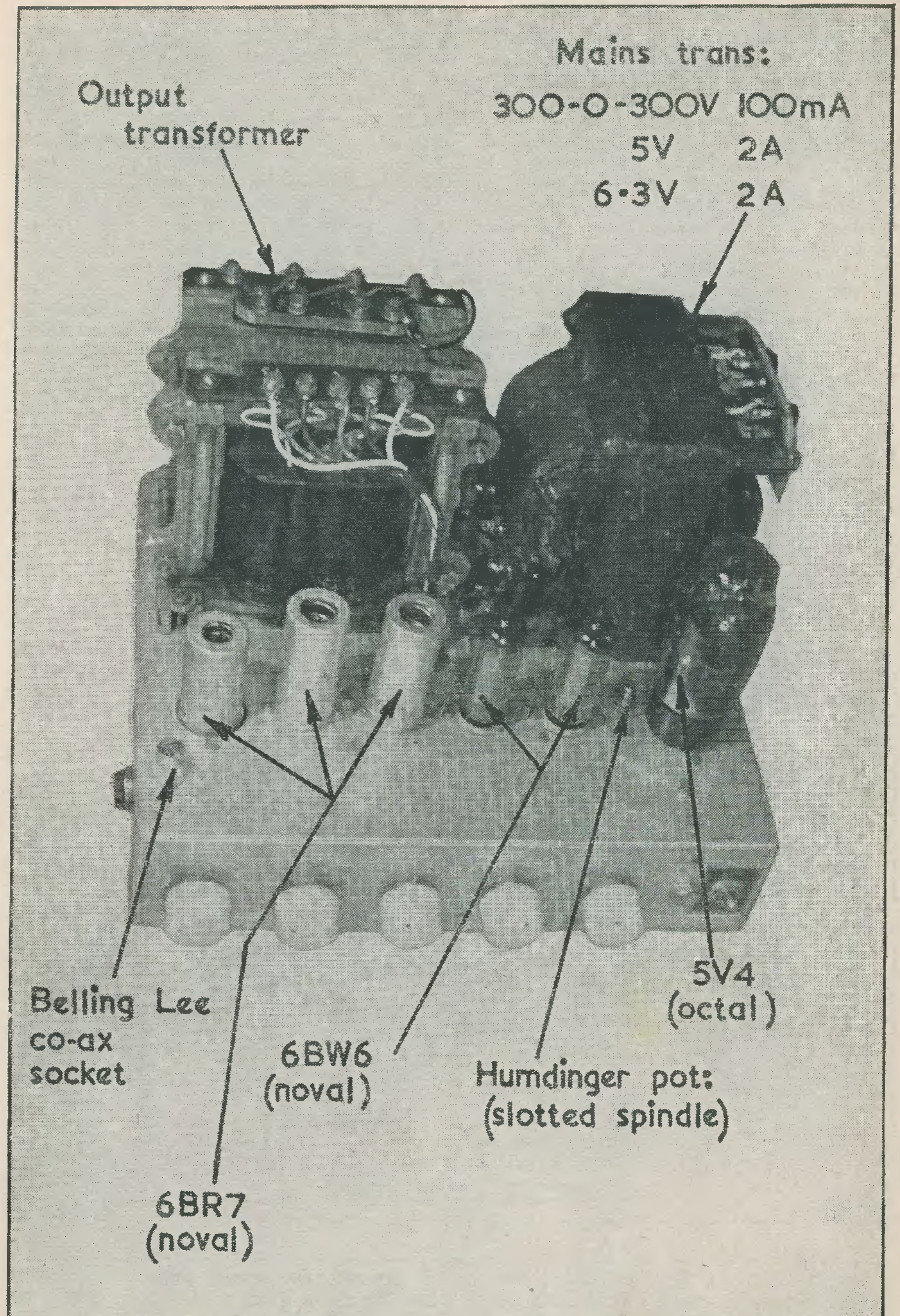
However, this particular amplifier is extremely bulky and physically generally too large for most domestic or small hall applications. Also, the high h.t. voltage makes the use of the standard range of electrolytic condensers unsuitable and higher voltage, more expensive, types necessary. Another complaint common on this unit as applied to home construction is the low margin of stability; and even when these are run under normally stable conditions, exhaustive testing often reveals parasitic bursts under transient conditions and h.f. oscillation with capacitive loading.

It is this desirability to obtain adequate power from an amplifier of reasonably small proportions which has led to the re-introduction of the ultra-linear method of operation, and its understandable popularity. With regard to h.t. current drawn and power output, this method gives an efficiency roughly equal to pentode conditions. The maximum output is also similar to pentodes. Distortion for a given output level is lower than either pentodes or triodes. Output impedance, an important factor in ensuring good speaker damping, is very much less than for pentodes and only a little higher than triodes. Linearity is also very good. All this is not achieved without loss; as the local feedback brought about by the screen tap requires slightly extra grid voltage drive over pentodes, but this is not unduly difficult to allow for in the amplifier design, Therefore, to obtain results at least comparable with triodes it is possible to make an amplifier either give more output, when using the original valves in the new arrangement, or to make an equivalent amplifier output with smaller valves and lower h.t. supplies. For normal use the latter arrangement is by far the more satisfactory, as it then allows the use of smaller and cheaper components (more conservatively rated) and a reduction in physical size, consumption and overall cost.

The American designers, Hafler and Keroes, who made this type circuit so popular, specify that for KT66 type valves the ratio of winding for the screen tap should be 43% for optimum results, but in Britain the published data would indicate that about 20–25% would be more suitable. However, most of the high quality output transformers produced here commercially for this application adhere to the American specification; although this may, of course, be done to satisfy the export market.

For 6V6 operation these same designers specify that the optimum tap ratio is 24%.

For the amplifier design given here type 6BW6 valves are used, as these are noval based versions of the 6V6 and electrically identical. With a mains transformer of 300/0/300V secondary this gives an h.t. line of around 330 volts; a figure which allows standard type electrolytics to be used for smoothing. The reservoir fitted was a paper type, as this was handy, and allowed better reliability, but it can be replaced by an equivalent capacity plain foil electrolytic of about 450/500 volts working. Although miniature valves are used throughout, the rectifier is a standard octal type in order to give very conservative current rating and to ensure adequate continuous sine wave power output and good high power transient response. Under these conditions the amplifier gives over 10 watts continuous sine wave output (this being the actual power measured into a resistor load of 15 ohms). In the region 20–20,000 cycles the output is around 10–12 watts at low distortion. At the high frequency end distortion is just perceivable on a scope at 7.5 watts at 50kc/s. At the low end this occurs at 15 cycles at 8.8w. Beyond these points the output handling capability drops off fairly rapidly, but in any case these are beyond the limits of the recordings and their associated pick-ups. The tone controls are also determined to give a limit to the frequency response. This excellent low frequency power handling is due to the very generous core size of the output transformer.



COMPONENT LAYOUT – TOP

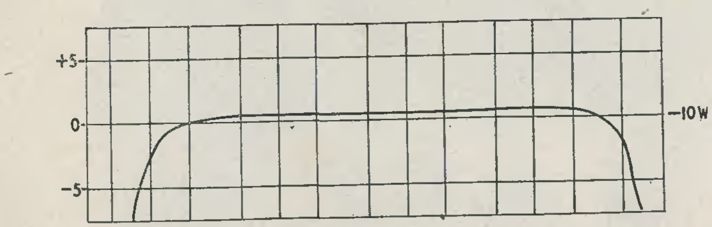
Frequency Response

The curves are shown for this at a reference level of 5V into a 15 ohm resistor load, this being a probable average mean level of music or similar signal. The input signal source consisted of a sine wave oscillator of constant amplitude covering the range 5.5 cycles to 70kc/s. The input was injected into the main amplifier with the specified 18db of feedback.

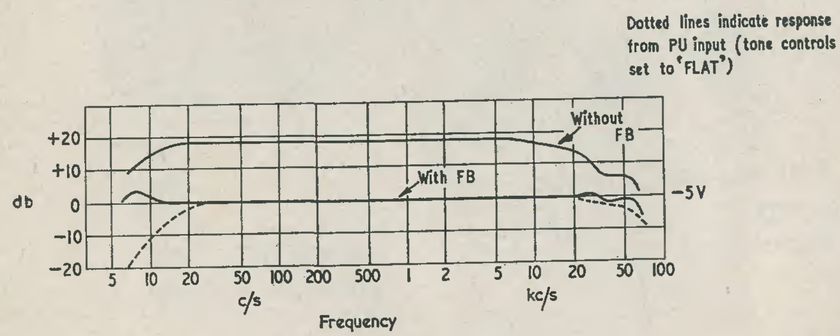
Even without feedback the frequency response is reasonably flat over the entire audio range, so that the amount of feedback is fairly constant in this range and maintains the low output impedance, low distortion, etc., well beyond the limits of any speaker into which it will feed. It was felt very desirable to maintain a high damping factor over as wide a range as possible in order to obtain optimum speaker performance.

and rises again slightly to a minus 1db condition at 54kc/s. Beyond this the response falls again and is some 3db down at 70kc/s. It is presumed that it continues to drop further after this point, but this was the limit of the test equipment. The slight rise at low frequency and the slight kink before the fall at high frequency are general characteristics of feedback amplifiers, and similar deviations occur in the Williamson and other similar units. However, these deviations are not of any significant amplitude and are outside the frequency range set by other requirements.

At low frequencies there is a tendency to reproduce turntable rumble if the response is extended too far, so that the time constants of the tone circuits and the pre-amplifier stage are set to give some degree of attenuation at these very low frequencies, thus they do not enter the main amplifier to any extent and the slight hump at 8 cycles assumes no significance. The tone circuits and pre-amplifier constants also give a gentle fall at the high frequency end. With the input into



POWER RESPONSE INTO 15Ω RESISTOR



RESPONSE CHARACTERISTICS

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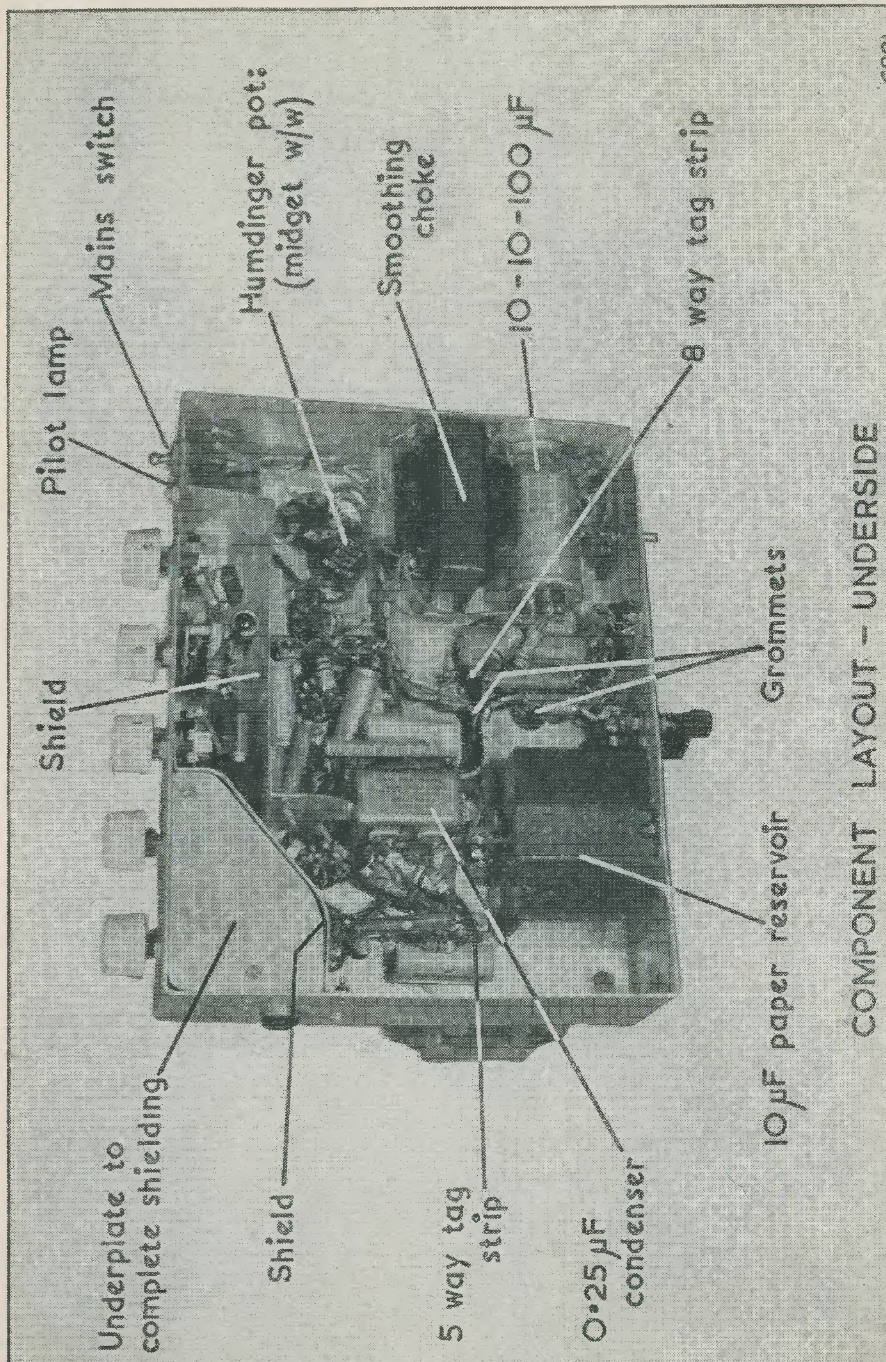
With reference to the mid-frequency level, the output rises approximately 3db at 8 cycles and falls back to zero level at 6 cycles. At the high end, the level rises approximately 0.5db at 30kc/s, falls to minus 2db at 36kc/s,



