100th ISSUE

The
RADIO Constructor

FOR THE RADIO AND TELEVISION ENTHUSIAST

VOLUME 9 NUMBER 4 NOVEMBER 1955

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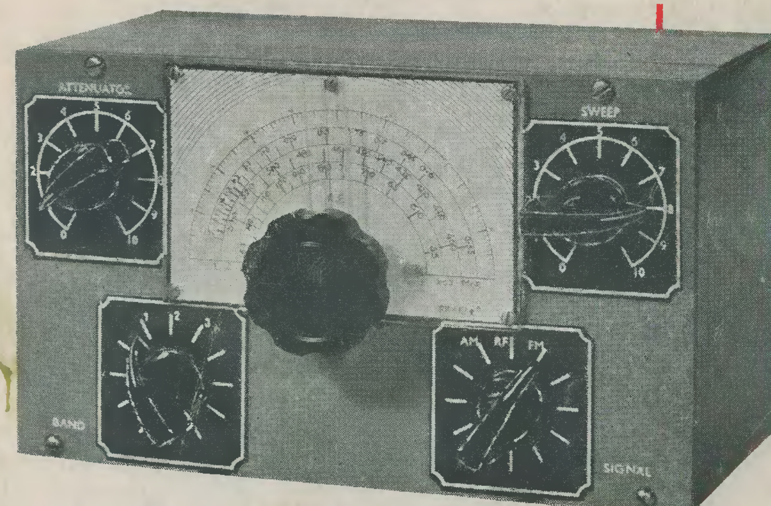

By W. PICKERING

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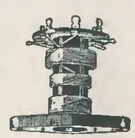

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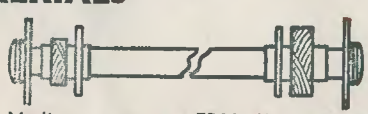

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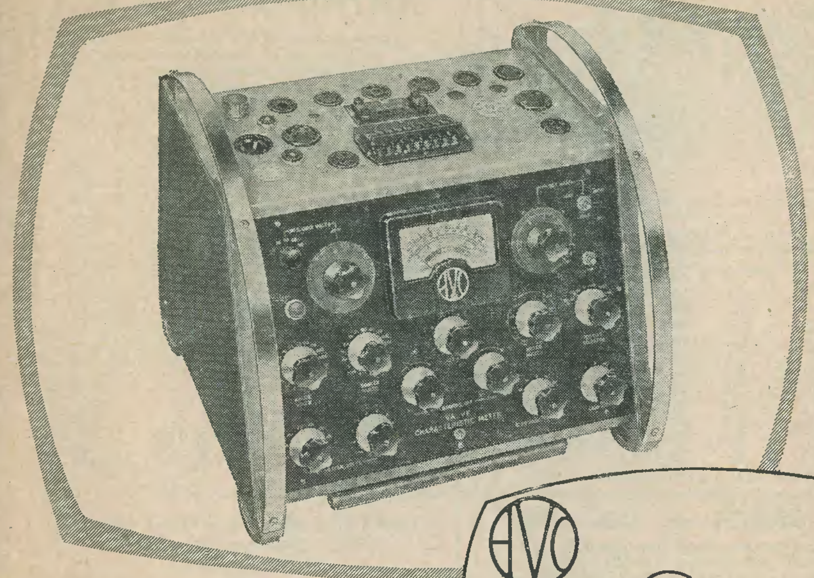

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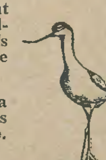

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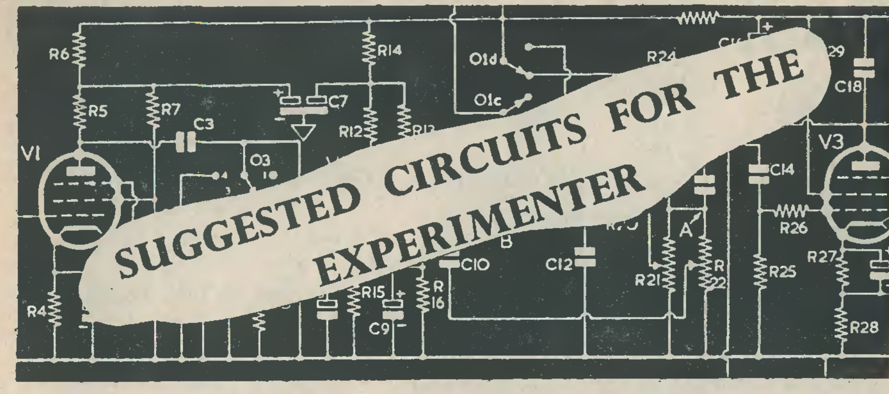


The circuits presented in this series have been designed by G. A. FRENCH, *specially for the enthusiast who needs only the circuit and essential relevant data*

No. 60: AN ADD-ON F.M. TUNING INDICATOR

IT APPEARS TO BE THE FASHION NOWADAYS to primarily design tuning indicators for f.m. receivers, and then discuss them in the technical press. The novelty of such circuits in this country presents something of a temptation to the technician; and the writer has, himself, given way on at least one occasion during the last year. However, he makes no apologies for introducing a further circuit in this article; and can only state, in his defence, that the device to be described has applications not fully covered elsewhere.

The Indicator

The necessity for an f.m. tuning indicator need only be touched upon quickly here. Should an f.m. receiver not be fitted with such an indicator, it is difficult to tune it such that the centre frequency lies exactly at the centre of the linear part of the discriminator characteristic. Whilst incorrect tuning may not reveal distortion at low levels of modulation, higher levels—such as are given by loud passages of music—may run into non-linear sections of the discriminator characteristic and result in serious distortion. Also, with many types of ratio discriminator, a.m. rejection is at its most efficient when the receiver is tuned exactly to centre frequency. Without an indicator, therefore, the f.m. listener is liable to be subjected not only to occasional distortion but also to intermittent interference which may be extremely difficult to tune out.

The normal type of f.m. tuning indicator functions from the rectified voltage developed at the discriminator load or the grid of the limiter valve (if one is fitted), and assumes that the i.f. strip is adjusted such that a slight peak occurs at centre frequency. This is not necessarily a practicable proposition, since an f.m. i.f. strip should, ideally, be flat over the pass-band. Further, due to altering circumstances in the receiver, such as valve ageing, vibration, etc., etc,. such peaks as are obtained are liable to drift off centre frequency as time proceeds.

Several circuits have been described which function from the voltage available at the audio take-off point of a balanced ratio discriminator. These tackle the situation from the most realistic point of view and suffer only from the fact that they usually require an additional valve apart from the indicator, and that they will only work with discriminators having balanced loads.

This Month's Circuit

The circuit to be described this month uses a very obvious approach and has several advantages. These are that it may be fitted to any conventional f.m. receiver, regardless of the type of discriminator arrangement which is employed. Also, it should apply negligible loading to whatever circuit in the receiver it is coupled. Presentation is achieved on the screen of a normal Magic Eye indicator, and is exactly similar to that given by the tuning indicators of conventional broadcast receivers. It suffers from the disadvantage that it requires an additional valve. This valve is, however, not a "critical" type and it can consist of any modern r.f. pentode which the constructor may happen to have on hand.

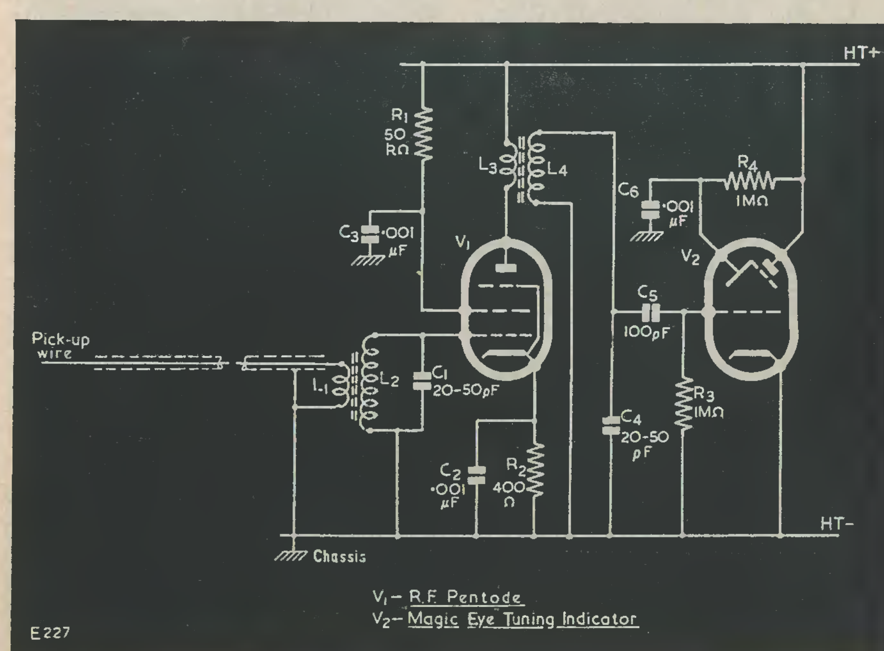
The indicator circuit is illustrated in the accompanying diagram, and its mode of operation will at once be apparent. It consists, quite simply, of an r.f. pentode, to whose grid and anode are coupled two tuned circuits, each of these being tuned to the centre i.f. of the receiver. Pick-up is obtained by positioning a short length of unscreened wire near the wiring of the last i.f. stage of the receiver. There is, normally, a considerable amount of i.f. energy at this point and this should be more than adequate for the purposes required here.

which couples into the second tuned circuit, L_4–C_4. L_4 is connected across the grid and cathode of the Magic Eye, these electrodes functioning as the anode and cathode of a diode. In consequence, a rectified negative voltage, with respect to cathode, appears on the grid of the Magic Eye; and this causes deflection of the shadow display in conventional fashion. Since the triode section of the Magic Eye would amplify the r.f. applied to its grid, and this could cause instability, the triode anode is decoupled to chassis via C_6.

The two coils L_2 and L_4 are adjusted to be resonant at the centre frequency of the i.f. strip. When the receiver is tuned towards this centre frequency the negative voltage appearing on the grid of the Magic Eye increases and its shadow "closes." Minimum shadow angle corresponds, therefore, to the position of optimum tuning.

Points of Design

There are one or two points of design which are worth discussing in greater detail at this



The i.f. energy picked up from the receiver is passed, via the screened cable, to the coupling coil L_1; and, thence, to the tuned circuit L_2–C_1, and the grid of the r.f. pentode. The anode of this valve feeds into the coil L_3,

point. To begin with, a tuning indicator for an f.m. receiver must obviously have a reasonably high degree of sensitivity if it is to be at all useful. It would appear safe enough to state, as a start, that a change in Magic Eye grid voltage from maximum to 0.707 of maximum would give a usable and easily discernible change in shadow angle. If such a change were considered sufficient for final fine adjustment of tuning, this could then be made to correspond to an arbitrarily chosen deviation of input frequency. (The figure 0.707 is chosen here for ease of later calculation.)

The linear portion of an f.m. discriminator normally extends over some 200 to 300 kc/s. As a second assumption, therefore, should we decide to take 2.5 kc/s as being the arbitrarily chosen off-set frequency needed to cause the drop to 0.707 of maximum Magic Eye grid volts, we would then have the condition in which a useful indication is given when the input frequency is displaced from the centre of the discriminator characteristic by approximately 1% of the linear section of that characteristic. This degree of sensitivity should be more than sufficient for normal purposes.

If we tried to obtain this sensitivity by using a single parallel tuned circuit between the i.f. stages of the receiver and the Magic Eye grid, it would be possible to calculate the approximate value of effective Q the tuned circuit should possess. This we would do by employing the formula:

$$Q \approx \frac{f_r}{f_1 - f_2}$$

where f_r is the resonant frequency, and f_1 and f_2 are the two frequencies on either side of f_r at which the r.f. voltage across the tuned circuit drops to 0.707 of its maximum value.

For a 10.7 Mc/s i.f., and a deviation on either side of centre frequency of 2.5 kc/s (giving $f_1 - f_2 = 5$ kc/s we would obtain:

$$Q \approx \frac{10.7 \times 10^6}{5 \times 10^3}$$

$$\approx 2{,}100.$$

A single tuned circuit having a Q of 2,100 at 10.7 Mc/s is obviously impracticable. If, however, we employ two separate tuned circuits connected in the grid and anode circuits of a valve, they will give the same effect as a single tuned circuit having the product of their individual Q values. Thus, if each of the two tuned circuits had a Q equal to $\sqrt{2{,}100}$ (=46), then their combined effect would be to give a Magic Eye sensitivity equal to that specified.

The construction of a tuned circuit having a Q of 46 when resonant at 10.7 Mc/s is quite easy to carry out, In the circuit discussed this month it is assumed that L_2–C_1 and L_4–C_4 have an effective Q which, including the losses caused by the circuits to which they are connected, is at least equal to this value.

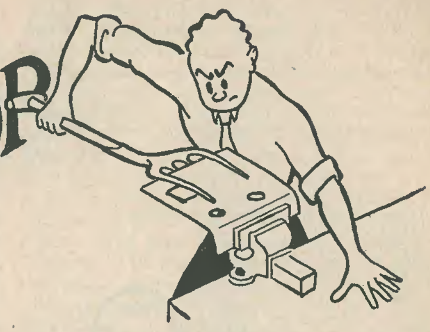
It must be pointed out, of course, that the above paragraphs are not in any way intended to provide a "mathematical" proof of the efficacy of the circuit described this month. Indeed, they could hardly do so, as the results obtained are based on several original assumptions, and the writer has made his job somewhat simpler by choosing figures which allow of easy calculation! Nevertheless, the procedure outlined is quite definitely of value since it enables approximate calculations of the usefulness of the circuit to be obtained before it is put into practice. It is far better to have a rough idea of what an unfamiliar circuit can do than to work "in the dark" all the way.

Practical Points

There should be little difficulty in bringing the indicator circuit into operation. It would be advisable, however, to screen the two coils. Excellent screening would be given if these were wound and mounted in small screened cans of the "Aladdin" type. The whole circuit should, preferably, be mounted on a small sub-chassis, complete with the Magic Eye.

The coupling lead to the i.f. stages of the receiver could consist of normal 75 ohm coaxial cable up to 2 feet long; approximately 1in of the inner conductor being left unscreened at the end remote from the indicator assembly. This short length of lead could then be positioned close to the i.f. wiring at the limiter or discriminator stage.

IN YOUR WORKSHOP



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

I HAVE JUST BEEN MILDLY TICKED OFF BY a reader for becoming "too technical." He states, mainly, that whilst he has no objections to my devoting some space every now and again to the more advanced side of radio and television, I shouldn't make too much of a habit of it!

"After all," he continues, "there are many beginners, like myself, who have not as yet fully absorbed the basic principles of normal television. For instance, although I have played around quite a bit with line and frame timebases, I have sometimes run into trouble in these parts of the television receiver, and have only been able to extricate myself by checking or replacing individual components until I had got everything working properly. This has been especially the case with blocking oscillators, and although I think I now have the "feel" of these circuits, some words from you on such oscillators would most definitely be welcome."

Well, that certainly seems to be fair enough; but I cannot help but point out that the practical experience this reader has had with timebases will stand him in excellent stead so far as an understanding of their working is concerned.

Blocking Oscillators

In its normal form, the blocking oscillator may also be described as a "sawtooth generator." When this oscillator was originally conceived, it consisted of a triode valve connected as an r.f. oscillator, and it incorporated a relatively high value of series grid capacity in order to give a "squegging," or blocking, action. This arrangement gave rise to bursts of r.f. oscillation at the commencement of each sawtooth cycle, these bursts causing the grid condenser to charge up and bias the triode beyond cut-off. After a period of time, the grid condenser discharged through its attendant grid leak, whereupon the triode again passed anode current; thus allowing r.f. oscillations to recur and the grid condenser to be charged once more.

In the more modern blocking oscillator, as used in television timebase circuits, the r.f. oscillator tuned and coupling circuits are replaced by an iron-cored transformer. Whereas, with the r.f. components, a number of cycles of r.f. oscillation were needed to give the grid condenser a sufficient charge to bias the valve beyond cut-off, with the iron-cored transformer only one cycle is needed. This has the advantage that the time taken to charge the grid condenser is substantially constant for each sawtooth cycle, with the result that synchronisation pulses give more accurate control of the initiation of the scan period of the cycle. Further, the possibility of wide-band radiation of the type associated with a "squegging" oscillator is removed. Also, the iron-cored inductive components which are employed may be manufactured to wide tolerances.

The blocking oscillator appears to be more popular in Great Britain in the frame timebase circuits of televisors rather than in the line timebase circuits; although there is nowadays a trend for its use for both purposes. In America, it appears to be used as frequently in the line timebase circuits as it is in the frame.

The Basic Circuit

The basic circuit of the blocking oscillator is shown in Fig. 1. The transformer has been drawn as an end-to-end winding to facilitate the process of explanation. In practice, the two windings would, of course, be tightly coupled on a common laminated iron core.

It is as well to consider the commencement of the sawtooth cycle at the point of applying h.t. to L_1 and, thence, to the anode of the valve.

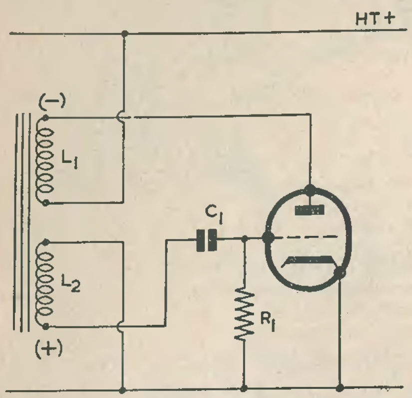


FIG.1.

Fig. 1. The circuit of the basic blocking oscillator

As soon as h.t. is applied, the anode draws current through L_1, causing a continuously increasing magnetic field to be built up in the transformer, and inducing a voltage in L_2. The voltage induced in L_2 is such that the bottom end of this winding becomes increasingly positive with respect to the cathode of the valve. This positive voltage is applied, via C_1, to the grid of the valve, causing this electrode to become positive also and thereby increasing the anode current still further.

At the same time, however, the grid and cathode of the valve act as the anode and cathode of a diode. Thus, the voltage appearing across L_2 is applied, via this effective diode, to C_1 and tends to charge it to the same voltage. As may be seen, the polarity of the voltage across L_2 (bottom positive, top negative) is in the correct sense for this conduction through the valve's electrodes to take place. The charge introduced in C_1 is such that its right-hand plate is negative and its left-hand plate positive.

All this occurs during the time that the anode of the valve draws its increasing current through L_1 and produces an expanding magnetic field in the transformer. However, after a period, a limit is reached, this being caused either by saturation of the valve or by saturation of the core of the transformer itself. When this limit is reached, the magnetic field ceases to expand and commences, instead, to collapse. This effect is immediately reflected in the voltage appearing across L_2, and, particularly, in the potential at the bottom end of this winding. This potential, which was previously becoming continually more positive with respect to the cathode of the valve, now commences to swing in the opposite, negative-going, direction. This causes the grid of the triode to become more negative also, with the result that the anode current decreases. This decrease makes the magnetic field in the transformer collapse even further, causing the grid of the valve to become even more negative. The effect is cumulative and continues until the grid voltage is taken well beyond the cut-off point for the valve.

The valve then, of course, ceases to conduct and its anode takes up the potential of the h.t. supply. At the same time, C_1, which was charged during the initial part of the cycle and which now holds the grid negative with respect to the cathode, commences to discharge, via L_2, into R_1. When it has almost completely discharged, the negative voltage on the grid becomes sufficiently low to allow the passage of anode current. This is drawn through L_1, causes the magnetic field to be built up in the transformer again, and thus initiates a new cycle.

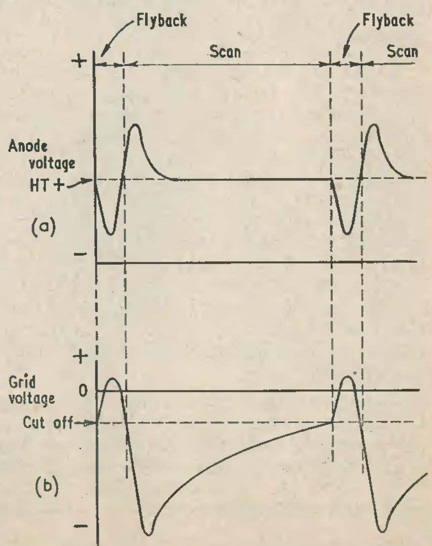


FIG.2.

Fig. 2. The voltage waveforms produced by the blocking oscillator are shown here. Curve (a) illustrates the voltage appearing at the anode, and curve (b) that at the grid

Waveforms

The voltage waveforms appearing at the grid and anode of the triode are shown in Fig. 2. Starting with the anode waveform, Fig. 2 (a), it will be seen that this remains constant at the h.t. potential during the period of cut-off, and then swings through a complete cycle during the period in which the grid condenser is charged.

In practice, the single cycle shown in Fig. 2 (a) may be a little idealised, as the frequency of this cycle depends upon the effective inductance and self-capacity of the transformer itself. Some ringing is to be expected. It is usually considered, however, that the transformer is sufficiently damped by its own iron laminations to prevent this effect from becoming too serious. Fortunately, also, a small amount of ringing may be tolerated since the most useful voltages appear at the grid, where transformer ringing for most circuit applications has little derogatory effect.

The grid voltage is shown in Fig. 2 (b), and is of considerable interest. It commences, as would be expected, with a short excursion into positive grid voltage, the consequent grid current sufficing, of course, to charge the grid condenser. It then falls quickly to several times the value of cut-off, after which it becomes slowly positive, following an exponential curve until it passes the cut-off point again.

The most useful part of the curve is the commencing positive pulse, as this may be applied directly to a discharge valve whose function is that of linear sawtooth generation. Alternatively, the exponential curve of Fig. 2 (b) may itself be used to provide a scanning voltage, although its severe non-linearity necessitates the use of special circuits to enable this to be done.

To conform with television practice, the various parts of the waveforms shown in Fig. 2 have been designated as "scan" and "flyback." It should be stated, however, that the length of the scan period depends mainly upon the values of C_1 and R_1, in Fig. 1, and that the length of the flyback period depends upon the inductance and self-capacity of the transformer.

Discharge Valve

It was stated just now that the most useful voltage given by the blocking oscillator is that occurring at the grid of the valve. Despite its severe non-linearity, the exponential curve appearing during the "scan" part of the cycle may, for instance, be used (after amplification) as a scanning voltage itself, although this is not usual. Alternatively, the positive pulse appearing at the grid during the "flyback" period may be used to control an additional discharge valve.

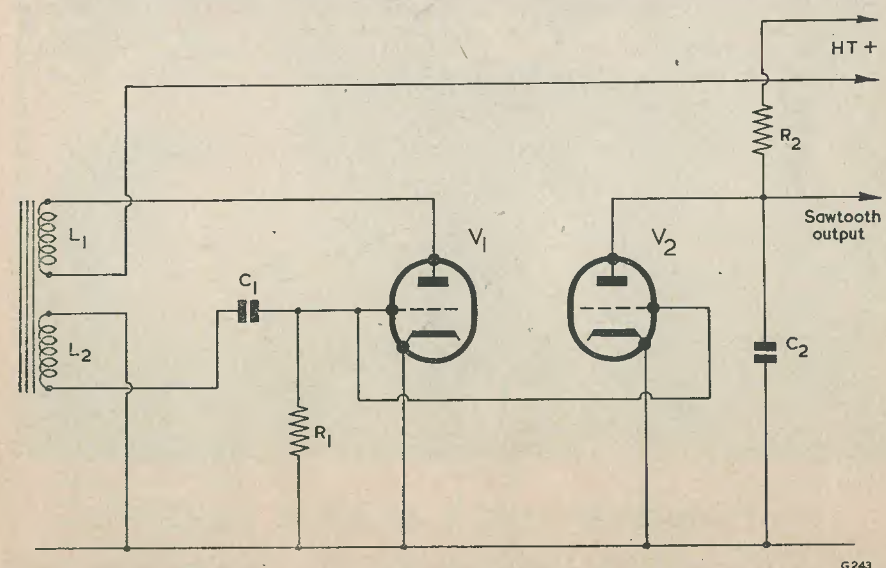


FIG.3.

Fig. 3. To obtain a more linear scanning waveform, it is usual to employ a separate discharge valve; this being connected to the blocking oscillator in the manner illustrated here

This second arrangement is extremely convenient, and the essential circuit needed is shown in Fig. 3. In this diagram V_2 is the discharge valve, and its grid is connected to that of V_1. Thus, the voltage appearing in Fig. 2 (b) is applied directly to the grid of V_2, with the result that this valve conducts and passes a relatively heavy anode current during the period of flyback, and is cut off during the scan period.

The purpose of V_2 in Fig. 3 is to discharge the condenser C_2 during the flyback period and to allow it to charge through R_2 during the scan period. The voltage appearing across C_2 thus takes on the character of a sawtooth.

Fig. 4 shows the voltage appearing across this condenser. If V_2 were taken out of circuit C_2 would tend to charge through R_2 to the full h.t. voltage, following the exponential curve shown continued by the dotted line in Fig. 4. The most linear part of this curve is that appearing at the bottom, and the function performed by V_2 is to allow the condenser to charge over this part of the curve, then to discharge it quickly during the flyback period. The voltage appearing finally across C_2, consequently, is that shown in continuous line in Fig. 4.

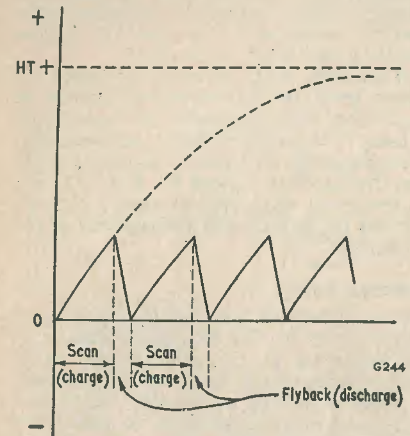


FIG.4.