COMPONENT LAYOUT – UNDERSIDE

the pick-up socket, tone controls set to flat, and volume control approximately half-way, the response falls 3db at 32kc/s—4db at 50kc/s—and 9db at 70kc/s. This easily satisfies the required response. These are the measurements at the "flat" setting, and a considerable plus and minus variation is possible at various settings of the tone controls, both at low and high frequency ends.

Stability

This is usually the bugbear of feedback amplifiers, and often the margin existing is too low to maintain absolute trouble free conditions under a wide variation of input signals (particularly transients). Also, the necessities of home construction often mean that there are very minor changes in layout and possibly component specification. Most people have the sense to adhere strictly to the output transformer specification, but there is often a great deal of variation in transformers made commercially, even though they are supposedly to the same specification. It is quite common for a specific amplifier to work satisfactorily with one make of transformer, and not with another made by a different manufacturer advertised as to the same requirements. Therefore a great deal of time was spent in very severe stability testing, and although the precautions taken and the tests themselves might possibly be regarded as over-elaborate in that they allow for conditions almost impossible to occur in practice (unless done deliberately), they do, in fact, ensure an adequate stability margin under any normal conditions.

(*a*) The output valves chosen are of lower slope than those often used for this type of output stage, and are less likely to suffer from parasitics. As an added safeguard, grid and screen stoppers are fitted at the valve pins.

(*b*) Although only 18db of feedback is used, and this is ample in obtaining optimum output conditions, the correction was set to allow a much greater amount. On test it was found that the feedback resistor could be reduced to a condition of over 30db of feedback before the amplifier developed h.f. oscillation, so that an ample gain margin exists.

(*c*) As a loudspeaker impedance rises very considerably at some frequencies (particularly when not ideally matched to a cabinet), many experiments were tried with other load resistances and also with an open circuit load as well as speaker loading. Also, various capacities were parallelled with the various loads to determine the maximum capacity loading permissible under widely differing load conditions. Most of the effect of capacity loading is to produce h.f. oscillation at higher capacity values. As the speaker coil looks like an h.f. choke at these frequencies, these tests can be simulated with a suitable choke. In fact, although speaker and choke were tried, the results under open circuit conditions and with pure capacitive load only, are so similar that this simple test is advised. It was found that under these conditions a resistor across the output raised the value of capacity necessary for h.f. oscillation to commence. This resistor was therefore fitted, even though the amplifier is completely stable without it, as it only absorbs some 2 or 3% of the power output and yet increases the stability against capacitive loading by a considerably greater amount. These tests were also carried out under square wave conditions.

Circuit

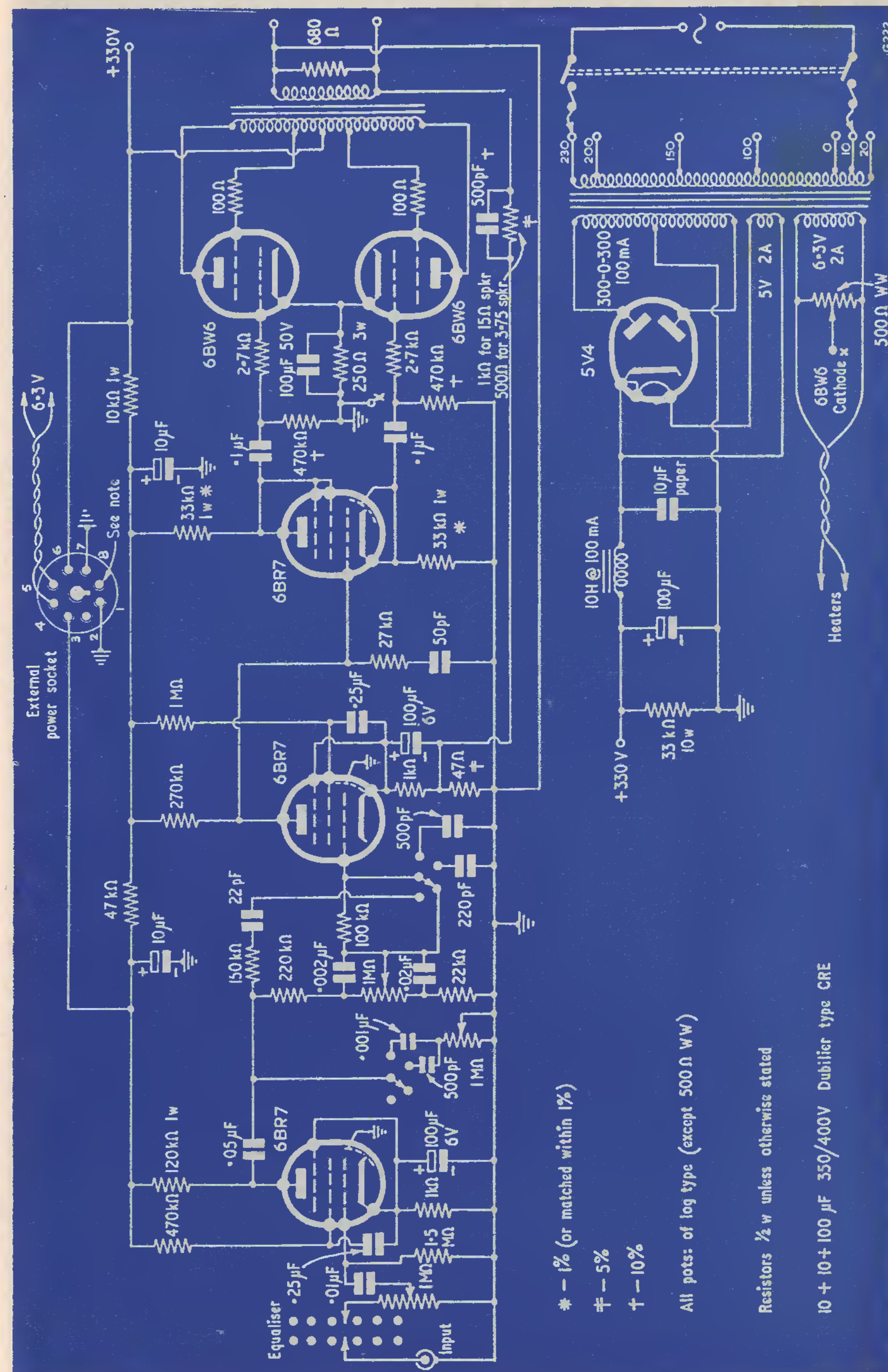
Primarily the amplifier was designed to work with crystal pick-ups of transcription quality (Collaro Studio "P," etc.) and it is possible that the use of high quality dynamic pick-ups would give insufficient output to fully drive the amplifier; particularly as these require rather more correction. However, a suitable head amplifier could be made as an extension, and an octal socket is provided at the rear of the unit in order to take off the power supply for this and similar purposes.

Following the input socket is a 6-way 2-pole switch, and this is arranged to bring in suitable equalisers for the particular type of pick-up, recording, tuner, etc., in use. Values are given for certain popular pick-ups for 78 r.p.m. and L.P. records. Other values will be dependent on the pick-up and can be obtained from the maker. Some amplifiers use a plug-in type of equaliser, but this could mean sorting out the appropriate plug and fiddling round the back of the amplifier, even to change from 78 r.p.m. to L.P. and vice versa. A switch was considered to be much more convenient.

Following the equaliser and the pre-amplifier are the tone control circuits. No originality is claimed for these, as they are similar to those used in the Osram 912. These give a range of control which covers almost every requirement, so that there is no point in spending time in making up a different circuit to achieve similar results.

The output from the tone control circuits feeds into the main amplifier. The first stage of this is a voltage amplifier. A pentode was chosen as it gives a greater undistorted output swing, and this is necessary due to the lower slope and larger grid swing of the output valves. It was felt desirable, also, to reduce the phase shift within the feedback loop as much as possible, and to this end the first stage is directly coupled to the phase splitter.

(*To be continued*)



A CONSTRUCTOR VISITS THE

1955 NATIONAL RADIO SHOW

ONCE AGAIN, THE RADIO SHOW AT EARL'S Court opened late this year. Whatever comments may have been made elsewhere, it can only be recorded here that the German Radio Show commenced on time; but the British show did not.

Television

The Radio Exhibition this year presented the same familiar scene to your reviewer as it has done for several years past. It was a "quiet" show, but at the same time it demonstrated the solid development work which has been in hand over the last twelve months. In the previous show Band III had captured the public imagination; with the result that Band III sets and associated equipment were in the forefront of almost every manufacturer's publicity campaign. Band III is now accepted as being part and parcel of the television scene, and 13-channel receivers were shown everywhere as standard equipment.

Nevertheless, one or two manufacturers went to considerable lengths to illustrate the effectiveness of their receivers on Band III. Pye, in particular, put on an eye-catching display which was especially impressive. This consisted of thirteen separate receivers ranged along the top of their stand, each of these being tuned to a separate channel and showing a different picture. The thirteen separate signals consisted of the B.B.C. and R.I.C. signals available at Earl's Court, plus pictures picked up by Pye cameras on their own stand.

Ferguson were also very much to the fore. The popular "Halolight" fitted in some Ferguson televisors showed its effectiveness especially well under the varying conditions of ambient lighting given by the show. The "Halolight" consists of a transparent surround around the tube screen which may be diffused with white light at any degree of brilliance desired. The result is a surprisingly strong impression of greater contrast in the picture itself. Ferguson, who have been amongst the first to introduce Band III converters for their existing Band I receivers, exhibited their full range of these converters. These differ from each other mainly in power requirements. However, their type "C" converter, which was designed for use with their earlier receivers, has an output at Channel 1, and could presumably be used with televisors of any other manufacture.

Converters by other firms were also in evidence, these including the Channel converters, the Ikopatent "Univerter," and the units manufactured by Valradio. Bush exhibited an "opened-out" sample of their "Telepic" tuning control, this being fitted to their converters and televisors in place of the more conventional turret tuner. The "Telepic" covers all 13 channels, tuning being effected by three ganged slugs moving in and out of the appropriate coils. Movement of the slugs is controlled by a cam coupled directly to the 13-position selector knob; whilst fine tuning is carried out by a mechanical device which causes a small amount of movement of the cores. A different set of coils is employed for either band, these being selected automatically by a switch mechanism operating from the selector knob.

The televisor which captured most attention in the lay Press was the Ekco portable receiver. This set functions either from the mains or from a car battery, drawing 7 amps at 12 volts in the latter application. A pull-out aerial is incorporated, and the screen diameter is 9 inches. A range of 25 to 30 miles is anticipated when the receiver is used with its own aerial. This set will also pick up f.m. on Band II. Its price, when released, will probably be around £60.