Fig. 4. The waveform appearing across the condenser C_2 of Fig. 3. For normal purposes it is advisable to use the early part of the exponential charging curve of the discharge condenser, since this possesses greatest linearity

It will be seen from Fig. 4 that the most linear part of the exponential charging curve of C_2 occurs over its lower part, and that its amplitude is proportional to the total h.t. voltage applied across R_2 and C_2 in series. It follows, therefore, that if this h.t. voltage were increased, it would be possible to obtain a sawtooth voltage from C_2 of similar linearity and greater amplitude. Or, alternatively, it would be possible to obtain a sawtooth voltage of similar amplitude and better linearity, since only a smaller (and, consequently, more linear) part of the exponential curve need be used. This point is of some importance, and, because of it, conventional timebase designs use the highest reliable h.t. voltage which appears in the television receiver for supplying the discharge network of the sawtooth generator circuit. In receivers employing the 200 volt rail given by a.c./d.c. power circuits this h.t. voltage is most often obtained from the boosted supply given by the line output circuit. It would be quite in order, therefore, to have the anode of V_1 in Fig. 3 fed from a 200 volt h.t. rail, whilst R_2 was connected to a 500 volt boosted supply.

The circuit of Fig. 3 is satisfactory and practicable, and is encountered (with, perhaps, a few trimmings) in many receivers. It is possible, however, to combine the functions of the blocking oscillator and discharge triode in one valve, this being achieved by the arrangement shown in Fig. 5.

In this circuit, the single triode functions in exactly the same manner as does V_1 of Fig. 3, only it now also discharges the condenser C_2 over the period of the positive grid pulse which occurs during the flyback time. For similar transformers, the flyback period obtained with this arrangement may be quicker than occurs with the circuit of Fig. 3, since the reduced anode voltage resulting from the discharge of C_2 now causes anode saturation to be reached at an earlier part of the flyback period. On the other hand, this quicker cessation of anode current reduces the charging time for C_1, which may not therefore take the grid so far negative for the commencement of the scan period. This has the result that frequency stability may be less reliable and synchronisation more critical. Further, the condenser C_2 may not be discharged so completely during the flyback period, so that, for similar h.t. voltages, it would not give sawtooth linearity or amplitude equal to that obtained from the circuit of Fig. 3. However, the circuit possesses the considerable advantage of saving a valve.

"To be continued"

It seems that I have now come to the end of my allotted space without yet having had the chance to deal with the synchronising requirements of a simple blocking oscillator. These will therefore be dealt with in next month's issue.

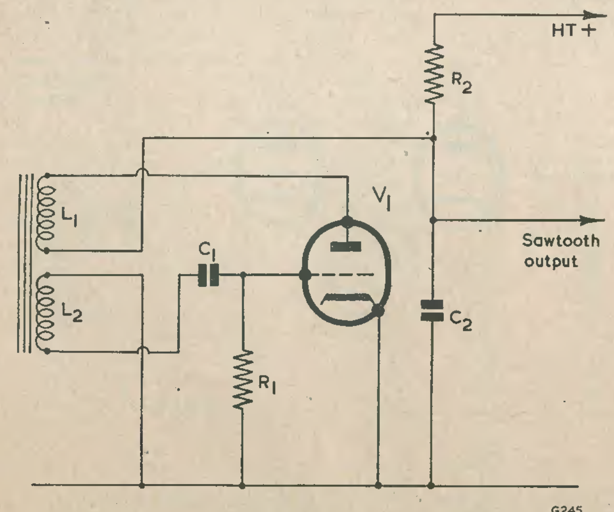
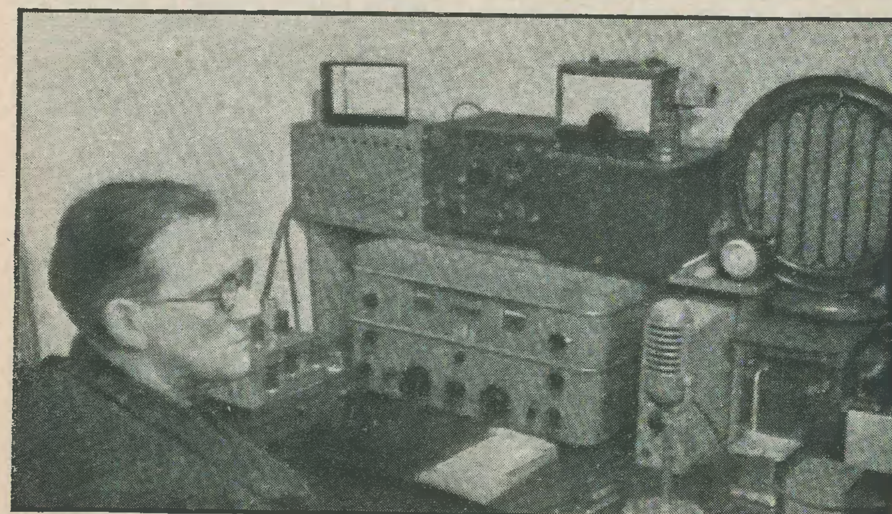


FIG.5.

Fig. 5. At the expense of slightly less efficient operation, it is possible to combine the two valves of Fig. 3 into the single-valve arrangement shown in this circuit



AMATEUR STATION G3EJO, BIRMINGHAM

On extreme left of the table are 2 metre and 70 cms crystal controlled converters with power pack on shelf above. The main receiver is an AR77E with BC221 and power pack directly above. To the right of the receiver is the control unit which relay-switches all apparatus. The transmitters (not shown) are on 160 and 2 metres, the main interest being in v.h.f. working.

AERIALS FOR BAND III

by R. J. CABORN

THE PROVISION OF AERIALS FOR BAND III reception is not necessarily so difficult a task as occurs at Band I frequencies. This is due to the fact that, owing to the smaller wavelengths involved, the lengths of the various aerial elements required are shorter than is the case for Band I reception. High-gain arrays are in consequence much more easy to construct and get into working order.

The Dipole

The simplest type of television aerial is, of course, the dipole. This is shown in Fig. 1. The dipole is cut to approximately one-half the wavelength it is intended to receive; and it is connected to the associated receiver by means of a transmission line, the two conductors of which are inserted at its centre. The impedance at the centre of a practical dipole is some 70 to 80 ohms, and an excellent match is therefore available for standard 75 ohm co-axial cable.

For best results, the actual length of the dipole of Fig. 1 should not be made exactly equal to one-half wavelength. This is due to what is known as "end-effect"; the two ends of the aerial tending to exert an additional capacitive load on the assembly. In consequence of this, it is necessary to shorten the dipole slightly to obtain an effective "electrical length" which corresponds to one-half wavelength of the received signal. For normal Band III applications the actual, measured, length of a dipole should be approximately 94% of the theoretical calculated length of one-half wavelength.

Fig. 2 (*a*) illustrates a folded dipole. If the two parts of this dipole employ conductors of the same diameter, the impedance at the point at which the transmission line connects in the diagram is approximately 4 times that of an equivalent simple dipole. Thus the impedance of the aerial of Fig. 2(*a*) is approximately 300 ohms.

In the same manner as the double-folded dipole of Fig. 2(*a*) increases the centre impedance 4 times, a triple-folded dipole increases the centre impedance 9 times, and a quadruple-folded dipole 16 times. A triple-folded dipole is illustrated in Fig. 2(*b*). Such forms of the folded dipole are not used very frequently, however.

The impedance of the folded dipole of Fig. 2(*a*) may be made greater by increasing the diameter of the right-hand element with respect to the left-hand element (or by decreasing the diameter of the left-hand element with respect to the right-hand element). Under certain conditions it is theoretically possible by this means to increase the impedance of the aerial by as much as 50 times over that of a single dipole.

Reflectors and Directors

An improvement in dipole performance may be obtained by adding parasitic elements to the original single dipole.

Fig. 3 shows a dipole fitted with a reflector, and Fig. 4 a dipole fitted with both a reflector and director. These additional elements result in a useful increase in gain and also make the aerial directional. Both these points are advantageous for television reception. For good results under usual conditions the spacing between the dipole and the reflector should be approximately one-fifth of the wavelength. The distance between the dipole and the director is, normally, approximately one-sixth of the wavelength. Still greater gain may be obtained by adding further directors, as shown in Fig. 5. These additional directors also increase the directional properties of the aerial. Spacing between successive directors is approximately one-sixth wavelength for good results under normal conditions.

The lengths of directors and reflectors are somewhat critical. It is usual practice to make the reflector some 5 to 6% longer than the dipole, and the first director approximately 4% shorter. The second director should then be made 4% shorter than the first, and so on.

A very important point brought about by the addition of directors and reflectors to a dipole is the fact that they reduce its impedance by a considerable factor. This has to be borne in mind when constructing aerials for Band III reception.

A Simple Aerial

For those living very close to the Band III transmitter, it seems probable that a

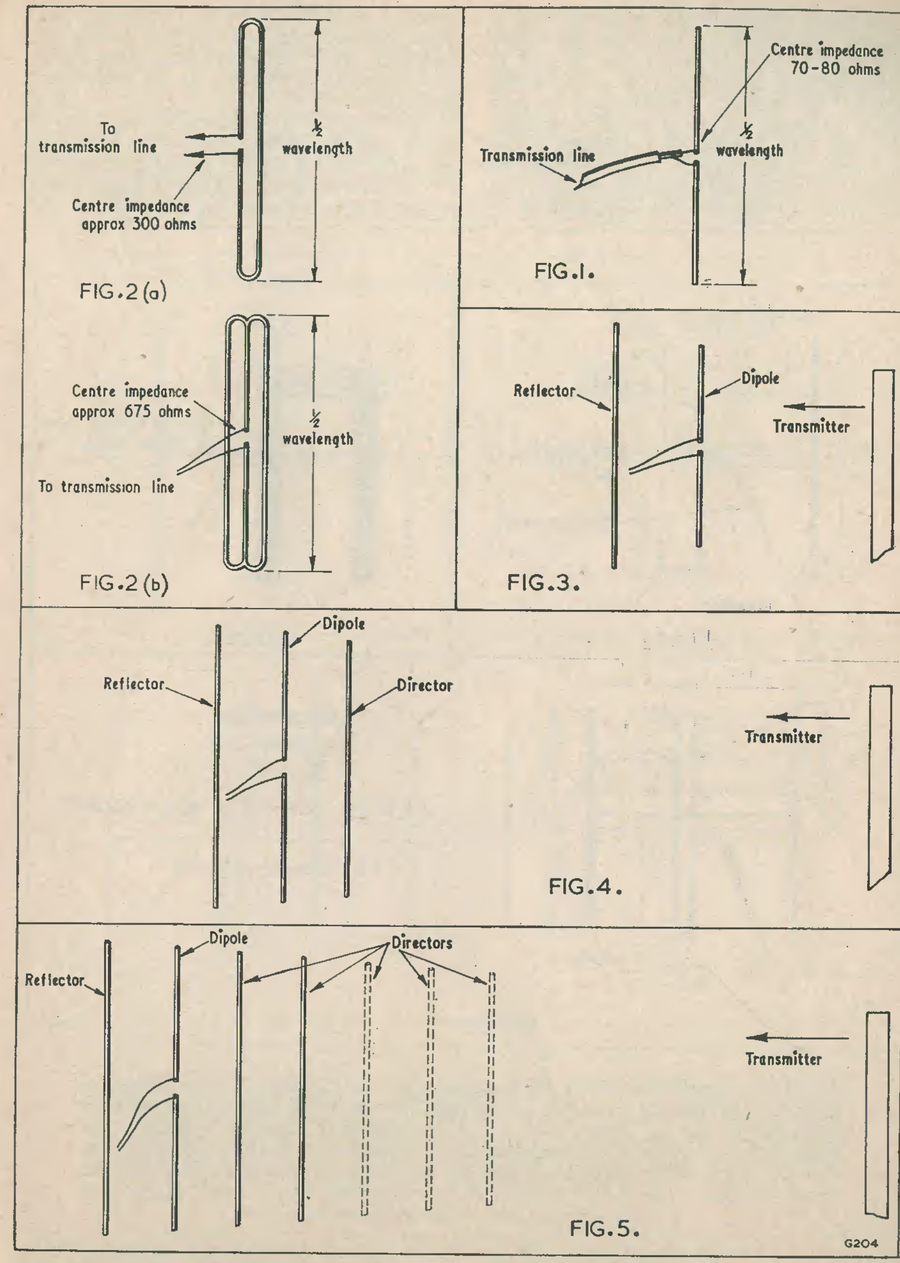


Fig. 1. A simple half-wave dipole. The transmission line to the aerial may consist of conventional 75 ohm co-axial cable. Fig. 2 (a). A conventional folded dipole. (b). A triple-folded dipole. Fig. 3. A dipole fitted with a reflector. Fig. 4. Adding a director to the dipole and its reflector. Fig.5. Further directors may be added as shown here

simple array incorporating a dipole and a reflector will prove to be quite adequate. Such an aerial is shown in Fig. 6, and is really nothing more than a scaled-down Band I "H" aerial. Nevertheless, it represents a simple assembly which combines low cost with reasonable sensitivity. The dimensions given in the diagram are for Channel 9 operation, whilst dimensions for Channel 8 are given in the caption. If it is desired to make the aerial a combined Channel 8–Channel 9 job, the dimensions employed should be approximately mid-way between those given for the individual channels. The same applies to the more complicated aerials which follow. The material used for the rod elements would most conveniently consist of duralumin, although other non-corroding metals may be employed if weight is of secondary importance.