The writer, on making enquiries, was shown a small portable monitor developed by Ekco for use by the G.P.O. The portable "civilian" televisor is a development of this monitor. There were, apparently, only a few of these portable receivers in existence when the Show started, and Ekco were not taking any chances with one of the two they had on display. It was chained to their stand!

Home-Constructors

This year our new transistor receiver was displayed by Standard Telephones and Cables, whose transistors are employed in its construction. This little receiver attracted considerable attention from the public and it is due to be described very shortly in future issues. On the S.T.C. stand, in addition, was our A.M.–F.M. Signal Generator—also to be described shortly. The transistor receiver, incidentally, was the only one of its type to be seen.

Mullard devoted part of their demonstration room space entirely to the home-constructor. Members of the Mullard staff were present to deal with technical queries. The new Mullard 20 watt amplifier, employing EL34's in the output stage, was also being demonstrated.

G.E.C. exhibited their new amplifier, the "912-Plus." This amplifier is suitable for radio, tape and mic. inputs. Existing "912" amplifiers can readily be converted to the new version.

Printed circuits for both the G.E.C. and Mullard amplifiers are now available from T.C.C. This firm also exhibited condensers having terminations especially designed for printed circuit work.

To return to transistors again, these were exhibited both by Standard Telephones and Cables, and by Mullard. Mullard had an interesting exhibit which consisted of a small transistor transmitter and receiver. Both of these units employed Ferroxcube loop aerials, and the output of the transmitter was kept to a few milliwatts to prevent interference with other exhibits. For the same reason a low radio frequency was employed—50 kc/s. The receiver was arranged such that its a.f. output was connected to an oscilloscope. Members of the public were then invited to speak into a microphone at the transmitter, whereupon the waveform of their speech was shown by the oscilloscope.

V.H.F.

Considerable space was given in the Show to v.h.f. sound receivers. It is, indeed, very encouraging to note that the new service is receiving such excellent support from manufacturers. The demise of the present "standard" broadcast superhet, with its attendant whistles and higher audio frequency attenuation, may prove to be earlier than was originally anticipated.

The v.h.f. sets at the Exhibition could roughly be divided into two classifications. The first of these is that in which the f.m. programme is reproduced with somewhat better quality than that given by normal broadcast receivers. In this category, no expensive attempts were made to fully utilise the superior fidelity feasible with the new medium; although reproduction would nevertheless still be better than that normally available on medium and long waves whilst the quiet background given by v.h.f. would provide an added attraction. The second category is that in which full advantage is taken of the wider frequency range available, and the resultant a.f. circuitry and components approach or are equivalent to those associated with high fidelity reproduction systems. Receivers in the first category started from around £20 upwards, whilst those in the second category were in excess of £30.

The 1955 Radio Show

The most frequently encountered a.m.–f.m. sets were those in which the v.h.f. band replaced the short-wave band; and such versions were quite numerous. Slightly more expensive receivers incorporated a short-wave band as well as the f.m. band.

There were few f.m. adaptors. One exhibited by K.B. could be used as a simple f.m.—only set or as an adaptor. Others (Dynatron, Ferguson, and H.M.V.) were intended for connection to a subsequent amplifier.

Other Details

Considerable space was devoted to radio as a career, and a large area of the first floor was occupied by a special "Electr nics and Careers" display. This showed specialised branches of electronics (including an effective operating theatre scene, complete with TV camera focused on the operating table) and depicted the various ways in which a young man may advance in this sphere. Be it known, incidentally, that the chief engineer of a company may be drafted just as readily from production as he may from the laboratory.

R.E.M.E., in the Services section, put on an interesting little exhibit, this consisting of a model of the globe which turned in mid-air without any obvious physical means of support. The secret was a heavy a.c. magnetic field in a box just below the rotating globe, the "levitation" being the result of the eddy currents consequently induced in the metal of the globe itself.

A word on the general appearance of the Show may not be out of place before concluding. As always, an effective layout was obtained; but it cannot be gainsaid that the stands seem to be becoming more and more box-like as the years go by. A most welcome break from this tradition was provided by the Philips exhibit. Here the motif was that of the harlequin who features in their advertisements. This firm had two adjoining stands and the manner in which these had been planned in relation to each other was so effective that one felt that one had walked into a separate exhibition altogether.

A "MARBLE" REFLEX LOUDSPEAKER ENCLOSURE

by F. JOHNSON

THERE COMES A TIME WHEN THE "QUALITY" enthusiast, having done his best to achieve high-fidelity in his amplifier, pre-amp, pick-up, radio tuning unit, etc., realises that the weakest link in the chain is the loudspeaker.

A good L.S. chassis is, however, wasted unless the diaphragm is adequately loaded by a suitable mass of air. Even from a cheap speaker the reproduction can usually be improved by proper loading. It can be taken as axiomatic that best results are secured more easily by mounting the speaker external to the cabinet which contains the radio tuner and/or gramophone pick-up.

The simplest method of mounting the speaker is, of course, the flat baffle board. This prevents the sound wave from the back of the cone cancelling out the wave from the front; obviously these two waves are exactly opposite in phase. The longer the wavelength of the note to be reproduced, i.e. the lower the frequency, the larger the size of baffle required. For the reproduction, without undue attenuation, of the lowest musical frequencies, a baffle size of approx. 6ft. square is necessary—quite simple in a hall but difficult at home.

In order to achieve similar results in domestic surround ngs we turn to the popular reflex cabinet. This, briefly, is a cabinet so designed that the front of the speaker cone faces an opening in the cabinet and is therefore loaded only by the volume of air in the room. The *back* of the cone, however, faces a critical volume of air in a confined space, which is compressed with each backward excursion of the cone.

This pressure is usually relieved by means of small vents or ports in the cabinet, although it *can* be made airtight (infinite baffle). It is very easy to see that these pressure waves will tend to make the cabinet material itself vibrate in sympathy: this would be in order if it vibrated uniformly at all frequencies but, of course, the cabinet sides have a resonant frequency of their own. Reproduction is affected adversely far more than the uninitiated would suppose, and the obvious requirement is a cabinet free from audible resonances.

It will be found in practice that wooden resonance-free structures of this kind are not easy to make. Naturally the *real* enthusiast gets busy in the front sitting-room with bricks and mortar and so achieves his heart's desire by means of a brick enclosure. As this type of activity is (to say the least of it) frowned upon by the gentler sex, a concrete reflex cabinet has been designed to fit into the corner of a room.

This is pre-cast in suitable surroundings, e.g. on the garden-path, and moved into position when completed: in order to enhance the appearance and render it suitable for inclusion in a nicely furnished room, the outside surface is polished to imitate marble. As concrete is 4 times as dense as hardwood, an enclosure of 2″ concrete is as good as a wooden structure having sides 8″ thick! When completed, it will be found to look very attractive, and the foregoing theoretical considerations are fully borne out in practice. The bass is crisp and clear without noticeable boom or resonances.

It will be noted from Fig. 1 that the two ports serve the dual purpose of relieving the air pressure inside the chamber and of clearing the skirting boards.

The speaker chassis is mounted on a wooden sub-cabinet constructed as follows: take a piece of $\frac{3}{4}$in. plywood or Weyroc 15in. × 15in. and cut out a circular hole suitable for the speaker chassis being used; plane the edges—not square but at a slight angle. (See Fig. 2). When bedded in concrete this helps to "key" the wooden insert securely. Cut 4 pieces of $1\frac{1}{4}$in. × $\frac{5}{8}$in. timber; plane square one edge only of each. Pin and glue the front to these, making a shallow box as shown in Fig. 3. Punch in the pins slightly below the surface and fill the holes with putty; waterproof glue is best to use but ordinary glue is permissible. All round the perimeter drive nails and screws at different angles but only half-way in. Give a coat or two of cheap oil paint everywhere excepting the front face; smooth this with glass paper and give a coat of undercoating of suitable colour (see later in the text).

The next step is to make the temporary wooden mould for the enclosure wall. This is made of boarding about $\frac{5}{8}$in. thick and held together by wood screws (greased before insertion). Once the idea is grasped from the diagrams and cutting list, the reader will no doubt be able to improvise and to utilise existing materials. If old timber is used it should first be scrubbed clean.

The 2 pieces *E* are secured firmly to the *bottom* ends of the 2 in. wide boards *C* in order to form the ports (see Fig. 6); the panel *F* can be of plywood or hardboard 3ft. 6in. × 2ft. × $\frac{1}{4}$in. or $\frac{3}{16}$in., but w'll need the support of board *D* underneath owing to the weight of concrete to be laid

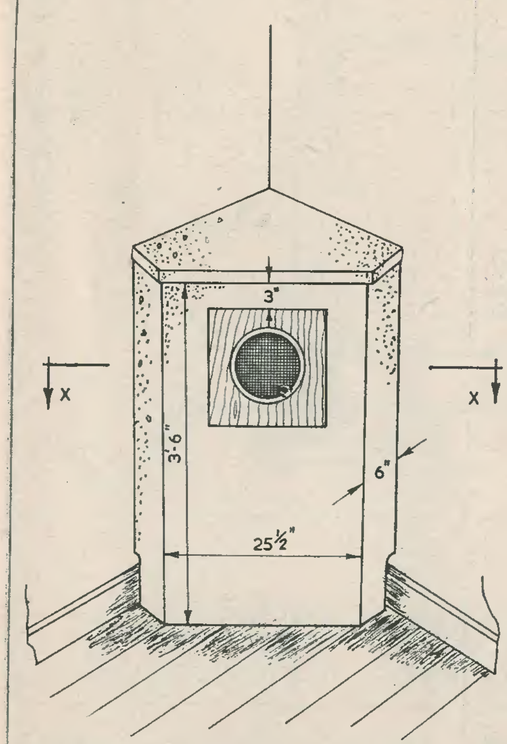


FIG. 1.

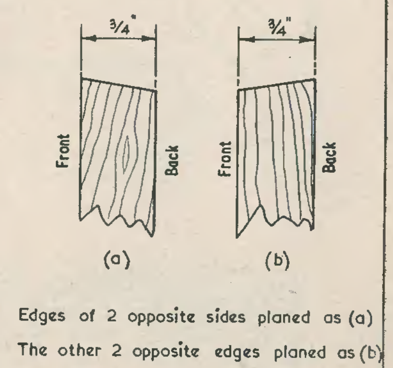


FIG. 2.

G199

on top: it should be supported at the ends by strips of wood 10in. × 1in. × $\frac{1}{2}$in. nailed to the insides of the ends *A*. (Fig. 7). The wooden sub-cabinet previously made should be temporarily fixed in the middle at a distance of 3in. from the top end (see section drawing).

The screws fit through the ends *A* into boards *B*, *C*, and *D*, but through the sides *G* into ends *A*. Also through *B* into *C*. Before final assembly the inside surfaces should be coated with grease or crude vaseline. Final assembly should be made on a piece of level firm ground—not soft earth. A few small nails may require to be knocked through panel *F* into board *D* to prevent it slipping, and any small holes or gaps at the edges can be filled with putty.

Now regarding the materials for the concrete—a mix in the proportions by volume of 4 aggregate, 2 sand, 1 cement is recommended, but 6:3:1 or 5:2½:1 are cheaper and would be satisfactory. The aggregate can be white chips of marble—either purchased as such or made oneself by cracking up scrap pieces from a monumental mason. The sand should be a good sharp washed sand of good quality.

White Portland cement is used, and in order to obtain the appearance of marble it is coloured by means of green, pink, or

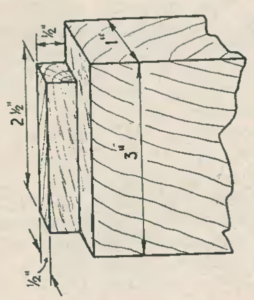


FIG.5.

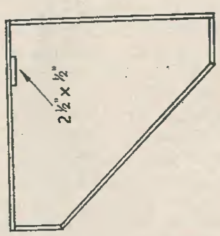


FIG.4.

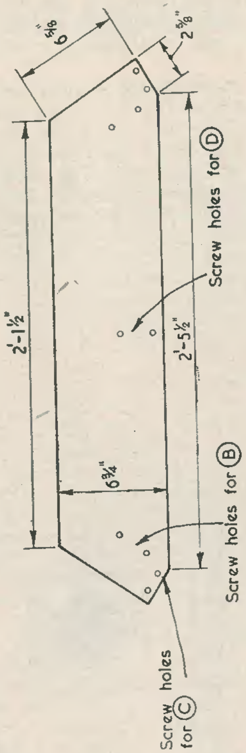


FIG.7.

VIEW OF END (A) 2 OFF

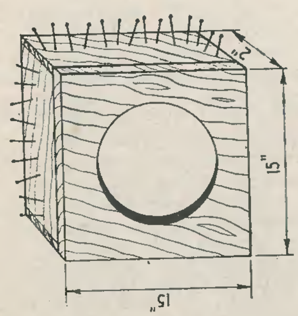


FIG.3.

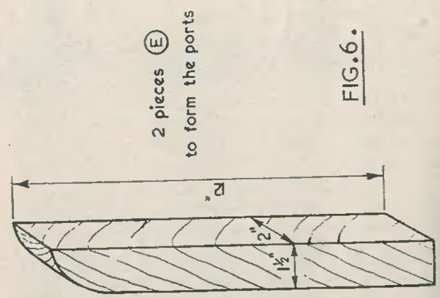


FIG.6.

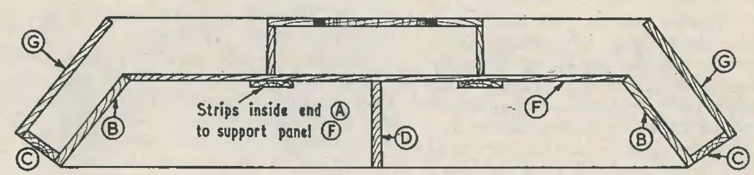
black pigment according to the effect desired. A small quantity only of pigment is required, say 2 to 4 ozs., and a few experimental tablets can be cast to ensure getting the desired colour and effect. The white cement is rather expensive compared to ordinary grey Portland, so I will explain at this point that I (being an indigent type) made two mixes—approx. half (the inner) being made of grey cement and broken brick; and the outer half, which shows, of white Portland and marble chips. The two kinds of concrete bond together and make just as good a job, with very little more trouble, but at smaller cost.

and pat it down with a straight-edge, level with the top of the end boards *A* and the front face of the wooden insert. If a plasterer's "float" can be borrowed, so much the better.

The whole thing can, if desired, be reinforced with expanded metal or steel wires. If there is any danger of frost the job should be given protection. When the "initial set" is completed in a few hours (say 24-hours for convenience), the outer boards *G* should be unscrewed and gently removed. The whole of the outside surface is now exposed; it should be rubbed down smooth with a flat piece of carborundum stone, using plenty of

CUTTING LIST

2	ends	A as FIG.7.	2'-10" x 6¾" x ⅝"
2	boards	B	3'-6" x 5⅞" x ⅝"
2	"	C	3'-6" x 2" x ⅝"
2	"	D	3'-6" x 4½" x ⅝"
2	"	G	3'-7¼" x 6⅝" x ⅝"
1	panel	F	3'-6" x 2'-0" x 3/16" or ¼"



END SECTION OF MOULD TAKEN ON LINE X-X OF FIG.1.

FIG.8.

Approx. quantities can easily be worked out from the figures given in the Appendix. Thoroughly mix the dry materials with a clean shovel, and again, and again, after wetting, thus producing a nice sloppy mixture. Ram the concrete to the bottom of the side wings in the mould, and tightly around the outside of the sub-cabinet and its projecting nails, etc. which will now reinforce the concrete and firmly fix the wooden insert. Fill the mould with concrete

water to wash away the slush—the carborundum easily grinds the chips of marble down until a mottled effect is obtained. The background tint will be the shade of the coloured concrete flecked with irregular patches of the colour of the aggregate used. Any colour scheme can be adopted as desired, e.g. black on white, white on green, etc. A final polish can be given with a smooth stone.

Leave the mould undisturbed for a few

days to attain strength. It is an advantage at this point—especially if the weather is hot—to keep the concrete wet; either by repeated spraying or covering with wet cloths. Should the weather be normal, however, you have nothing to worry about; rain will help to prevent it cracking. The reader should clearly understand that the concrete gets harder and stronger every day for a very long period. By now it would be too hard to carry out the polishing process without a lot of work. In, say, 4 or 5 days time it will be safe to move. Remove the end boards *A*: lift the structure into a vertical position; remove boards *B* and *C* and the panel *F*. Generally clean up the edges and wash it down; if desired a strip of thin felt can be stuck with Bostik on each of the vertical sides so that the concrete does not need to touch the walls when in position.

In case transportation to the permanent position presents a problem, I will explain that the slab can be lifted by two people; but it is more readily moved by means of rollers, first lifting the slab on to a board. For rollers the writer recommends half a dozen beer or lemonade bottles (previously emptied during rest intervals—mixing concrete is thirsty work!)

Just before placing into position, fix the speaker chassis by means of wood-screws. The wooden sub-baffle will accomodate speakers up to 12in., but 15in. bass speakers would require slight modifications to this item. The wooden part of the front will now require enamelling two coats of a suitable colour. With regard to finishing off the front aperture—some readers may prefer a high note diffuser of hardwood strips; others perhaps will be satisfied with a piece of expanded aluminium mesh, fixed by means of wooden beading. It is suggested this should be of octagonal shape with mitred joints.

The 1in. thick lid is similarly cast and polished, using a mould made of 1in. × ½in. wooden strips lightly nailed together. Do not assume the corners in your house are right-angles; make the mould an actual fit by trying it in the corner; also note that the lid should be large enough to overhang the front of the enclosure by about ¼in.

Cut a small piece of wood 2½in. × ½in. × ½in. and pin it to the lid mould at a distance of 2½in. from the corner as shown in Fig. 4, so as to produce a slot in the lower half of the finished lid.

A piece of wood 3ft. 6½in. × 3in. × 1in. has a tenon cut at one end as in Fig. 5. It should fit in the slot under the lid. This support for the rear of the lid rests on the floor and is loosely fixed by a single screw to the skirting near the corner of the room, in a position such that the lid slot will just engage with the tenon when the lid is in position.

When casting the lid, the mould should be laid on a clean smooth surface; a couple of pieces of glass placed side by side is ideal. Polish the top and the front edges as before with the stone; a ¼in. bevel can easily be ground on the upper edge.

The enclosure does not require any bolting or fixing; it merely stands in the corner of the room. As its centre of gravity is *inside* the chamber, the cabinet cannot possibly fall outwards. The lid is lowered gently, keeping the fore-arm underneath, until its rear is held by the support; the arm is then withdrawn and the front of the lid lowered gently until at rest on the front wall of the enclosure.

The completed reflex chamber will be found to give excellent results and is well worth the labour involved. It costs less than a wooden one of similar size and gives better reproduction. Furthermore, if two or more enthusiasts can get together, one mould can be used to cast several sound chambers.

If it is found that high notes are a little too pronounced, owing to internal reflections, they can be damped down by lining the chamber with felt or merely sticking some corrugated cardboard inside.

It is very doubtful if the whole of the chamber would ever need lining with any type of speaker, as this would deaden the reproduction quite a lot, but this question of "to line or not to line" is largely a matter of personal taste.

Possibly some readers may prefer a lighter model than the one described: in this case it is merely a matter of modifying the dimensions of the mould so that the front wall is 1½in. thick instead of 2in.

Appendix

Volume of air column—approx. 8½ cub. ft.
Weight of front—approx. 190 lbs.
Weight of lid—approx. 34 lbs.
Quantity of aggregate required—approx. 2 cub. ft.
Quantity of sand required—approx. 1 cub. ft.
Quantity of cement required—approx. 40 lbs.

THE "MICROAMP" HI-FI MINIATURE AMPLIFIER

We understand from the author of this article in the September issue, Mr. O. J. Russell, that improved performance of the treble control will result if a 470kΩ resistor is inserted between the grid of V_1 and the volume control. The 0.001μF and 2MΩ variable will remain on the grid side of this resistor.

Query Corner

A *Radio Constructor* Service for Readers

Audio Distortion

The increasing interest which is being shown by constructors in high fidelity amplifiers has been apparent for some time now. Many readers take advantage of our circuit checking service and send in circuit diagrams of apparatus which they propose to construct; about three-quarters of these now refer to high quality reproducing gear, whereas two years ago this same proportion was concerned with t.v. problems. In dealing with these audio queries it has frequently been noted that the sender has not fully appreciated the differences between the various types of distortion which may be present in his equipment, and as a result he may be overhauling the amplifier when in fact it is the speaker which requires attention. This month's article is therefore being allocated to a short survey of the various forms in which distortion can present itself. There is no doubt that the search for realism in audio reproduction is a most absorbing part of our hobby, and one which can provide keen satisfaction as each new step is taken towards perfection.

When a good reproducer is compared in performance with an ordinary radio receiver, the latter can be made to sound lifeless and artificial. A piano may assume the sound of a banjo and a cymbal like the scraping of sand on a piece of tin. Such loss of realism is often attributable to a number of different forms of distortion which have to be traced and eliminated individually. The wider the frequency coverage is made the more obvious will the various forms of distortion become.

Frequency Response

Without adequate coverage of the audio spectrum one cannot hope to obtain realistic reproduction. It is, however, important for the response to be balanced at both ends of the spectrum; to have good bass with little top is as bad as having very good treble with attenuated bass. It is not advisable to spend a lot of effort in extending the top response if, for example, the speaker and its associated transformer are incapable of handling frequencies below about 70 c/s. It has been

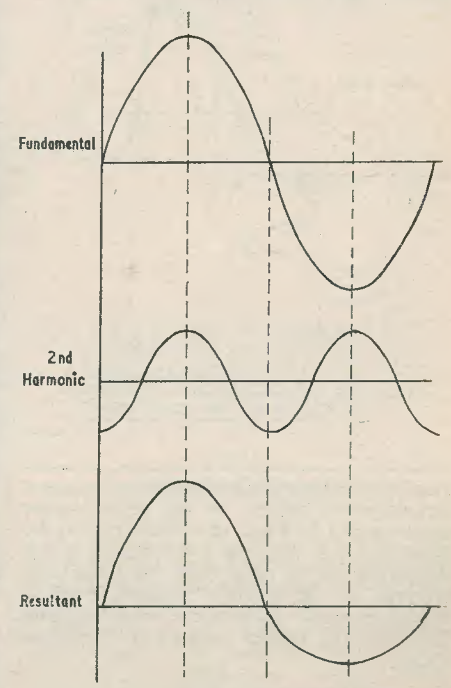


FIG.1.
SHOWING SECOND HARMONIC DISTORTION

claimed, correctly in the writer's opinion, that to achieve a balanced response the ends of the response curve should be limited as follows:

Limit of H.F. End	*Limit of L.F. End*
5 kc/s	100 c/s.
8 kc/s	70 c/s.
10 kc/s and over	40 c/s.

The range chosen will depend largely upon such limiting features as the pick-up, the speaker and transformer and the speaker enclosure. A coverage of 40 c/s to 15 kc/s is sufficient to reproduce the complete range of orchestral music with no loss which is appreciable to the trained ear. Lack of h.f. response can remove the higher order harmonics from basic tones which may produce a certain unnaturalness in the reproduction accompanied by a lack of brilliance. On the other hand, a very good top which is not supported by a good bass response can produce an annoying "thinness" which impairs realism. These effects are avoided by observing the correct balance as indicated above.