Fig. 7 shows a more ambitious type of aerial. In this case a director is added to the array, and a folded dipole is employed at the centre. It is necessary to employ a folded dipole because the addition of the director would reduce the impedance of a simple dipole to some 15 to 25 ohms. The quadrupling effect of the folded dipole brings this impedance within the region 60 to 100 ohms; thereby allowing a direct connection to normal 75 ohm co-axial cable, without

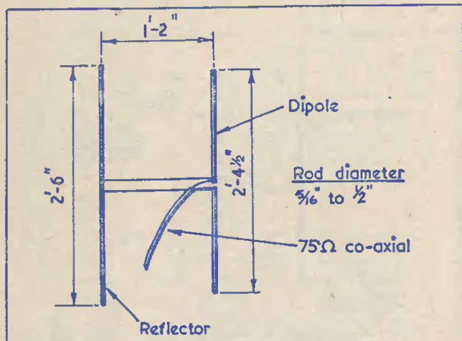


FIG.6.

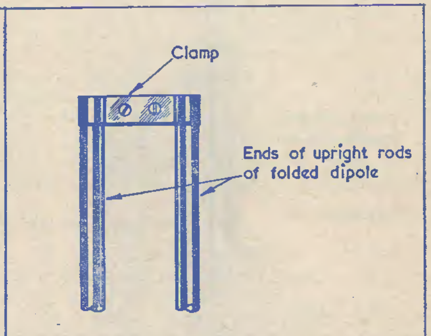


FIG.8.

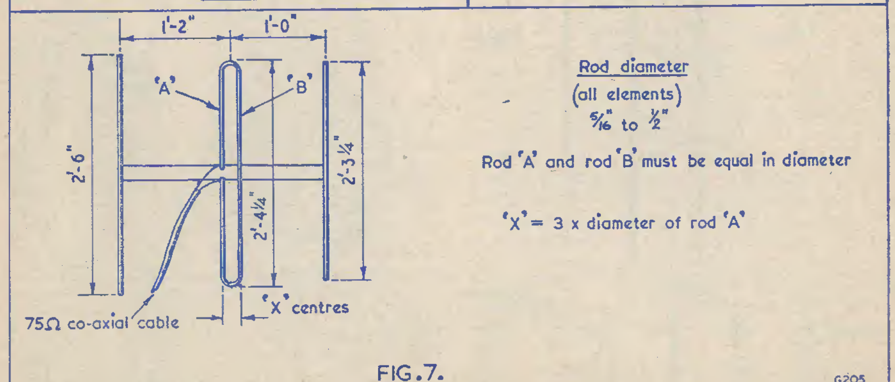


FIG.7.

Fig. 6. A simple "H" array for local reception on Channel 9. For Channel 8 reception the reflector should be 2ft 7in long, the dipole 2ft 5½in, and the distance between the two 1ft 2½in. Fig. 7. A three-element Channel 9 array. For Channel 8 the lengths of the dipole and reflector are as for Fig. 6; whilst the added director should be 2ft 4¼in long, and the distance between the director and the dipole 1ft 0½in. Fig. 8. A joint for the extreme ends of the folded dipole may be afforded by clamps, as shown here

incurring too serious a mismatch.

It will probably be difficult to bend the tubing forming the folded dipole such that it takes up the appearance shown in Fig. 7. In such a case the arrangement illustrated in Fig. 8 may be employed, where the ends of each rod are bridged over with clamps. When clamps are used in this fashion, the electrical connections formed must be made as reliable as possible.

A Four-Element Array

A four-element array is illustrated, with dimensions, in Fig. 9. This has an extra director in addition to that of Fig. 7. In consequence of this the impedance of a simple dipole element included in the array would be around 10 ohms. In order to bring the impedance close to that required for matching to 75 ohm co-axial cable, the folded dipole components vary slightly from those shown in Fig. 7. However, the alterations needed should cause little trouble in practice. (It should be pointed out that the aerial shown in Fig. 9 will still afford a reasonable —although not so efficient—match to the co-axial cable if the two rods A and B have the same diameter).

A five element array is illustrated in Fig. 10. This aerial should be sufficient for most applications up to the worse fringe areas. The folded dipole dimensions are again slightly different from those for Fig. 9,

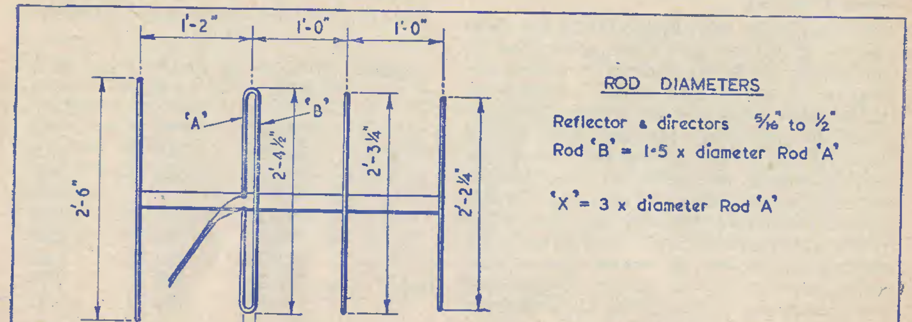


FIG.9.

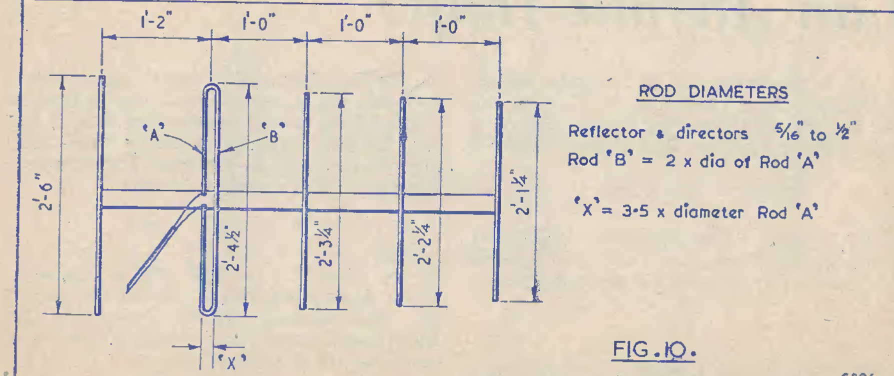


FIG.10.

Fig. 9. A four-element Channel 9 array. Apart from the different dipole rod diameters and the added director, this is similar to Fig. 7. For Channel 8 reception the dimensions should be altered as for Fig. 6 and 7, the added director being 2ft 3¼in long. Fig. 10. A five-element array for fringe reception. For Channel 8 reception the final director should be 2ft 2¼in long, the other elements being altered as in the previous diagrams

this being due once more to the necessity of obtaining a reasonably efficient match to 75 ohm co-axial cable. It would be inadvisable in this case to make the folded dipole with rods having the same diameter, as the mismatch to 75 ohm cable would become serious. If the folded dipole *must* employ rods of the same diameter, a triple-folded dipole of the type illustrated in Fig. 2 (*b*) would provide a better solution.

Other Channels

As will have been appreciated, the dimensions given for each aerial described in this article apply to Channel 9 operation, Channel 8 dimensions being provided in the captions. It is not yet known when any other channels will become available in Band III for television purposes. Nevertheless, it would be useful to give further information on aerial dimensions for all Band III channels; and this has been done in the table given here. This table gives multiplying factors to make any of the aerials shown in this article suitable for other channels. Thus, if the three-element array of Fig. 7 were required for channel 13 operation, each dimension given in Fig 7 should be multiplied by 0.91, the latter being the factor given in the table.

For reference purposes, the table also shows the sound and vision frequencies employed in Band III.

Table showing sound and vision frequencies of Channels 6 to 13. The "multiplying factor" refers to aerial dimensions and is explained in the text

Channel	Sound Freq. (Mc/s)	Vision Freq. (Mc/s)	Multiplying Factor
6 ..	176.25	179.75	1.08
7 ..	181.25	184.75	1.05
8 ..	186.25	189.75	See captions
9 ..	191.25	194.75	1.00
10 ..	196.25	199.75	0.98
11 ..	201.25	204.75	0.95
12 ..	206.25	209.75	0.93
13 ..	211.25	214.75	0.91

Can Anyone Help?

A. E. STONESTREET, of 29 Chaplin Road, Willesden Green, London, N.W.2, would like to buy or borrow the handbooks or a copy for the Receiver R1116 and 1224A.

* * *

P. R. CLARKE, "The Walmers," Collington Lane, Bexhill, Kent, wishes to buy or borrow the circuit of the Charles Concerto Amplifier.

* * *

J. POLLOCK, 13 St. Katherine Road, Sheerness, Kent, would like to obtain the ratings of the metal rectifier marked H-18-16-1 ETF.

* * *

N. F. CASS, 60 Briardale Road, Liverpool 18, wishes to buy or borrow the circuit of the Meissner 9-1085.

* * *

P. H. BROOKE, 137 Kingswood Chase, Leigh-on-Sea, Essex, asks if anyone will sell or lend to him a copy of the circuit for the American Collins Transceiver T.C.S.10, and if any reader can supply him with a spare output transformer for the CR100.

W. H. LONGHURST, 82 Gower Road, Sketty, Swansea, Glam, would like to buy or borrow a handbook, or any information such as i.f., etc., for the American Receiver SLR-12-B, manufactured by E. H. Scott Laboratories, Chicago.

* * *

G. A. TURNER, 11 Bath Place, Margate, Kent, is very anxious to obtain the circuit or under-chassis wiring data of the McMichael model 335 receiver, as he has a complete set of components.

* * *

G. STOKES, 59 Hatherleigh Road, Ruislip, Middx., wishes to borrow the circuit and data of the R.S.G.B. 2-metre Converter, which appeared in the "Bulletin" about 12 months ago.

* * *

C. W. ALDRED, 6 Mumford Place, Chichester, Sussex, asks if any reader can sell or lend to him the circuit and data for the Ekco TSC 30A 9in televisor. He has been unable to obtain from the manufacturers as it is out of print.

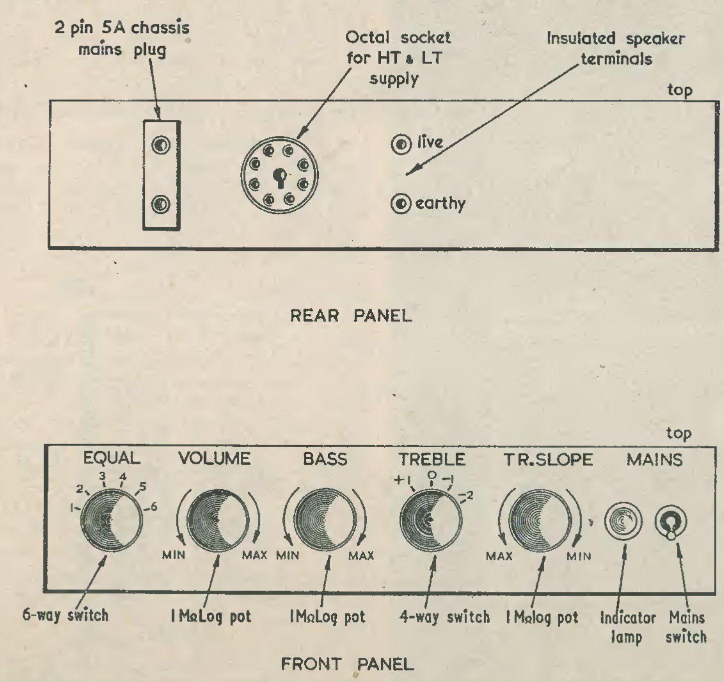
HIGH QUALITY 10 WATT ULTRA-LINEAR AMPLIFIER

PART 2.

by L. F. SINFIELD

THIS PUTS SOME COMPLICATION INTO THE design of the first stage, in that it must work at an anode voltage which is necessary for correct conditions in the phase splitter stage. However, after some tests with an audio oscillator and a 'scope, component values were determined which give more than adequate output voltage without waveform distortion. The feedback is introduced into the cathode of this valve, and its high stage gain also allows ample feedback without undue loss of sensitivity. At the anode of this stage is connected a phase correction network. Although the phase splitter is in fact a triode and would not normally provide ample voltage swing under the usual conditions to fully drive the output valves, the large stage feedback of the un-bypassed cathode resistor reduces any distortion that might have been introduced internally in this stage to negligible proportions. After the phase splitter come the output valves. As in the rest of the main amplifier, the time constants have been kept rather long; also, the cathode resistor is common to both valves so that the response at low frequencies is improved over the condition when separate bias is used. This can be readily shown on a low frequency square wave test. Although, strictly speaking, the cathode by-pass condenser could possibly be omitted, this is included in order to give improved response at high level transients.

FRONT & REAR OF CHASSIS



The heart of any feedback amplifier is, of course, the output transformer. A large core area was used and this was designed to give a primary inductance of greater than 80H at 5V, 50c/s, with low leakage inductance and output impedances most adaptable for general use.