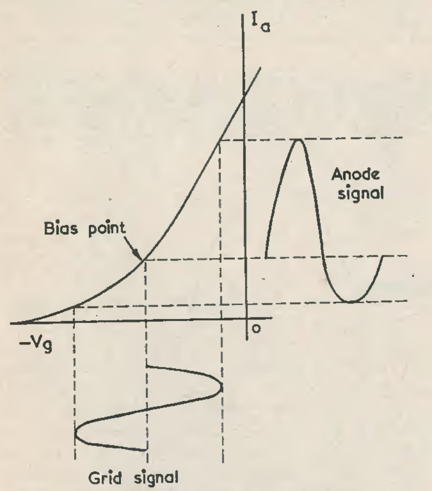


FIG.2. SECOND HARMONIC PRODUCED BY CHOICE OF WRONG BIAS POINT

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Harmonic Distortion

Any distortion of the original waveform which is fed into an amplifier will produce harmonics of the fundamental frequency. Unless this type of distortion is severe, it often goes undetected provided it is not accompanied by some other form of distortion. Harmonics are most readily produced as a result of amplitude non-linearity which occurs during each individual cycle. This does not necessarily mean that the amplifier has amplitude distortion (which means that changes in amplitude at the input do not cause corresponding changes in level at the output. This trouble is described later.). Reference to Fig. 1 shows how adding a second harmonic to the fundamental produces a distorted waveshape. Figure 2 illustrates the manner in which a similar second harmonic distortion is produced by incorrect biasing in an amplifier valve causing non-linearity. This is but one example of how harmonics are produced, but it serves to illustrate the principle.

Intermodulation Distortion

This is perhaps the form of distortion which is most apparent and is usually the most difficult to avoid. It results in a certain confusion occurring in the reproduction, which is usually particularly noticeable on loud passages, making it difficult to pick out any individual instrumentalist. Because of this it is possible for an amplifier which has a remarkably good frequency response to still not give the sharp clear-cut reproduction which is so much sought after. To understand the manner in which intermodulation distortion occurs, assume an amplifier into which two separate sine waves of different frequencies are fed, the lower frequency wave having the greater amplitude. Now if all is well the output waveform would appear as shown in Fig. 3A, where both halves of the low frequency wave are of equal amplitude. If, however, non-linearity is present in the amplifier it can distort the lower half of the wave as already shown (Fig. 2) and this in turn will reduce the amplitude of the higher frequency signal. The result on this signal is shown in Fig. 3C, from which it is seen to be amplitude modulated in sympathy with the larger signal. The effect caused by intermodulation between two separate tones has been demonstrated, the effect upon the very complex series of tones which make up the sound of an orchestra can be imagined. Any reader who possesses two separate sine wave sources may be interested in repeating the experiment described and listening to the results. It will be found that at low volume levels, where the non-linearity of the amplifier is negligible, the two separate tones are clear and easily distinguished. As the volume is advanced to the point at which non-linearity occurs, the output degenerates into a harsh combined note. If all is well this should not occur until the normal point of overload is reached.

Intermodulation distortion is also produced in the speaker, and, to overcome this, quite complicated double cone loading enclosures have been devised, or conversely twin speakers with a suitable cross-over network are employed. Such arrangements are intended to segregate the greater amplitude bass response from the top notes, thus reducing the risk of intermodulation.

Amplitude Distortion

As has already been stated, a graph of the output of an amplifier plotted against input should be substantially a straight line. It is claimed that a dynamic range of 70 db is required to give the maximum realism from modern recording if overloading on the peaks is to be avoided. Because of the wide dynamic range of long playing records, contrast expansion is not employed on modern amplifiers.

Resonance

An abrupt peak or hump in the frequency response curve of the amplifier can cause shrillness if it is in the treble region, or boominess if in the bass. The trouble is sometimes traced to a defective negative feedback arrangement or a poorly designed out-out transformer. If the amplifier is in order but the trouble is present, it may be due to acoustic feedback between speaker and pickup or a resonance in the speaker enclosure.

Transient Distortion

The equipment must be capable of responding to sudden impulse sounds without any tendency to overshoot. To test for this characteristic a square wave is fed into the amplifier and the output viewed on an oscilloscope. Any tendency for spikes to appear after the vertical sides of the waveform shows that overshoot is present. This can sometimes be corrected by modifications to the feedback circuit to reduce the dynamic output impedance of the amplifier, and thus improve the speaker damping. If the vertical sides of the square wave appear slightly sloping, this indicates a poor transient response—a defect which should also show up as a poor treble response.

Phase Distortion

Due to the use of capacitative and inductive elements in the amplifier, there will be a small but progressive phase shift across the amplifier as the signal frequency is increased. This will have the effect of shifting the phase of harmonics with respect to their fundamental, but extensive listening tests have shown that within the limits normally encountered this shift is not aurially detectable. It is, however, important to keep the phase shift of that part of the amplifier over which negative feedback is employed to a minimum. For this reason the tone control circuit is rarely included within the feedback loop.

Phasing is important when two or more speakers are used simultaneously in close proximity to each other, and care is thus required when connecting up the speakers.

Wow

This trouble is most readily detectable on a constant tone record, when it will show up as a wavering in pitch of the tone, It is usually traceable to minor deviations in turntable speed.

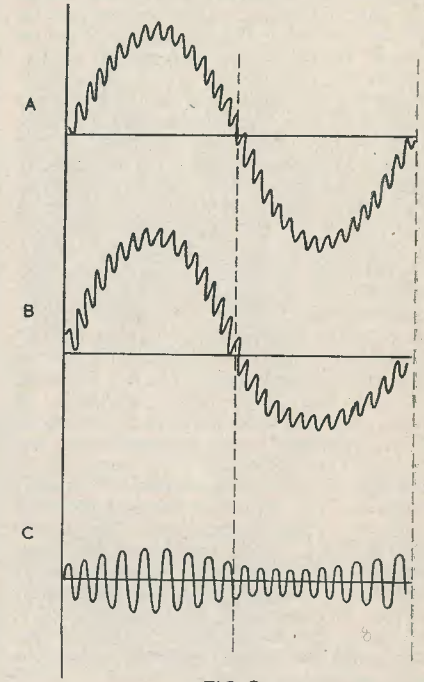

FIG.3.
INTERMODULATION DISTORTION

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The various types of audio distortion have been described separately, but in many cases they are attributable to the same fundamental cause. Unless test gear is available to definitely prove the presence of distortion, it must not be assumed to be there merely because it is heard on one recording; the record may be a bad one. Careful listening tests on good quality records are usually necessary before it can be definitely decided that some particular form of distortion has to be eliminated.

(*For* QUERY CORNER RULES, *see page* 89, *September issue*)

Radio Miscellany

By the time these words appear in print, the I.T.A. will be getting into its swing. While it is impossible to get an accurate figure of the percentage of t.v. receivers in current use which have been constructed by amateurs, it is obviously higher than many people thought possible. I have myself often been surprised at the most unlikely people who have successfully built t.v. sets from kits and wiring plans. Add to these the many hundreds with some radio knowledge who have bought sets, and one ceases to be surprised that the number of home-built converters already runs into many thousands. As soon as the test transmissions from Upper Norwood began, many dealers in Greater London found the demand for coils and components outpaced delivery from the makers. The B.B.C. sat up and took even more notice, although, of course, they had long since been worried by I.T.A. "pinching" *their* technical staff and artistes. They intensified their campaign by stepping up the programmes—a notable example of the beneficial effect of even the threat of a little competition. The artistes and the B.B.C. staff, too, must feel more cheerful now they have an alternative employer to whom they can take their talents. To crown it all, the Chief of the T.V. Service (at the Radio Show) admitted that they could no longer grumble about the money allocation.

In recent weeks there has been a conspicuously strange silence among the normally verbose opponents of Independent T.V. Perhaps they are busy studying statistics so they can let us know all about it if there should happen to be an increase in juvenile delinquency next year!

At a Discount

Not only those engaged in other forms of entertainment, and moralists who concern themselves over t.v. as time-waster No. 1, but transmitting amateurs also are growing to view the expanding hours of t.v. programmes with anxiety. Especially the amateurs now that colour and 3-D t.v. loom in the background with their consequential demand for greater bandwidths. Amateur operation during t.v. hours becomes an increasingly difficult problem. The short waves were given to amateurs because they were thought to be o little use for much else. Now, what with f.m. and t.v., it is possible that they will get pushed off the short waves and given a few kc/s in the broadcast bands. More unlikely things have happened.

Amateur communications radio has already suffered a recession for various reasons, not only in Britain but throughout the world. Perhaps the most spectacular drop has been in Italy, where the number has slumped by nearly three-quarters. In addition to their other troubles a special licence and a fee was required—plus the introduction of a morse test.

Maybe the fee part wasn't regarded as so important. In Italy taxes and other Government dues seem to be a matter of mutual adjustment. They simply go along to the collecting office and have either a friendly or argumentative discussion about it. The possessor of quick wits and a persuasive tongue often gets away with half-price or even less. Imagine trying that with the dame behind the counter at the local post office and getting your t.v. licence for thirty bob!

Thinking of cut prices reminds me that much is being made in the press of a new t.v. tube firm who threaten to slash prices by a third. When I recently mentioned tube prices several readers wrote to tell me that prices ought to be cut by 80%—not a mere 33⅓%. However, I gather they will not be in production for eighteen months yet—then for a time it will be 21in. tubes only, and even they will be for new sets and not available for replacements until some time after that.

More Space

My recent comments on this subject have brought several letters from readers. Undoubtedly the recent announcements of "Step 1" experiments will quicken and extend that interest.

To quote from a letter from Mr. J. D. Pearson (BRS20368) of Barrow-on-Humber, "As any future development in space travel is inevitably and inextricably bound up with radio, it is only fitting that *The Radio Constructor* (along with other radio periodicals) should at last begin to evince an interest in the problems involved in solar exploration. A regular series of articles on the lines of your notes would no doubt increase circulation tremendously, and at the same time provide interesting reading matter for the majority of your regular readers.

"Like yourself I am very interested in this subject and have studied it for some years. I soon discovered that a knowledge of electricity and magnetism is an almost indispensable aid to the study of astronomy and solar navigation.

"There are several sources in outer space from which emission of radio waves has been detected and recorded; recently from the planet Jupiter on a frequency of 22Mc/s. This would suggest that the ionosphere does not work in reverse—i.e. it will reflect waves reaching it from the earth on 22Mc/s but does not reflect back into space the transmissions of the same frequency from Jupiter.

"With reference to your "bat-men" paragraph, I fear it does not appear to have occurred to your learned self that any life which there may be on the planets will have evolved and adapted itself to the conditions. Therefore it is quite feasible that the inhabitants of Mercury (if any) should be 'red-skinned types with crustaceous, lobster-like limbs' if one bears in mind the fact that the temperature, perpetually facing the sun, is hot enough to melt lead.

"As for the inhabitants of Saturn having 'big staring eyes,' the planet is 886,000,000 miles from the sun and consequently receives only a fraction of our light. It could be argued that the eyes of its inhabitants would expand through the ages to make the best possible use of the light available. Saturn, too, is enveloped by a cloud-laden atmosphere many thousands of miles in depth. I make these points simply because there is a tendency these days, even among educated people, to scoff at anything not 'earth-y' in conception. I do not, of course, refer to yourself.

"Finally, I must query your statement that the sun bombards the earth with electrical particles. Ionisation, I have always believed, is the action of the sun's rays on the upper atmosphere. Your phrase suggests a projection 'fired' from the sun. In other words, if there was no atmosphere there would be no ionisation, whatever the radiation from the sun may contain.

"In closing, I would like to thank you for providing a very entertaining and interesting column."

The Younger Set

A 17-year-old reader, Brian C. Smith, of 9 St. Margarets Road, Westgate-on-Sea, Kent, forwards details of a proposed "Experimenters Club" to cover radio, chemistry and matters of scientific interest for the under 21's. Despite the attacks from a certain quarter on organisations of this nature, I feel it would be a mistake to condemn such efforts out of hand.

Incidentally, I understand the particular organisation criticised offered to open their accounts for inspection and audit—naturally at the expense of any responsible person wishing to investigate them. The offer does not appear to have been taken up.

Correspondence with many readers has convinced me that they are not such chumps as to send money to any organisation (or person) without finding out what it is all about first. It is therefore only fair to accede to Brian Smith's request that the proposed club and its activities should be made known. I know nothing of him other than the fact that he seems to have plenty of enthusiasm, but there is certainly no reason why such a club, sensibly managed, should not be a success. Here's wishing them luck.

CENTRE TAP *talks about* TV HOURS / SPACEMEN / PROPOSED CLUB

Conversation Piece

Reader: "You remember a couple of months ago you wrote of plugging unwanted holes with wire wool before making an invisible repair with solder?"

Me (cautiously): "Yes."

Reader: "Do you know how tinkers repair holes in pots and pans?"

Me: "To be quite honest, I have never seen a tinker filling in holes."

Reader: "Well, they hold a piece of clay against the hole. This is called a tinker's dam. After the solder sets they throw it away, hence the expression 'Not to care a tinker's dam'."

Me: "Oh! I thought it was a tinker's cuss."

Reader: "Perhaps in those days they were too polite to use the word dam, so they may have called it a cuss instead. The people using the expression, I mean, not the tinkers."

Me (unable to think of anything better to say): "We live and learn."

Reader: "I thought you might as well have the full story."

Me (humbly): "Thanks, OM."

Reader: "You're welcome. So long."

Let's Get Started 28:

THE TRANSITRON

by **A. P. BLACKBURN**

LAST MONTH, IN DEALING WITH TIMEBASES, we arrived at the Miller circuit. It was mentioned that this circuit was often used in conjunction with a "transitron." This is probably one of the most versatile circuits in electronics. In its normal form it only requires one valve, and with very little modification may be used as a generator of sine waves, sawteeth or square waves, as required.

Like so many circuits in wide use to-day, it originally made its appearance many years ago. It was first described by Herold in 1935. It finally came into prominence just before and during the war.

Before thinking about its applications, the first thing to do is examine the circuit in its basic form.

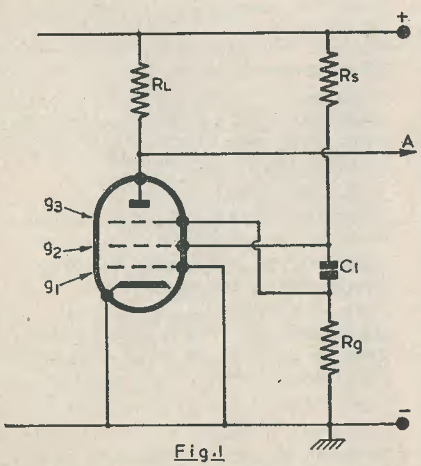


Fig.1

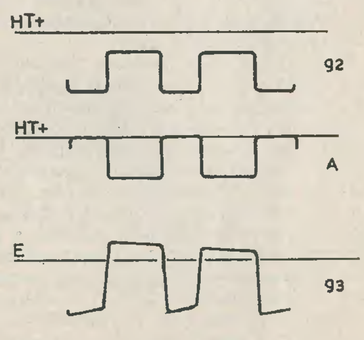


Fig.2
Waveforms in fig.1

E227

Operation

The transitron is an oscillator of a type similar to a multivibrator. That is, it does not itself produce a sinusoidal waveform. The basic circuit is shown in Fig. 1. It can be seen that an unusual feature of the circuit is the use of the suppressor grid in the valve.

The first relevant feature to note is that if g_3 were made negative with respect to cathode, the current flowing to the anode would be reduced. G_2, however, would take a greater current and the screen voltage would drop. If g_3 were made more positive the anode would take more current and the screen less, therefore the screen voltage would rise. G_2 and g_3 are then in phase, and if coupling were placed between them, oscillation could occur. That is what, in fact, does happen.

Imagine for a moment that the suppressor was at cathode potential. The anode and screen would both be taking current. If some disturbance now occurred which caused the suppressor to become a little more negative than the cathode, some of the current to the anode would be diverted to the screen. The screen voltage would drop, and by virtue of the coupling capacitor C_1 the suppressor g_3 would be driven more negative. This in turn would divert more current to the screen from the anode, and the screen voltage would drop further, thus driving the suppressor more negative.

This action takes place very rapidly until the suppressor is driven so far negative that all current to the anode is cut off. At this point, then, the action ceases. The charge that has accumulated on C_1 during this process will now begin to leak away through R_g, and the suppressor grid will slowly become more and more positive until some current is permitted to flow to the anode. When this occurs, the screen voltage will begin to rise, because some of its current is now being diverted to the anode. The rise in screen voltage is transferred to G_3 via C_1, and G_3 becomes yet more positive and permits more current to flow to the anode. There is, therefore, less current in the screen and its voltage rises still further, taking the suppressor with it. Once again this process continues until the valve approaches saturation, when any further increase in G_3 voltage produces no increase in anode current.

At this point the action ceases, and C_1 will be nearly completely discharged. C_1 will now slowly charge, taking the suppressor back toward cathode potential. However, in this case, the time will be shorter than when the suppressor was cut off, because current will flow not only through R_g but also into G_3. After a while, the suppressor voltage will have dropped sufficiently to regain control of the anode current.

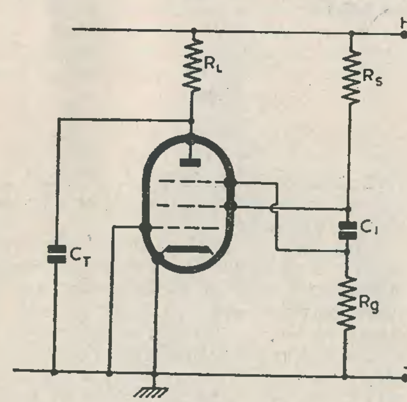
When this occurs, the anode current will begin to decrease, the screen current to increase, the screen voltage to drop, causing the suppressor to go negative once again. Well, this is where we came in. The cycle is complete and another has started. Note that during the charging and discharging periods of C_1, the screen voltage remains constant. The screen waveform therefore is square in shape, as shown in Fig. 2. The anode waveform is also shown in Fig. 2 and can be seen to be an inverted version of the screen.

In its simplest form, then, the transitron produces a square wave of either polarity. There are very many applications where square waves are of tremendous use, but we will leave that and return to the transitron for timebase applications.

Timebases

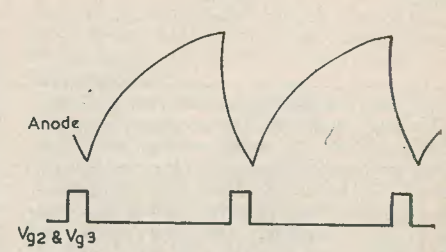
The simplest transitron timebase is shown in Fig. 3. The circuit is the same as before, except that the capacitor C_T has been added. The transitron action is still the same as before, except that when the anode current is cut off, the capacitor C_T will charge toward h.t.+ through the anode load resistor R_L.

If the time constant of C_1, R_g is just right, the circuit will begin to change state when the capacitor C_T is on the way to being fully charged. The change of state will turn on anode current and the capacitor C_T will discharge through the valve.



E228

Fig.3



Waveforms in fig.3
Fig.4

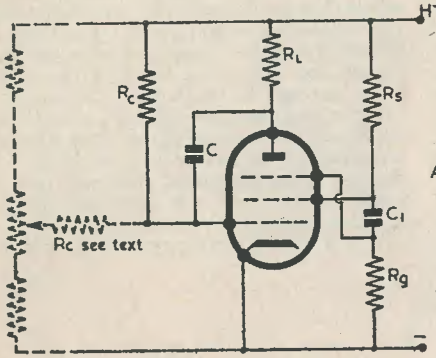
A disadvantage of this circuit is the non-linearity of the resultant sawtooth. Waveforms are shown in Fig. 4 where it can be seen that the screen waveform is essentially the same as in Fig. 2, but the anode waveform is a sawtooth.

An almost ideal circuit is obtained by combining the Miller circuit described last month and the transitron. The whole circuit may be combined within the same valve, but the two parts of the circuit perform quite separate functions. The Miller connection provides the linear sawtooth, and the transitron acts as the switch which initiates and terminates the sawtooth. The circuit is shown in Fig. 5 and the waveforms in Fig. 6.

In this circuit the two actions are comparatively separate from one another. Let us start from the moment when the suppressor is negative and there is therefore no anode current. Capacitor C, the Miller capacitor, will be charged; that is, one plate will be at

If a large range of timebase speeds are required it is normally necessary to switch the timebase capacitor C and the recycling capacitor C_1. Also, if continuous variation o the timebase speed is required, R_c may be returned to a point of adjustable voltage, as shown dotted in Fig. 5. This control becomes the fine frequency control and the switched capacitors the coarse control.

A suitable point for the injection of synchronising signals is either at the screen or suppressor. If either of these points is used, care must be taken to ensure that the synchronising voltage is not too great, other-



E229 Fig.5

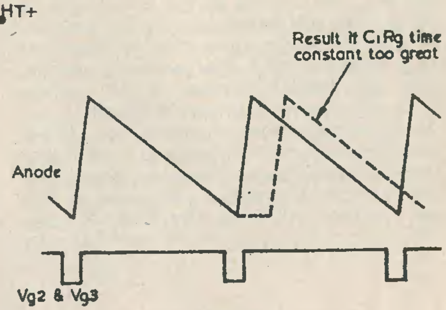


Fig.6

h.t.+, and the grid plate at cathode potential. When the transitron changes state and anode current flows, the anode voltage will drop, this drop being transferred to the control grid, via C. The Miller run-down then commences, as explained last month. When the run-down is complete, and the valve has "bottomed," no fly-back will occur until C_1 has charged through R_g, and the transitron has changed state.

When this occurs, the anode current will cease, and C will charge up to h.t.+ once more, thus completing the cycle. In order to avoid a waiting period between the end of the run-down and the fly-back, the time constant C_1R_g should be chosen to cause the transitron to fly back just before the pentode bottoms. This is illustrated in Fig. 6.

During the fly-back, a negative pulse appears at the screen and suppressor of the valve. This may be used to "black out" the flyback trace on the c.r.t. tube, by connecting the transitron screen to the grid of the c.r.t.

wise the trace will be distorted or may even collapse altogether.

Triggered, or single stroke operation—briefly mentioned last month—although infrequently used in oscilloscopes used for radio purposes, may be achieved with the circuit of Fig. 5. All that is necessary is to return R_g to a point sufficiently negative with respect to earth to ensure that the suppressor grid is cut off. The application of a brief pulse to the suppressor will cause the circuit to produce one sweep, whereupon it will fly back and wait until another pulse is applied.

Wide Range Oscillator

The transitron makes a very useful sinusoidal oscillator. The frequency range obtainable can be from a few cycles per second up to nearly 100Mc/s. The circuit is shown in Fig. 7. One advantage immediately becomes clear. The oscillator circuit merely requires a tuned circuit. There are no taps on the coil, and no coupling winding. For this reason the circuit is sometimes called a "two terminal oscillator."

The output may be taken from the junction of C_2 and the tuned circuit. However, in order to reduce loading on the oscillator, a coupling winding may be introduced. If the oscillator is to be used over a wide frequency range the value of C_2 would have to be switched. If the reactance of C_2 becomes too high at the operating frequency, oscillation will not be maintained. Typical component values would be:

$$R_L = 20k\Omega;$$
$$R_s = 20k\Omega;$$
$$R_g = 50k\Omega$$

and C_1 and C_2 may be found experimentally at the frequency in use.

A Frequency Divider

The original circuit shown in Fig. 1 may be used as a frequency divider. The action is very similar to that of a multivibrator. Imagine that a synchronising signal cut off the suppressor just before the normal action of the circuit drove the suppressor into cut-off. Subsequent synchronising signals would not affect the circuit, because they would only try to drive the suppressor further into cut-off.

The cut-off condition will remain until C_1 has discharged sufficiently to allow the circuit to change state. When this occurs the circuit will remain in the other condition until C_2 has charged sufficiently to cause a relapse to the original condition, thus completing the cycle. The transitron will, therefore, have produced one cycle for a number of synchronising cycles, i.e. it is frequency dividing.

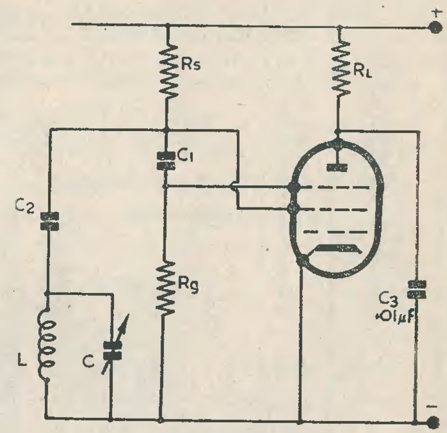
Valves

It is worth mentioning a few suitable valves for transitron operation. Obviously, they must be pentodes and the suppressor grid must be available at a pin. Among surplus types, the EF50 (VR91) is particularly suitable. The suppressor cut-off is in the region of 50–60 volts. The SP61 (VR65) will work reasonably well, but the suppressor has a very long base and the valve is therefore less flexible than the EF50.