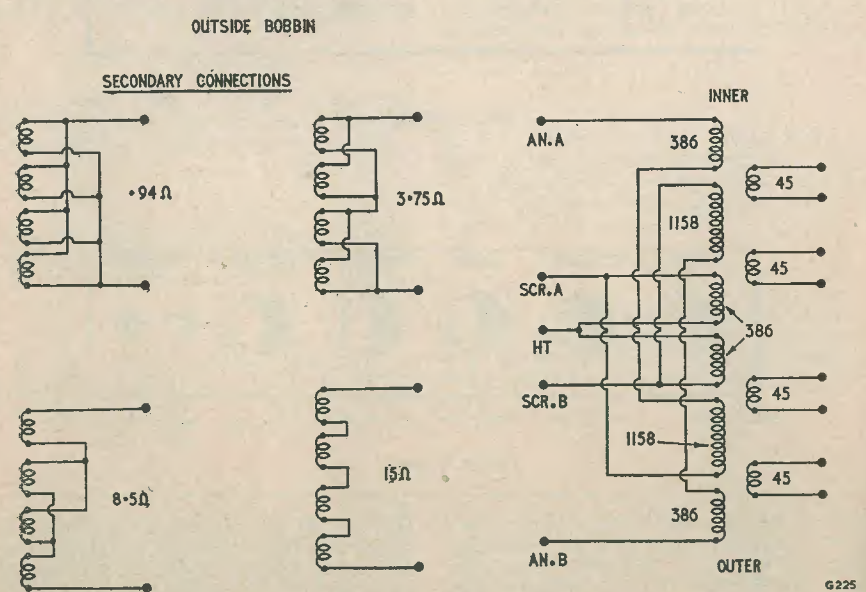
It has been shown in leakage inductance charts that for a given number of windings the best coupling is achieved when the outer sections are about half the size of the inner ones. In this particular unit the two primary halves are cross-coupled with roughly this ratio of distribution. Suitably interspersed

ULTRA-LINEAR OUTPUT TRANSFORMER DATA

Primary inductance greater than 80H at 5V, 50 c/s.
Anode-Anode load 7kΩ.
Screens tapped 20% of winding ratio from centre.
Secondary 4 windings each of 0.94 ohms (0.94Ω—3.75Ω—8.4Ω—15Ω).
1½in stack of M. & E. Alloys No. 60 Super Silcor 0.014in. Interleaved.
Core Area 1.875 sq. in.
Primary total 3,860 turns. Secondary 4 × 45 turns.
Order of winding. On bakelite bobbin with wires brought direct through sides of bobbin. *Not up sides of bobbin cheeks.*

P/	2	layers of	193	turns	34g. enamelled over full width (within $\frac{1}{16}$ of edge)
S/	1	,,	45	,,	20g. ,, ,, ,, ,,
P/	6	,,	193	,,	34g. ,, ,, ,, ,,
S/	1	,,	45	,,	20g. ,, ,, ,, ,,
P/	2	,,	193	,,	34g. ,, ,, ,, ,,
P/	2	,,	193	,,	34g. ,, ,, ,, ,,
S/	1	,,	45	,,	20g. ,, ,, ,, ,,
P/	6	,,	193	,,	34g. ,, ,, ,, ,,
S/	1	,,	45	,,	20g. ,, ,, ,, ,,
P/	2	,,	193	,,	34g. ,, ,, ,, ,,

All windings in same direction.
1 to 2 thou. paper between primary layers.
2 layers of 5 thou. empire tape between primaries and secondaries. (Or equivalent thickness of paper.)
Whole impregnated.
Windings connected as shown.



are the four secondary windings, so that there is tight coupling both between primary halves and also between primary and secondary. Winding details and connections are given in this article. The original transformer was, in fact, wound by hand, using only a hand drill clamped in a vice. The only deviation in the data, compared with the original, is that a few extra turns have been added, as the original was rather close to the inductance figure and this addition allows a more ample margin. Inductance should be checked by measuring the a.c. through the whole primary with 5V, 50c/s applied (it should be 200μA or less). The fact that the winding is wound right across the bobbin, instead of in two separate side-by-side bobbins, makes it much easier to wind. As the primaries are inter-coupled this evens out the d.c. resistance so that the resistances of the two halves are almost identical.

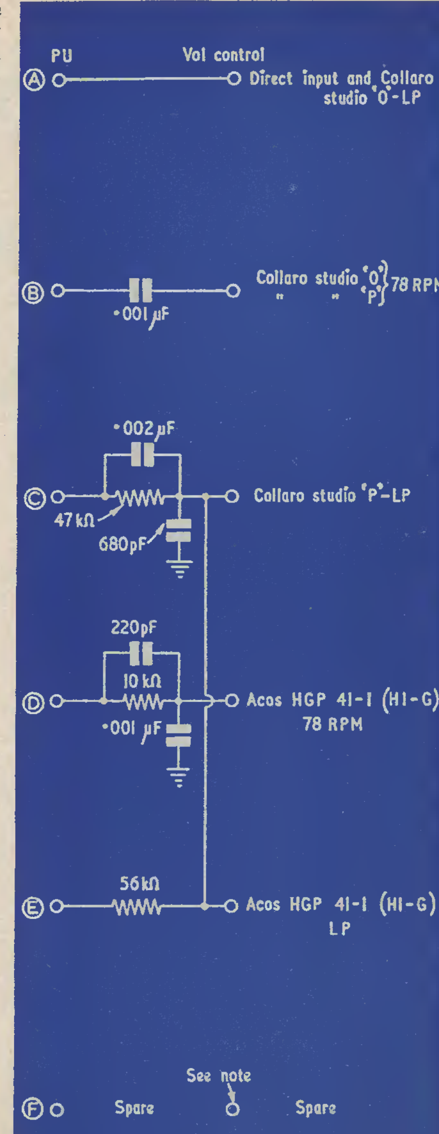
It is essential for optimum performance that all the windings of the secondary be in use, and various ways of connecting them to obtain differing output impedances are shown. The 3.75Ω and 15Ω conditions are best. For 15Ω the feedback resistor should be 1,000Ω and for 3.75Ω output the feedback resistor should be 500Ω. Ideally, the condenser in the feedback path should be increased to 1,000pF in the 3.75Ω condition, but this can be left at 500pF for both.

Commercial Output Transformers

There are available several commercial output transformers for ultra-linear use which have the correct impedances; primary to secondary ratio and primary tap ratio. However, many of these have insufficient primary inductance to meet the specification of this particular amplifier. Of the ones which might be suitable, that made by R. F. Gilson Ltd. (type W.O.710) was tested, as this is also of very reasonable price and should therefore appeal to those who would rather buy the ready-made product. This unit is not wound to the winding data given but to the manufacturer's design. Outwardly it would appear to be extremely small in comparison, but the laminations are of grain orientated material, so that over most of the range the performance is the same.

The frequency response was found to be almost identical. Power handling over most of the range, including the high frequency end, is quite adequate. At the low frequency it falls off a little before its larger counterpart due to the core size, but the low frequency power handling is ample for any speakers which would be normally used.

The transformer will allow a somewhat better margin of negative feedback, but has somewhat less discrimination against capacitive loading. However, these tests were far



SUGGESTED EQUALISER CIRCUIT

It is suggested that the volume control side of the 'spare' switch position should be connected by screened cable to pin 8 of the octal power socket, enabling this to be used as an 'external unit' position worse than would normally appear in practice, so that the W.O.710 should be quite suitable. No trouble was experienced with its use under normal conditions. The output windings are actually two windings of 3.7Ω giving either a (parallel) output of 3.7Ω or (series) output of 15Ω. These two impedances cover most of the speakers which would be used.

Construction

The amplifier was constructed on an aluminium chassis 10½in × 8in × 2¼in with welded corners. This includes all the circuit; the tone controls, on/off switch and indicator lamp all being mounted on the front under the chassis. Almost half the top area of the chassis is taken up by the mains transformer and output transformer, the valves being in single file in front of these. All other components are fitted under the chassis, The layout shown should be copied in order to reduce stray pick-up.

The pre-amplifier valve has a P.T.F.E. holder mounted on rubber grommets, but this valve is of anti-microphonic design and so it may be possible to eliminate this precaution. The valve has a steel can to reduce electrostatic and electromagnetic fields, and the base is boxed in by separate shielding. This extends across the base, with the anode side protruding, and also encloses the equaliser circuits and the volume control. A shield also extends behind the tone controls up to the 0.25μF screen by-pass condensers. These are mounted in "double decker" fashion and in turn provide an extension of the shielding, so that all the input stages are shielded from the phase splitter and output valves. The remaining 6BR7's are also fitted with cans. This virtually rules out the possibility of any feedback due to stray couplings. The actual signal wiring is carried out by mounting the components close to the valve bases to keep the wiring as short and direct as possible. The heater wiring is in twisted pair, close to the holders, but it should be kept away from the pre-amplifier grid circuits. The additional shielding already mentioned on this stage makes this point relatively easy. All the other circuits, such as h.t. feeds and connections to by-passed points, are run in cable form and laced up, as all these leads are "dead" as regards to signal.

To combat hum, no heater current flows through the chassis. Also, as there is a fairly high alternating current flowing into the reservoir condenser, the earth of the transformer h.t. winding is returned direct to the earth connection of the reservoir; then to chassis. This cuts out the charge current flowing through the chassis.

Apart from the output transformer, all the items should be easily obtainable from reputable dealers. Do not be tempted to use cheap components, as they often result in failure and cause valve or other breakdowns which are certainly not cheap. All coupling condensers are of the paper type hermetically sealed in aluminium tubes. Small values are either mica or ceramic types of adequate working voltage. The screen by-pass condensers were Dubilier "Nitrogol" block type, but these can be of a similar type to the coupling condensers. The h.t. electrolytic is a 10–10–100μF 350/400V Dubilier "Drilitic" type C.R.E. (*See note below—Ed.*)

Panel

The control panel was engraved in laminated black plastic (white letters on a black ground) and gives a professional finish to the amplifier.

Miscellaneous Data

Input into P.U. socket for 10W output, 87mV.

Input into P.U. socket for 1W output, 27.5mV.

Controls at "Flat"

With *no* load connected: amplifier is stable with 0.06μF or less across output terminals. H.F. bursts occur when capacity is 0.07μF or over.

With 47Ω load, capacity must be > 0.75μF for h.f. oscillation.

With 15Ω load, capacities up to 24μF (paper) tried. *No effect.*

Octal Socket Connections

1—earth.
2—
3—H.T. supply to pre-amplifier valve.
4, 5—6.3V heaters.
6—330V smoothed h.t.
7—Earth.
8—Signal input (co-ax. to equaliser Pos. 6).

Tone Controls

Bass ± 13 db at 50c/s (Flat at "0").

Treble +1	+ 5.5db at 10kc/s.	Flat at "0"
Treble —1 (Max. Slope)	— 12.5db at 10kc/s	Flat at "0"
Treble —2 (Max. Slope)	—26db at 10kc/s	Flat at "0"

Negative Feedback — Approx. 18db

Notes.—It has been found that 10+10+100μF C.R.E's were made for export. A 16+16μF 350V for the 10+10μF, and a 50+50μF 350V in parallel for the 100μF, are suitable alternatives.

In the circuit diagram, last issue, the heater tap X should have been connected to the cathode side of the 250Ω 3W.

BAND III TELEVISION for the HOME CONSTRUCTOR

PART 5. *by* S. WELBURN

Continuing our Band III series, S. Welburn writes this month on Band I breakthrough and Band I–Band III switching

Band III transmissions are now getting into their stride. These are early days yet for predictions of all the troubles which may beset the Band III viewer to be made, but some of the problems to be encountered can certainly be anticipated at this stage. In this article, the writer hopes to deal with some of those which will probably be most persistent.

Band I Breakthrough

Many Band I televisors are fitted with converter units which convert the Band III signal to Band I. The output of the converter then feeds into the aerial input socket of the televisor. Two typical examples of such converters have been described in the last two issues of *The Radio Constructor*. Both of these converters, using Teletron coils, are excellent units and both may be recommended to the home constructor. There are, as well, a large number of other units on the market which function in the same manner.

It may happen, in some districts, that Band I breakthrough may occur when converters of this type are employed. Such districts will almost certainly be those which are very close to the Band I transmitter. Fortunately, it should be possible, by quite simple means, to obviate this breakthrough to a negligible quantity; and it is intended to discuss suitable ways and means in this article.

Causes

Band I breakthrough will be caused by the Band I signal being picked up on the i.f. stages of the converter-plus-televisor combination. These i.f. stages will start at the input circuit of the televisor, and their frequency will be that of the Band I signal.

The most persistent effect given by Band I breakthrough will be that of patterning on the screen when receiving the Band III signal. If both signals were capable of being given equal amplification in the televisor, the Band I signal would probably have to be some 40 dB down on the Band III signal for patterning to be invisible or, at worst, negligible. As Band I breakthrough becomes worse, the patterning on the screen becomes very noticeable; and it may also be possible to hear Band I modulation on sound during quiet periods of the Band III programme. Really bad cases of breakthrough will result in picture tearing and heavy Band I sound superimposed on the Band III modulation.

The above symptoms have not included the possible whistle on sound resulting from the converted Band III and Band I sound carriers beating together. This whistle should not be so troublesome as may be anticipated. Although it is possible to hear such a whistle, weakly, in cases where Band I breakthrough causes slight patterning on the screen, it can easily be tuned out by adjusting the frequency of the oscillator, without loss of picture or sound strength. This is due to the fact that the whistle, if present, only occupies some 20 kc/s of the tuning range (i.e. twice the audio spectrum, assuming 10 kc/s to be the highest a.f. capable of reproduction), and is small compared to the i.f. passband of the televisor. Indeed, it is often a lot more difficult to tune such a whistle *in* on a Band III converter than it is to tune it *out*!