A surplus valve especially designed for the use of the suppressor is the VR116. In this case the suppressor cut-off voltage is about 10 volts.

Among modern miniature valves are the EF91 and the 6F33. The latter is a miniature equivalent of the VR116, but an internal diode is connected between the suppressor and cathode. The EF91 makes a fairly good transitron valve, despite the suppressor grid base, which is of the order of 90V, and very variable from spe imen to specimen. Another valve is the triode pentode ECL80, which works very well in most transitron circuits, and has the extra triode free for some other purpose.

It should be remembered that the suppressor characteristic is not necessarily held within close limits on most valves (except the



E230 Fig.7

VR116 and 6F33) and one may therefore strike an occasional valve which will not work in a transitron circuit, but which is perfectly good in every other way.

ERRATA

On page 160 of this issue, the third paragraph under "Alignment", the Band I aerial should be connected to the grid of $V_2(a)$, and not $V_1(a)$ as stated.

VIBRATOR DATA

PART 3. *Compiled by* E. G. BULLEY

Radiart	*ART*	*Turner*	*Delco*	*Elec-tronics*	*James*	*Mallory*	*Meissner*	*National Union*	*Utah*	*Oak*	*Wearite*	*Volts*	*Max. load (amps)*	*Frequency c/s*	*Remarks*
5409-4	541	—	8751	835	—	W245	815	—	4SP5	—	—	4	6	115	S
5409-12	—	—	—	—	—	—	—	—	—	—	QL12	12	3	115	S
5409-32	—	—	—	—	—	—	—	—	—	—	—	32	1	115	S
5410	521	T60	5053181	714	PJ60	245C	714	—	SP55	—	—	6	6	115	S
5411	522	T58	5052525	712	PJ58	246	712	600	SP60	50A6	QE6	6	4	115	S
5413	520A	—	1211573	716	—	245A	787	—	SP56	—	QL6	6	6	115	S
5413-4	541A	—	8752	800	—	W245A	800	—	4SP56	—	—	4	6	115	S
5415	541A	—	8752	—	—	W245A	800	—	—	—	—	4	6	115	S
5416	503	T55	8618	707	PJ55	270B	705	—	SP50	—	—	6	6	115	S
5418-12	—	—	—	—	—	—	—	—	—	—	QD12	12	3	115	S
5420P	522	T58	5052525	2089	PJ58	246	712	600	—	—	QE6	6	4	115	S
5421	522A	—	—	—	—	246A	785	—	SP646	—	—	6	6	115	S
5422	—	—	—	—	—	—	—	—	SP7	65UGS	—	6	5	115	S
5425	508	T54	5040700	2682	PJ54	273C	704	—	SP51	—	—	6	6	115	S
5426	547	T66	7238525	2092	PJ66	716	726	500	SP54	—	—	6	6	115	S
5427	529	—	8753	—	—	W246	801	—	—	—	—	4	6	115	S
5428	—	—	—	—	—	—	—	—	—	—	—	6	4	115	S
5429	507	T62	5041376	718	PJ62	273D	718	—	SP52	—	—	6	6	115	S
5430	—	—	—	—	—	—	—	—	—	—	—	6	6	115	S
5431-4	—	—	—	—	—	—	—	—	3PV9	—	—	4	5	115	S
5433	—	—	—	—	—	—	—	—	—	—	—	6	5	180	S
5434	—	—	—	729	—	—	—	—	SP64	—	—	6	6	115	S
5435	522	T58	5052525	—	PJ58	246	712	600	NP62	35ZH	QE6	6	6	115	S
5435-4	529	—	8753	801	—	W246	801	—	—	—	—	4	6	115	S
5436	—	—	—	—	—	—	—	—	—	V5868	—	6	5	180	S
5437	544	—	8635	—	—	952W	780	—	SP645	—	—	6	5	180	S
5438	524	—	5053501	2107	PJ65	248	723	602	SP640	—	—	6	6	140	S
5439	562	—	8614	—	—	743	786	—	—	—	—	6	6	115	S
5439-12	—	—	—	—	—	—	—	—	—	—	—	12	3	115	S
5440	—	—	—	728	—	—	—	—	SP69	—	—	6	6	115	S
5443	523	T59	5053179	—	PJ59	247	708	—	SP6	—	—	6	6	115	S
5443-32	2401	32T59	1208920	—	—	F247	561	—	18161	—	—	32	1.4	115	S
5454	561	—	1214832	—	—	742	—	—	—	—	QD6	6	6	115	S

*S=Synchronous. NS=Non synchronous. *(to be continued)*

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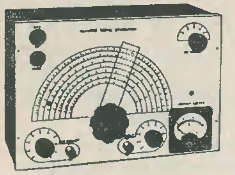

Coverage 120 Kc/s-320 Kc/s, 300 Kc/s-900 Kc/s, 900 Kc/s-2.75 Mc/s, 2.75 Mc/s-8.5 Mc/s, 8 Mc/s-28 Mc/s, 16 Mc/s-56 Mc/s, 24 Mc/s-84 Mc/s. Metal case 10" x 6¾" x 4¾". Size of scale 6½" x 3½". 2 valves and rectifier. AC mains 230-250V. Internal modulation of 400 c.p.s. to a depth of 30 per cent, modulated or unmodulated RF output continuously variable 100 milli-volts. CW and mod. switch, variable AF output and moving coil output meter. Black crackle-finished case and white panel. Accuracy ±2%. **£4 19 6** or **34/–** deposit and 3 monthly payments **25/–**. P. and p. 4/– extra.

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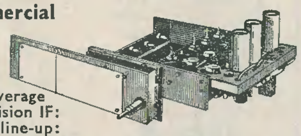

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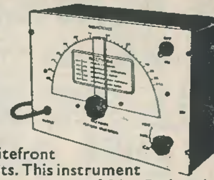

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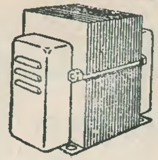

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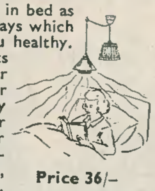

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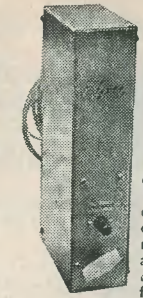
The two units for **£4 10 0**, or **30/–** deposit and four payments of **18/–**, post and insurance 5/–

ADDITA BAND III CONVERTER



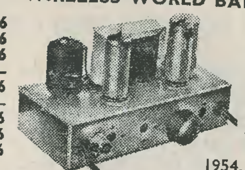
Our *Addita* **is giving very satisfactory results and we have had many pleasing reports regarding its performance.**
It is a very neat-looking unit and fits to the side or the back of the televisor. It is designed to convert any TV superhet or TRF and no internal modifications of any kind are required. You have Band I or Band III at the flick of a switch.

Build it Yourself
Price of all components, including stove enamelled case and even transfers for the front, is **£4 5 0**, plus 2/6 post, or **£5 5 0** if mains components also required.

BAND III LOFT AERIAL KIT

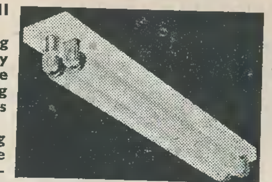
Known as the Folded 'V' this is directional, signal strengthening and noise reducing. Complete kit including alloy elements, plastic centre piece, and fixing bracket. Mounts anywhere. Price **8/6** plus 1/6 post.

WIRELESS WORLD BAND III KIT

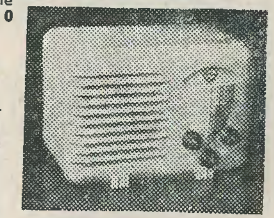


One of the most successful circuits for Band III conversion was published in the *Wireless World*, May 1954. We consequently offer a complete kit of parts, including the specified EF80 valves, wound coils, drilled chassis, in fact, everything including a copy of the circuit diagram. Price only **42/6**, post 2/6 extra. Mains components if required, **25/–** extra.

THE TWIN 20

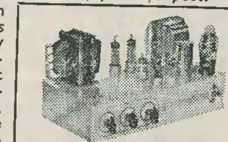


This is a complete fluorescent lighting fitting. It has built-in ballast and starters—stove enamelled white and ready to work. It uses two 20-watt lamps. Price, with two tubes, **39/6.** Post and insurance 5/–. Extra 20-watt tubes, **7/6** each.



MAINS—MINI T.R.F.

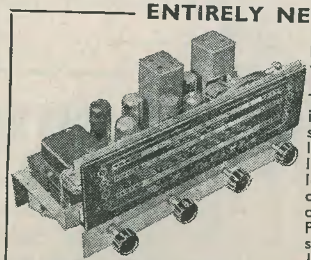
Uses high-efficiency coils—covers long and medium wavebands and fits into the neat white or brown bakelite cabinet—limited quantity only. All the parts, including cabinet, valves, in fact, everything. **£4 12 6**, plus 3/6 post.



MULLARD AMPLIFIER "510"

A high quality Amplifier designed by Mullard engineers. Power output exceeds 10 watts, harmonic distortion less than 0.4%. Frequency response almost flat from 10 to 20,000 c.p.s.—very suitable for use with the Acos "Hi-G" and other good pick-ups. Completely made up and ready to work is **£12 10 0** or **85/–** deposit, plus 10/– carr. and insurance.

ENTIRELY NEW CIRCUIT



Redesigned and developed and built by the Cleveland Co.—very good reports received.

THE "WINDSOR 5"

This is a 5-valve AC superhet covering the usual long, medium and short wavebands. It has a particularly fine clear dial with an extra long pointer travel. The latest type loctal valves are used and the chassis is complete and ready to operate. Chassis size 15" x 6" x 6". Price **£9 19 6** complete with 8" speaker. Carriage and insurance 10/–. H.P. terms if required.

ELECTRONIC PRECISION EQUIPMENT LTD

Post orders should be addressed to Dept. 34, 123 Terminus Road, Eastbourne

Personal shoppers, however, can call at

42-46 Windmill Hill, Ruislip, Middx. *Telephone* RUISLIP 5780. Half-day Wednesday

152-3 Fleet Street, E.C.4 *Telephone* FLEet 2833 Half-day Sat.

29 Stroud Green Road, Finsbury Park, N.4. *Telephone* ARChway 1049. Half-day Thurs.

249 High Rd. Kilburn. *Telephone* MAlda Vale 4921. Half-day Thurs.

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Readers' small advertisements will be accepted at 3d. per word, including address, minimum charge 2/-. Trade advertisements will be accepted at 9d. per word, minimum charge 6/-. If a Box Number is required, an additional charge of 1/- will be made. Terms: Cash with order. All copy must be in hand by the 8th of the month for insertion in the following months' issue.

PRIVATE

AMATEUR EMIGRATING. Send SAE for list of TV, radio and electronic equipment, cheap. Tovey, 59 Fourth Avenue, London, E.12.

FOR SALE. Taylor 66A signal generator, £12. Taylor 20B circuit analyser, £6. Both as new with instruction books. Also Invicta battery/mains portable, needs slight attention, £4. Madle, 8 Acacia Avenue, Hornchurch, Essex.

FOR SALE. Homelab type 10 signal generator, working, £5. Premier 12in magnetic televisor chassis with valves, £9. *Practical Wireless* Minifour all-dry portable, £4. Sterns 4-valve battery suitcase portable, £5. 52 copies *Radio Constructor* August, 1950–July, 1955. 67 copies *Practical Wireless* April, 1949–December, 1954. 57 copies *Practical Television* May 1950–May 1955. Offers. G. Goodwin, 6 Upper Tollington Park, London, N.4.

UNWANTED GIFT. New unused American service valve tester by Hickock, with instruction book. First £7 10s. received secures this bargain. Carriage paid. Smith, 35 Aldersley Road, Tettenhall, Wolverhampton, Staffs.

REAL BARGAIN. Portable O.v.1 SW battery receiver, will cover all bands; fitted bandset, bandspread; calibrated, very economical, excellent condition, very cheap. SAE for particulars. Box No. D161.

EDDYSTONE 750 speaker and S meter, good condition, £45. Qualtape tape deck, 2 motors, needs attention, £5. Box No. D169.

FOR SALE. AVO model "D" and Pullin series 100, both guaranteed in perfect condition after manufacturer's overhaul. Best offer over £6 each. Box No. D170.

TAPE DECK parts or complete outfit wanted. Reasonable price. Box No. D171.

FIRST CALLER with £15 gets two incomplete Pye television with two 9-inch tubes; one Premier television with 5-inch tube, less power pack; one Pye 45Mc/s strip; 30 B7A valves (including 9 EF91); over 50 used old type valves; two mains radios and a lot of good junk. Harrow area. Phone first, WOR 7512.

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(continued on page 195)

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Rapid Heating—Extreme Lightness—20 different models — Bit sizes, 1/8", 3/16", 1/4", 5/16", 3/8"—*Prices from* **19/6** *Details of full range in folder No. S8, sent on request*

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1R5	7/6	6F8G	8/6	12AX7	8/6	EF22	7/6
1S5	7/6	6G6G	4/9	12K8GT	8/6	EF36	7/6
1T4	7/6	6J5GT	6/6	12K7GT	8/6	EF37A	14/6
3V4	7/6	6K7G	5/6	58	7/6	EF39	7/6
5U4G	8/6	6K8G	8/–	5763	7/6	EF80	11/6
5Y3GT	9/6	6L6G	9/6	954	2/6	EF85	11/6
5Z4G	8/6	6Q7G	8/–	9006	5/6	EF91	7/6
6AG5	6/9	6Q7GT	8/6	AZ31	10/6	EF92	4/6
6AM6	7/6	6SN7	8/6	DAF91	7/6	EL32	7/6
6AL5	6/6	6SJ7	8/–	DF91	7/6	EY51	12/6
6AT6	8/–	6SK7	8/–	DH77	8/–	EZ35	8/–
6BE6	8/–	6SL7GT	8/–	DL63	8/6	KT66	11/6
6BW6	8/–	6SS7	6/9	DL94	7/6	UI42	9/6
6B7G	8/6	6U7G	8/6	EA50	2/–	PL81	12/6
6B8	7/6	6V6G	7/6	EAF42	9/6	PL82	10/6
6B8G	7/6	6U5G	7/6	EB91	6/6	U78	8/6
6BA6	8/6	6X4	8/–	EBC33	8/6	UCH42	11/6
6BS7	8/–	6X5GT	8/–	EBC41	8/6	PCC84	11/6
6SA7	8/–	12AH7	7/6	ECH42	11/6	UY41	8/6
6F6G	8/6	12AT7	9/–	ECL80	12/6	X65	10/6

Matched Pairs KT66, **25/–**; 6V6G and GT, **17/–** per pair. 6K8G, 6Q7G, 6V6G, 5Z4G, 6K7G, **34/6** per set. 1R5, 1T4, 1S5, 3V4, **27/6** per set.

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2/350V B.E.C., **1/3**	8/500V Dubilier, **1/9**
8/350V T.C.C., **1/6**	8 x 8 450V B.E.C., **4/–**
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FM COILS Osmor QAFM, QIFM, **7/–** each; QOFM **7/6**; QRFM **5/–**; QICD (inc. 2 GEX34) **25/–** each

Aladdin Formers and Core, Low Loss, ¼", 8d each. **Bias Condensers:** 12/50V T.C.C., **9d.**; 25(25V, **1/3**; 25/50V, **1/6**; 50/25V, **1/6**; 50/50V, **2/–**. Small Mica: 2-2,000pF, **6d.**; 0.003-0.1mfd, 500V Tubular, **8d.**; 0.25-1mfd, 500V, **1/–**. Mica: 1,000V wkg. T.C.C., 0.0015, 0.002, 0.0025, 0.003, 0.004, 0.005, 0.008, 0.01, **1/–**. Paper Block T.C.C. 0.25/1,500V, **2/3**; 2mfd, 100V, **1/3**; 4/100V, **1/6**; 2/350V, **2/6**; 4/350V, **3/–**; 2.5 x 2.5 x 1/400V, **3/6**. **Meters:** 0-4amp. Thermo, 0-2mA M.C. movement, 2" scale, 3½ x 2½, **7/6**. **Microphones:** Marconi hand type, carbon with switch, **4/6**. **Potentiometers:** all values long spindled, s.p., **4/–**; d.p., **4/9**; less SW, **3/–**; W.W. preset, 3W, **3/–**. **Resistors:** ¼W, **4d.**; ½W, **6d.**; 1W. **8d.**; 2W, **10d.**; 6W, **1/–**; 10W, **1/3**. **Switches:** midget long spindled, 1P 12W, 2P 6W, 3P 4W, 4P 2W, 4P 3W, **4/–**. **Coaxial Cable:** stranded, 75 ohm, ¼", **7d.** yard. **B7G V-holders:** ceramic with scng. can, **1/–**; B9A, moulded, **2/–**; I.O., moulded, **6d.** **Toggle Switches:** Q.M.B., s.p., **2/–**; s.p.d.t., **3/6**; d.p.s.t., **3/9**; d.p.d.t., **4/6**. **O.P. Transformers:** Pen. 60mA, **4/6**; 45mA, **3/6**; Chokes, 15h, 80mA, **4/9**. Fil. Trans. 6.3V 2A, **7/6**.

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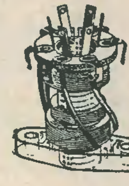

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Dual range Coil with reaction with 2 mains and 2 battery circuits, type DRR2 **4/0**

Matched pair Dual Range T.R.F. Coils with reaction; with battery and mains circuits, type DRM3 **8/0 Pr.**

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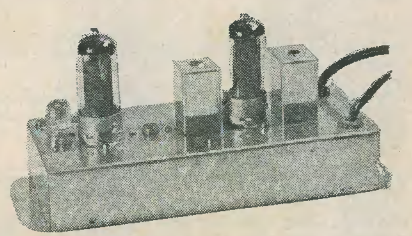
BAND 3 CONVERTERS



Teletron Mark I Converter Kit. Complete kit of parts, including coils and valves, etc., **£2 7s. 0d.,** post 6d.

Teletron Mark 2 Converter Kit. As featured in this issue. Complete kit of parts, as illustrated above, including valves (PCC84 & PCF80) and coils, etc., **£2 15s.,** post 6d. Mk. 2 Kit, less valves, **£1 15s.** post 6d.

Both these Kits include all resistors, condensers, valves, valve bases, coil sets, pre-punched chassis with bottom screen, nuts, bolts, etc., wiring instructions, circuit diagram and alignment instructions.

Mark 1 Coil Set, complete with wiring diagram, circuit and alignment instructions, **15/–**, post 3d.

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Wireless Marketing Co
29 PRAED STREET **LONDON W2**
Established 1926 *Telephone PAD 1903*

SMALL ADVERTISEMENTS

continued from page 193)

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FM DIPOLE, comprising two rod elements complete with junction box, suitable indoor or outdoor erection, 8s. 3d. plus 6d. carriage. **BAND III** TV aerial, suitable loft or outdoor erection, 2 element Yagi complete with junction box, 7s. 6d. carriage 6d. Cheapest aerials on the market. Complete range Teletron coils at list prices. All radio components stocked. Goods sent per return. Wireless Marketing Co. (Supplies), 29 Praed Street, London, W.2. Tel. PAD 1903.

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1S5	7/6	6H6M	5/–	807 (U.S.A.)	7/6	EF92	5/–
1T4	7/6	6J56T	6/–			EL35	9/–
1A3	4/6	6J6	5/–	832	30/–	EL41	10/6
1L4	4/6	6K7G	5/–	866A	12/6	EL84	11/6
1LN5	5/6	6K7GT	6/6	954	5/–	EL91	6/–
2A3	7/6	6K7M	6/6	955	5/–	EY51	12/6
2X2	3/6	6K8G	8/6	956	5/–	EZ40	8/6
3A4	6/6	6L7M	7/6	9001	5/–	EZ80	8/6
3D6	5/–	6Q7G	8/6	9003	5/–	PCC84	12/6
3Q5GT	9/6	6SA7M	8/6	9006	5/–	PCF80	12/6
3S4	8/6	6SG7M	7/6	CBL1	10/–	PCF82	12/6
3V4	8/6	6SL7GT	7/6	CV286	6/6	PL81	13/6
5U4G	8/6	6SN7GT	7/6	CV287	6/6	PL82	9/6
5Z4G	8/6	6SS7M	6/6	DL33	9/6	R12	12/6
6AB7M	7/6	6U5G	7/6	DAF96	9/–	R19	12/6
6AC7M	6/–	6V6GT	7/6	DF96	9/–	TZ40	30/–
6AG7M	9/–	6X4	7/6	DK96	9/6	SP61	3/–
6AK5	6/6	6X5GT	7/6	DL96	9/6	UCH42	10/6
6AL5	6/–	6Z4	5/–	EA50	2/–	UL41	10/6
6AM6	6/–	7B7	9/–	EAF42	9/6	UY41	8/6
6AQ5	9/–	7C5	9/–	EBC3	10/–	VS110A	4/6
6AT6	8/–	7C6	9/–	EB91	6/–	VU120A	3/6
6AU6	8/6	7Y4	9/–	ECC81	10/6	VR105/30	
6B8M	7/6	12A6M	7/6	ECC82	10/6		7/6
6BA6	8/6	12AU7	9/–	ECH35	10/–	VR150/30	
6BE6	7/6	12BE6	7/6	ECH42	10/–		7/6
6BJ6	7/6	12J7GT	9/–	ECL80	11/6	VT62	10/–
6BS7	7/6	12K7GT	9/–	EF37	7/6	W77	5/–
6BR7	11/6	12Q7GT	9/–	EF50		X66	7/6
6BW6	7/6	15D2	4/6	(Syl)	7/6	Z77	6/–
6C4	5/–	25L6GT	10/–	EF5	10/–	EM80	9/–
6CH6	6/6	35L6GT	10/–	EF6	10/–		
6F6G	7/6	35Z4GT	9/6	EF54	5/–		
6F7	8/6	80	9/6	EF80	10/–		

DENCO F M RECEIVER

Drilled chassis, FM manual, all components, nuts and bolts, etc., and 5 valves (for 2 IF stages), EB91, 6BA6 (2), 12AH8 and EF91. **£6 7s. 6d.** or with Denco dial and drive 9/– extra

P.O. Type 3000 Relays. 20,000 ohms, heavy make and break. Ditto with 6,500 ohm coil and double make and break (light contacts). Both types **10/6** ea.

"Panl" Crackle Paint. Black, brown and green, **3/–** tin.

B7G and B9A moulded V/hldrs. with screens, **2/–** set **22/6** doz.

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Mica 0.001 mfd, 0.01 mfd. 350V wkg. **3/–** doz., **24/–** gross

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American oil-filled Block Condensers with clips. 10 mfd 600V wkg. **7/6**

M.C. Meters, 2" round flush, 0-500 micro-amps (scaled 0-10V) **17/6**. 2" sq. fl. 0-50M/A **8/6**

For the Radio Controller. 5-way solenoid operated selector mechanisms. A.M. ref. 5D/609. Will operate 5 sequential controls. See picture in "Radio Control of Models" **10/–** ea.

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DENCO FM TUNER	circuits 1/6
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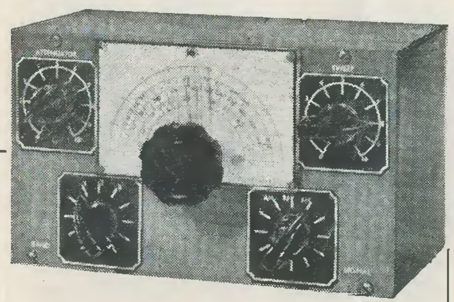

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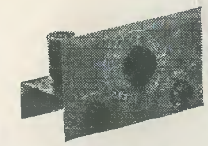

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