Local Pick-up

There are two main causes of Band I breakthrough in a converter-plus-televisor combination in which the "intermediate frequency" is at Band I. These are where the

Band I signal is picked up by the circuits and wiring of the Band I televisor, including the coaxial lead joining the televisor to the converter; and where the Band I signal is picked up by the aerial system and is transferred to the televisor by stray couplings. The second type of breakthrough can, normally, only occur when a Band I–Band III switching arrangement is employed.

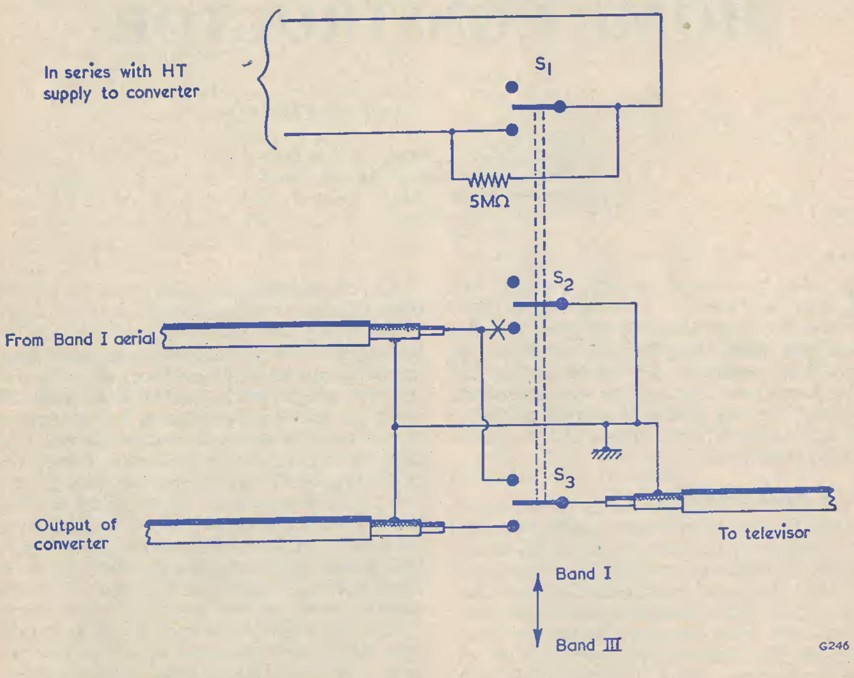


FIG. 1.

Fig. 1. A simple Band I–Band III switching circuit. The Band III aerial is permanently connected to the input of the converter. All leads must be kept as short as possible

The case where the Band I signal is picked up by the televisor and its wiring will be considered first.

This type of pick-up is liable to be most prevalent if the televisor is of the t.r.f. type having unscreened coils in its r.f. strip. Such receivers were usually made immediately after the war, and there should not be many in use at the present time. Later, superhet, models employed far more intensive screening and should not suffer to any great extent from such a fault.

If Band I breakthrough is being experienced, even when no direct connection to the Band I aerial is in existence, it is advisable to test the televisor on its own. To carry out this test, the televisor should be set up, complete with coaxial lead to the converter, and switched on. Both Band I and Band III aerials should be disconnected. After the set has warmed up, its contrast control should be turned to maximum and a check made to ensure that the Band I signal cannot be seen or heard. Normally, it will be impossible to receive the Band I signal under such conditions unless the receiver is sited within a short distance from the Band I transmitter.

If breakthrough is discovered, the coaxial lead to the converter should be disconnected at the receiver input socket. Should Band I signal become noticeably weaker it is possible that the coaxial lead is acting as an aerial, and its length should be changed (preferably shortened).

A Cure

Assuming that breakthrough is experienced, the next course consists of finding an effective cure. There are two ways of doing this. One consists of modifying the existing televisor such that, on its own, it is less sensitive to Band I pick-up. The other consists of increasing the strength of the Band III signal applied to the converter, with the result that this enhanced signal, plus the gain of the converter itself, is sufficiently great to override the Band I interference. As will at once be seen, the end-product of these two techniques is the same: that of ensuring the minimum of 40 dB difference between the two signal strengths which is required to reduce the breakthrough to a negligible quantity.

Of these two methods of attack, the second appears to the writer to be the more attractive. Unless the Band I televisor employs exceptionally bad internal screening, it seems feasible that the strength of the Band III signal, picked up on a normal Band III aerial placed at a reasonably high location and added to by the gain of the converter itself, should easily become the overriding factor. (Incidentally, many converters give a very useful amount of gain. For instance, the high-gain converter described here last month should give at least 20 dB gain on its own.)

Aerial Breakthrough

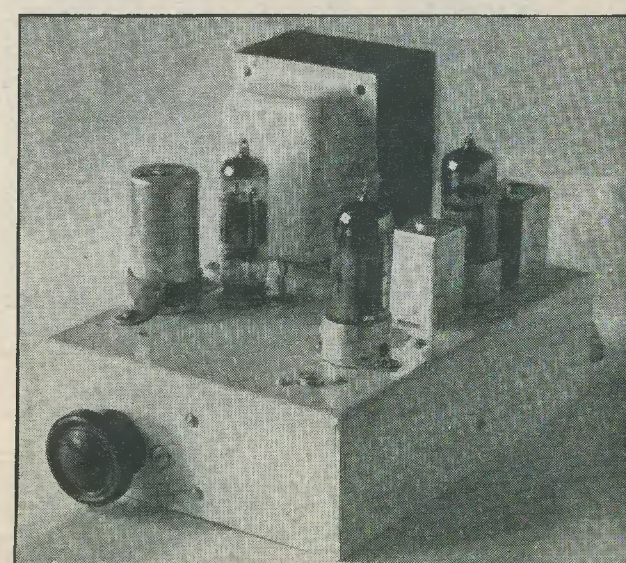
Breakthrough of the Band I signal via the Band I aerial is quite a different state of affairs. Unless some switching system is employed, the Band I aerial plug would normally be disconnected from the televisor when receiving Band III signals. In consequence Band I breakthrough via the aerial will only occur if an attempt is made at Band I–Band III switching.

Switching from Band I to Band III can cause quite a lot of unexpected difficulties. Indeed, if the constructor is building his own converter he might be well advised not to attempt wiring up any switching circuits he may have in mind until he has completed the converter and got it working properly with direct connections. If, when he later adds switching circuits, he runs into Band I breakthrough, he will at once be able to localise the trouble.

To function satisfactorily, a Band I–Band III switching system has to transfer the televisor input connection either to the Band I aerial or to the converter output. It also has to switch off the converter when set to Band I. Further, it has to prevent stray couplings from the Band I aerial when set to Band III.

A practical method of carrying out these processes is illustrated in Fig. 1. The arrangement employed is extremely simple. S_1 switches out the h.t. supply to the converter when Band I signals are required. As it is harmful to run valves for long periods without h.t., a 5MΩ resistor connected across the switch contacts ensures that a very low h.t. current is passed to the converter.

The aerial switching is slightly more complicated. This is due to the fact, men-



A version of the Teletron Mk. 1 Band III Converter, with self-contained power supply and the switching arrangement shown in Fig. 2.

tioned just now, that it is not only necessary to switch the televisor input connection to the Band I aerial or to the converter output, but that it is also necessary to ensure that the Band I signal is effectively "killed" when receiving a Band III programme. If this were not done, stray couplings could pass the Band I signal to the televisor input connections, with consequent breakthrough. In Fig. 1, the Band I aerial input is short-circuited (by S_2) when the switch is set to the Band III position.

the constructor wishes to experiment, he may try connecting a 75 ohm carbon resistor into the circuit at the point marked with a cross. The Band I aerial down-lead would then be correctly terminated; but whether this caused greater or less breakthrough would be a matter for individual experiment.

The third process carried out by the circuit of Fig. 1 is that of transferring the televisor input connection either to the Band I aerial, or to the converter output. This is done by S_3.

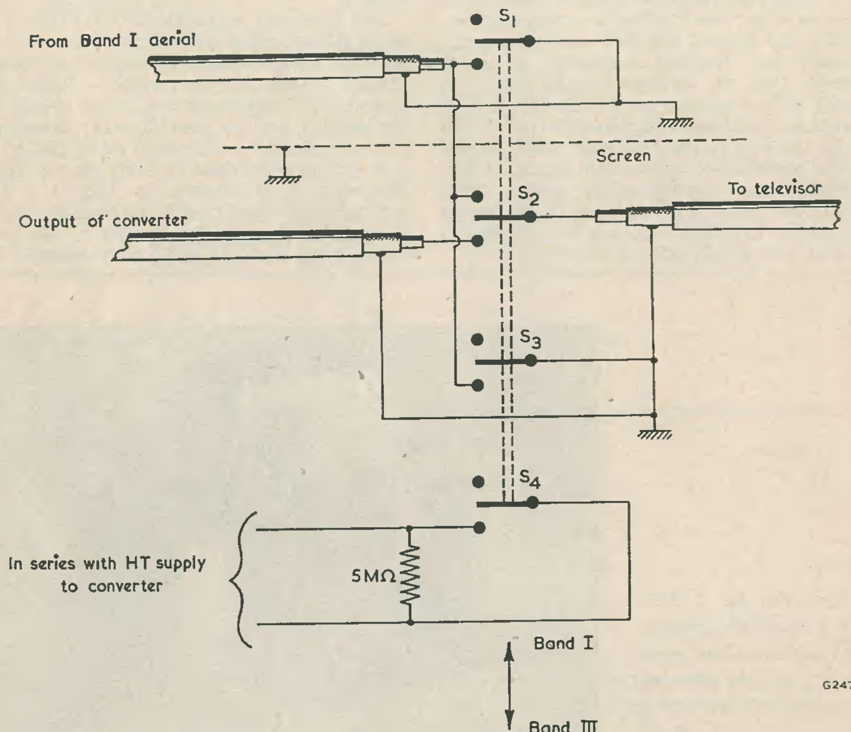


FIG.2.

Fig. 2. A more ambitious and more effective switching circuit. Once again, all leads must be kept short; including, especially, connections to chassis

It is possible that a few technical eyebrows may be raised at the idea of short-circuiting the Band I aerial during Band III reception. This would be due to the fact that such a course is certain to cause standing waves to appear along the Band I coaxial down-lead, and these could interfere with the signals in the Band III down-lead which may be running alongside it. However, in practice the short-circuit appears to give best results. If

The circuit shown in Fig. 1 is suitable for use with an ordinary wafer wavechange switch. "Miniature" switches are not recommended here, owing to the relatively high capacity existing between contacts. It is most important to ensure that all coaxial cables are connected to the switch tags by as short a lead as possible. The outer conductor of each coaxial cable should, indeed, be taken up to, at most, a quarter-inch from the switch tag

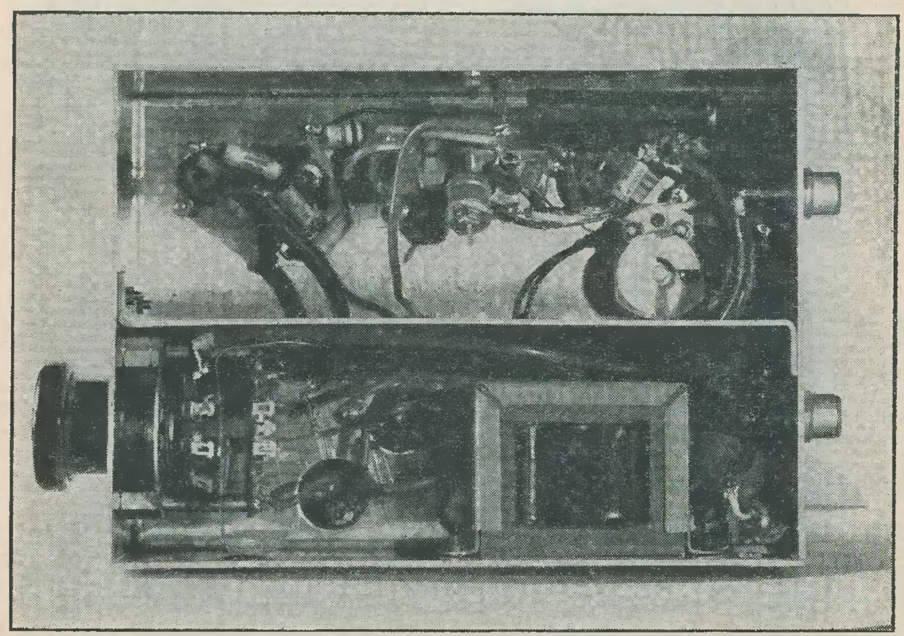
to which the inner conductor is soldered.

Fig. 1 will cope for most instances but it may still introduce a slight amount of troublesome breakthrough in one or two cases. The switching circuits can, of course, be checked for possible breakthrough by disconnecting the Band I aerial. Should be breakthrough then disappear, the switching circuit is obviously at fault.

It should be mentioned at this stage that if a *very* high signal strength is obtained via the Band I aerial, it might be advisable to fit it with an attenuator before applying it to the switching circuits. Such a course is probably

connecting lead is connected directly to chassis via S_3. Thus, not only are the Band I contacts screened from the remainder of the switch, but the lead which, by virtue of stray capacities, could carry some small amount of Band I energy is earthed as well. Band I breakthrough via the stray couplings in the switching circuit should, in consequence, be as low as it possibly can be.

The photographs accompanying this article illustrate a converter using the Teletron coil-set, which has been fitted with a power pack and a switching circuit of the type shown in Fig. 2. This particular unit has been built by



Underneath view of the converter shown on page 227. Note the thorough screening between input and output circuits, completed by bottom plate not shown.

preferable to that of constructing extra-effective switching circuits. The attenuator should still allow adequate Band I signal to be obtained by the televisor.

An Improved Method

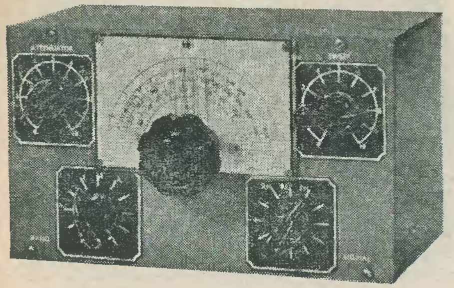
A more ambitious, but more effective, switching circuit is illustrated in Fig. 2. This utilises a two-wafer switch in which the two wafers are isolated by means of a screen.

In this circuit, the Band I aerial is coupled to the televisor input via the lead joining S_1 and S_2. When switched to Band III, the Band I aerial is short-circuited, and the inter-

the staff of *The Radio Constructor*, and has given excellent results in practice.

Warning

Before concluding, the writer would like to emphasise that the circuits of Figs. 1 and 2 assume that the converter has a chassis isolated from the mains. If the converter has a live chassis, both Band I and Band III aerials *must* be isolated by series condensers of the correct capacity and voltage rating. Such condensers must be connected in series with the inner and outer conductors of both Band I and Band III feeders.



BUILD YOUR OWN A.M.–F.M. SIGNAL GENERATOR

PART 1.

by **W. PICKERING**

Introducing a compact and serviceable item of test gear which can be constructed in the home workshop from standard materials.

ONE OF THE MOST VALUABLE ITEMS OF equipment in the radio workshop is a signal generator. However, whilst an instrument of this type is invaluable for the normal problems encountered in construction and servicing, it does not enable the finer points of receiver alignment to be carried out. For such work a "wobbulator," or frequency-modulated signal generator, is required.

The a.m.–f.m. signal generator described in this and the succeeding article has been especially designed for this class of work. It has three frequency bands; these being 0.55 to 1.7 Mc/s (Range 1), 400 to 540kc/s (Range 2), and 55 to 160kc/s (Range 3). These three ranges cover the intermediate frequencies likely to be met in almost all broadcast and communications receivers; whilst the fact that one of the ranges approximates closely to the medium-wave band ("broadcast" band in American receivers) enables alignment to be carried out even for the extremely occasional instances when the receiver i.f. does not happen to fall within the frequencies covered by the instrument.

To increase the usefulness of the signal generator, further modulation facilities have been added. A three-position switch enables the r.f. output of the oscillator to be unmodulated, modulated at a.m., or modulated at f.m.

The Circuit

The circuit of the signal generator is given in Fig. 1.

In this diagram, $V_{1(a)}$ functions as the r.f. oscillator. When the four-pole three-way switch, S_1, is set to Range 1, the anode of $V_{1(a)}$ connects to the feedback winding of L_1. The other end of the feedback winding connects to the h.t. rail via R_1, and is decoupled to chassis via C_2. The grid of $V_{1(a)}$ connects, via $S_{1(c)}$, to the grid winding of L_1. This winding is that which is tuned, the tuning condenser being C_4.

When S_1 is set to Range 2, the feedback connection made via $S_{1(b)}$ remains unaltered. However, the grid of $V_{1(a)}$ is now connected to the tuned winding of L_1 via $S_{1(c)}$ and $S_{1(d)}$. In addition, $S_{1(c)}$ switches a fixed condenser, C_3, in parallel with the tuning condenser. C_3, whose value is 350pF, reduces the resonant frequency of the grid tuned circuit, enabling the signal generator to cover Range 2 without the necessity of employing another coil.

Turning S_1 to Range 3 disconnects the anode and grid of $V_{1(a)}$ from L_1 altogether, connecting these elements, instead, to L_2. This then allows the third tuning range to be covered.

It will have been noted that L_1 and L_2 each have a third winding which is not connected in either the grid or anode circuits of the r.f. oscillator. These windings are fitted for coupling purposes, and are intended to match the output of the oscillator into the low impedance attenuator provided by VR_1. Switching of the coupling windings for each tuning range is carried out by $S_{1(a)}$.

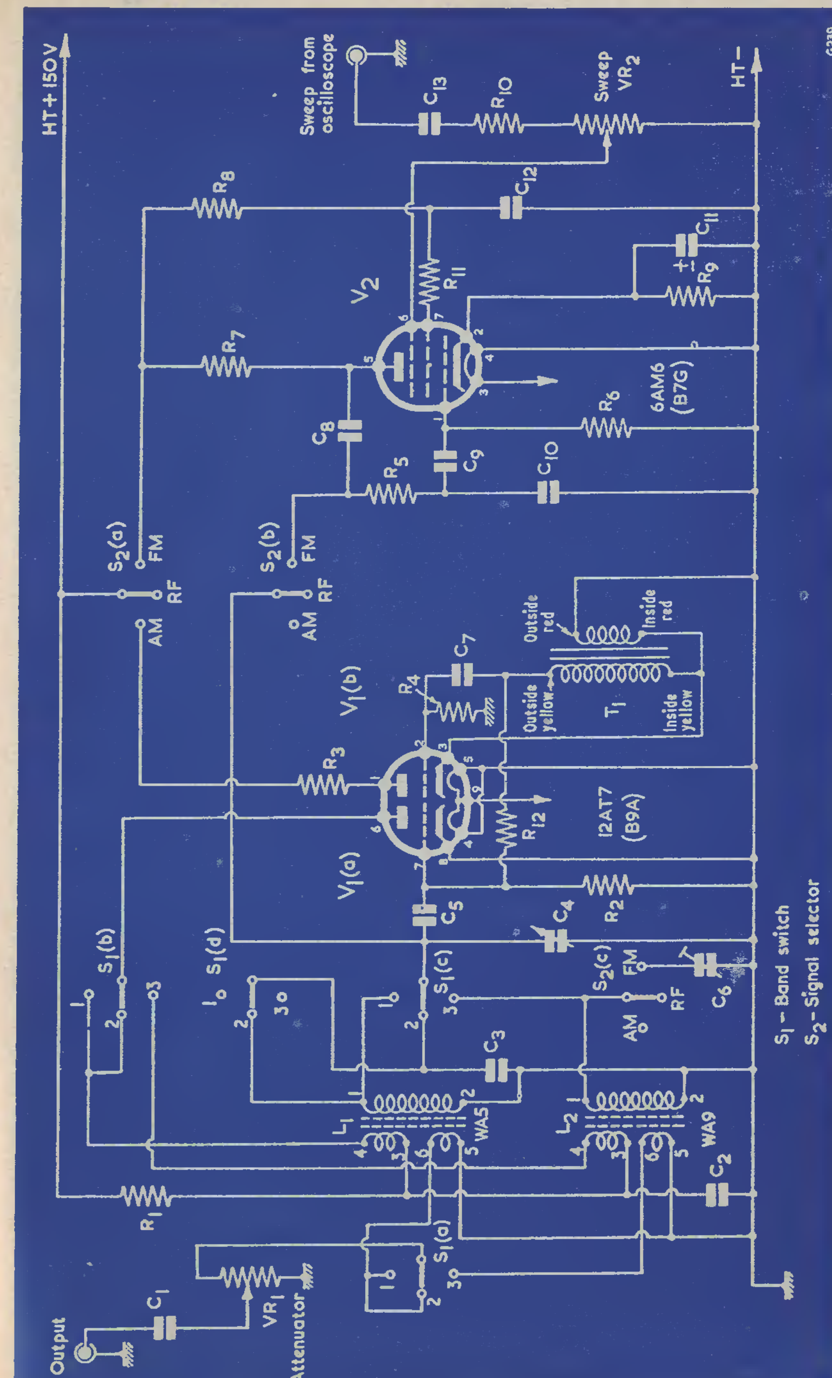


Fig. 1. The circuit of the f.m.–a.m. signal generator described in the text

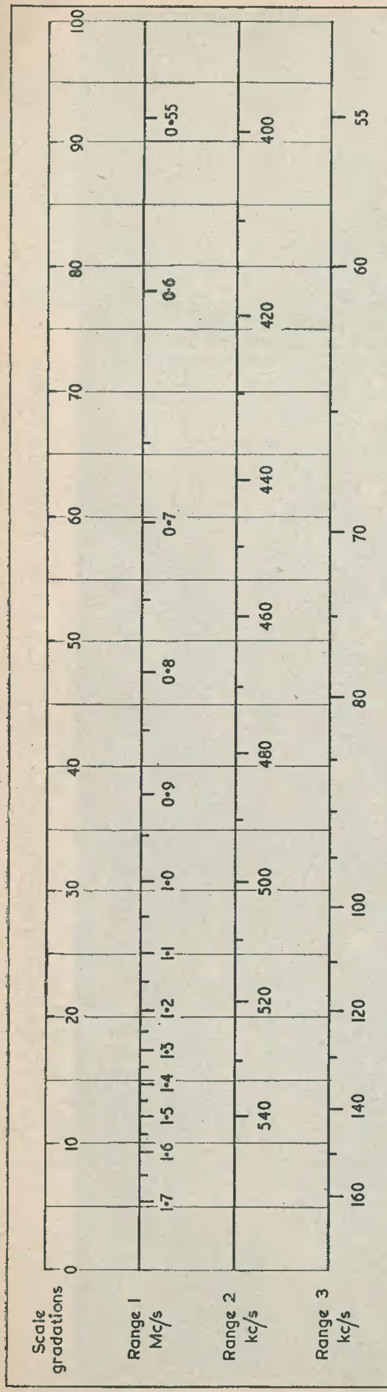


FIG.10. THE SCALE CALIBRATION OBTAINED WITH THE PROTOTYPE

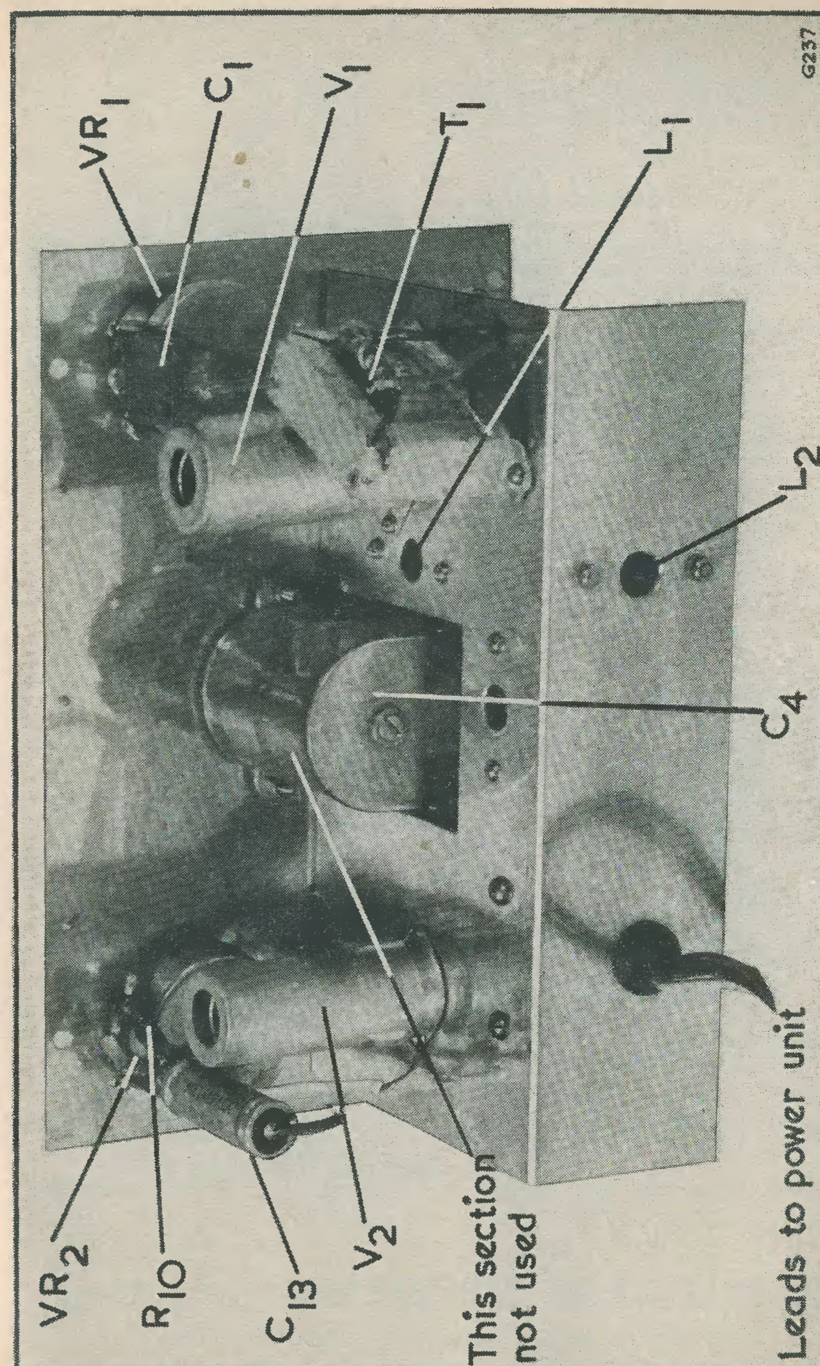
Modulation

A source of amplitude modulation is provided by $V_{1(b)}$. This valve functions as an a.f. oscillator in conjunction with transformer T_1. The latter is an "intervalve" type, whose windings are connected in series. The cathode of $V_{1(b)}$ is taken to the tap between the two windings, whereupon the whole circuit functions as an electron-coupled oscillator. The self-capacity in the transformer windings is adequate to tune the inductance such that it provides a comfortable a.f. tone, although slight alterations to frequency may be made by connecting an additional tuning condenser across the whole winding. Normally, however, such a course should not be necessary; and the oscillator will function close to 400 c/s.

A.F. modulation is achieved by injecting the a.f. voltage appearing across T_1 into the grid circuit of $V_{1(a)}$. In practice, the a.f. voltage is applied to the fixed potentiometer given by R_{12} and R_2 in series, R_2 serving also as the grid leak of the r.f. oscillator. This method of connection has the advantage of causing very little change in the characteristics of the r.f. oscillator circuit as amplitude modulation is switched in and out.

The reactance valve V_2, provides frequency modulation of the oscillator. This it does by reason of the resistance-capacity network connected between its anode and grid. The r.f. voltage appearing across the grid winding of the tuned circuit is applied to both the anode and grid of V_2. However, due to the presence of the anode-grid network the anode current given by change in grid voltage is very nearly 90 degrees out of phase with the applied anode voltage. In consequence, the anode-to-cathode impedance of the valve is almost entirely reactive and is capable of changing the resonant frequency of the tuned circuit across which it is connected. With the circuit shown in Fig. 1, the phase shift between anode and grid is such that V_1 provides an inductive reactance, the effect of which is to raise the oscillator frequency.

The degree by which V_2 changes the oscillator frequency may be varied by controlling its mutual inductance. This control is achieved here by varying the voltage on its suppressor grid. In practice it will be necessary to have the frequency varied rapidly by means of a timebase, with the result that the oscillator sweeps continually across a band of frequencies. The response of the receiver to which the wobbulator is connected may then be displayed on the screen of an oscilloscope. The timebase required for the control of frequency variation is normally that employed for horizontal scanning in the oscilloscope itself; i.e. the timebase driving the X plates. Almost all modern oscilloscopes provide a timebase out-



Above chassis layout of Signal Generator. C_1 and C_{13} are taken to Belling-Lee coax sockets—see text.

let for connection to an f.m. signal generator. The connection between the f.m. signal generator and the oscilloscope should be made via a short length of coaxial cable. The low capacity of this cable then obviates distortion of the wave shape provided by the timebase, as well as providing screening and an automatic earth connection between the two items of equipment.

A quantitive control of frequency variation is provided by VR_2. This component taps into the timebase output voltage provided by the oscilloscope and thus controls the total deviation given by the reactance valve.

Modulation Switching

Modulation switching is provided by the three-position switch, S_2. Only three poles of this switch are employed, the fourth being unused. The choice of a four-pole switch here is due to the fact that conventional "miniature" switches on the home-constructor market are twelve-contact assemblies; and it will be found easier to purchase a four-pole three-way switch than a three-pole three-way component of similar size and construction.

When S_2 is set to the "A.M." position, $S_{2(a)}$ applies h.t. to the anode of $V_{1(b)}$, via R_3. As a result, $V_{1(b)}$ oscillates and the r.f. output from $V_{1(a)}$ is amplitude modulated.

In the "R.F." position, all three poles of S_2 connect to blank contacts. In consequence $V_{1(a)}$ alone functions, and the output of the signal generator consists of unmodulated r.f.

The third position of S_2 is that providing "F.M." In this position, $S_{1(a)}$ connects the h.t. rail to the anode and screen-grid of V_2; thereby bringing this valve into operation. Also, $S_{2(b)}$ connects the tuned winding of the r.f. oscillator to the junction of C_8 and R_5, thus allowing the r.f. tuned circuit to be frequency modulated. Finally, $S_{2(c)}$ connects a small-capacity trimmer, C_6, across the tuned circuit. The purpose of this trimmer is to off-set the effect of the reactance valve in altering the centre frequency of the r.f. oscillator. As was mentioned above, the reactance valve raises this frequency. C_6 tends to reduce it again, thereby enabling the dial calibration to be maintained.

Next Month

Constructional details of the f.m.–a.m. signal generator will be given in next month's issue.

COMPONENTS LIST

Resistors

R_1	10kΩ ½ watt
R_2	50kΩ ¼ watt
R_3	10kΩ ¼ watt
R_4	47kΩ ¼ watt
R_5	220kΩ ¼ watt
R_6	1MΩ ¼ watt
R_7	100kΩ ½ watt
R_8	270kΩ ½ watt
R_9	270Ω ¼ watt
R_{10}	3.3MΩ ¼ watt
R_{11}	10kΩ ¼ watt
R_{12}	150kΩ ¼ watt
VR_1	100Ω Potentiometer
VR_2	1MΩ Potentiometer

Condensers

C_1	0.002 μF moulded mica
C_2	0.1μF 350 W.V.
C_3	350pF silver mica
C_4	400pF (half Polar miniature twin-gang)
C_5	300pF silver mica
C_6	60pF trimmer
C_7	0.005μF moulded mica
C_8	200pF silver mica
C_9	100pF ceramic
C_{10}	100pF ceramic
C_{11}	0.1μF 350 W.V.
C_{12}	0.1μF 350 W.V.
C_{13}	0.1μF 350 W.V.

Valves

V_1	12AT7 (Brimar)
V_2	6AM6 (Brimar)

Inductors

L_1	Teletron, type WA5
L_2	Teletron, type WA9
T_1	Radiospares, 5 : 1 intervalve transformer

Tag-strips

4 five-way (R. Davies, Swansea)

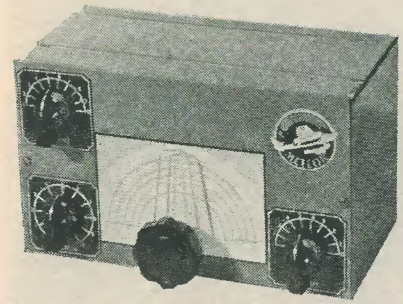
Sundries

2	Belling-Lee coaxial plugs and sockets
2	4-pole, 3-way, rotary switches ("miniature")
1	B7G holder, with screening can
1	B9A holder, with screening can

Chassis and cabinet, RCS Products (Radio) Ltd.

Panel-Signs Transfers, set No. 2.

The "METEOR" MINI-RECEIVER *for the Beginner*



PART 3.

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 of the second stage and panel fittings, etc., are given

In the last issue of the magazine, we described the wiring up of the detector stage; and readers who have progressed thus far will, by now, be ready to commence with the second, or audio, output stage. The addition of this will, of course, greatly increase the audio output of the receiver, so that many stations which up to now have been barely audible will be heard with much greater strength and clarity. In effect, then, we are really increasing the range of the receiver as a whole.

Wiring the Receiver—the second stage V_2

Before commencing the actual wiring of this stage, we must first disconnect C_5 from the phone output jack, assuming of course that the receiver has been completed as a one-valver and is working satisfactorily. The connection from the jack to earth (chassis) is left as connected.

The now disconnected end of C_5 is now taken to pin 6 of V_2, also to this same pin R_6 is soldered; the other end of this resistor being taken to the earthed tag alongside the valveholder. The cathode resistor R_8 is connected between pin 7 and the previously mentioned earthing tag. Next, to pin 7 solder one end of the cathode bias condenser C_8; this should be the end of the condenser marked plus (+), or, should the specified component not be used, it may be simply coloured red. The other end of this condenser is now soldered to the earthed connection of C_b (see photograph). The next step is to run the h.t.+ line into this second stage, this being done by soldering a length of PVC wire from the h.t.+ input connection to pin 5 of V_2 (see Fig. 9). Having done this, connect one end of R_7 to pin 5 and the other end of this resistor to pin 2 of the valveholder. Also to pin 2 solder one end of C_7, and take the other end of this to the phone jack connection from which C_5 was removed (see Fig. 8). Both connecting wires of C_7 should be covered with suitable lengths of systoflex for insulation purposes. This completes the wiring details of the second stage and therefore the whole receiver. However, the set as a whole is not yet complete, and we describe in the following paragraphs those final touches which make all the difference to both the visual appearance and the operating efficiency of the receiver. We also include a voltage table for those beginners who may be fortunate enough to be in possession of a test meter. The voltage readings given are those obtained from the actual prototype, with a 1000Ω/V meter (1mA F.S.D.).

Front Panel Accessories

To the front panel we must now affix the Panel-Sign transfers as the next step to the completion of the receiver. For this we shall require both sets, No. 1 and 2. The small dial is included in the latter set, whilst the remainder of those required are supplied with the former set. Although only a few of the total number of transfers are used here, the remainder will be found extremely useful in other constructional items which are described in this magazine from time to time. Once purchased, they will last the average constructor a very long time.

TABLE 1

Anode V_1, 80V	Anode V_2, 85V
Screen V_1, Nil (R_4 at min. setting)	Screen V_2, 90V
	Cathode V_2, 1.95V
C H.T. Input, 90V at 16mA (R_4 at min. setting)	

All above readings taken under no signal conditions, R_4 at zero, phones not inserted. Current with R_4 at max. setting, 20mA, conditions as above.

The first transfer to affix to the panel is the full vision dial which is used for Bandspread purposes. Full instructions for fixing these are given with every set supplied. With the prototype, no varnish was used as very little heat is generated internally, and therefore the ordinary gum contained on the rear of each transfer is sufficient for the purpose. Having

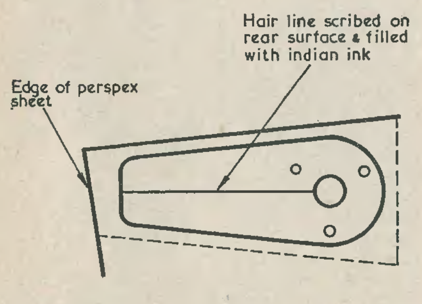


Fig.11
Details of cursor

E224

affixed this dial, allow to dry for at least two or three hours before removing the thin tissue paper. With this operation completed, proceed to fix both the lower panels followed by the upper transfer. In all this, of course, one should ensure that these panels are mounted as square as possible in order to obtain a tidy and neat appearance. With all tissue paper removed, and the transfers thoroughly dry, cut out the required wording (see illustrations) and fix these over the control panels. Next, fit and screw into position the control knobs in the correct positions. These are as follows: Aerial Trimmer-pointer set at position 1 with the condenser vanes fully meshed. Reaction-pointer at 0 with potentiometer in fully anti-clockwise position. Bandset-pointer at 10 with condenser vanes fully meshed. The correct position of the Bandspread dial, when completed (see following paragraph), should be with the pointer at 50 and the condenser vanes at half mesh. If preferred, of course, the large dial could be used as the Bandset control and the smaller panel as the Bandspread. This is merely a matter of preference and only involves the changing over of the two variable condensers so that the large Bandset condenser occupies the central position of the chassis. Should this be done by the beginner, there is no reason why the dial should not be calibrated against known stations by marking the dial with ordinary indian ink.

The "Meteor" transfer should now be fixed. This is obtainable from most bicycle stores, where they are sold for applying to cycles.

The 'Perspex' cursor must next be made and fitted. This is shown in Fig. 11 and from this, individual measurements can be taken. The 'Perspex' sheet can be easily marked by scoring the outline of the cursor with the edge of a scriber or some other sharp pointed instrument. It is a good plan to use one edge of the supplied sheet as one side of the actual cursor (see drawing). This should now be cut around with a small saw, allowing about a tenth of an inch margin from the actual outline. This margin should then be filed away after the cursor has been cut from the sheet. The next step is to mark and drill the spindle aperture. For this, a centre punch and a quarter inch drill are required. The fitting of the cursor to the knob is largely a matter of screwing the 'Perspex' to the knob. In the prototype this was done by three holes through the "Perspex" and into the rear face of the knob. Into these holes were fixed Parker-Kalon self-tapping screws, although ordinary wood screws, preferably of the flat-headed type, would suffice. Before drilling these fixing holes, however, it is as well to fit into the spindle aperture and the knob, a short length of old spindle, or that removed from R_4, as this will probably be too long as supplied. This is important if the cursor is to run "true" over the full vision dial.

We have now completed the constructional details of this receiver and it remains for the beginner to explore the various bands at his leisure. Before doing so, however, it may be as well to give some guidance on the various sources of information that are available—and necessary if the utmost enjoyment is to be derived from the hobby.

Aids to the S.W.L. (Short Wave Listener)

First and foremost, the listener should have at hand all those details concerning both Broadcast and Amateur bands, without which he will be all at sea and constantly perplexed. For the Broadcast bands, one could not do better than obtain a copy of "World Radio Handbook," which contains a first-class station list and full details of every station in the world. For the Amateur bands one would require a copy of "Radio Amateur Operator's Handbook"—this containing all the necessary information about these frequencies, operating practices and much other useful information, including a complete chapter on Amateur operating technique.

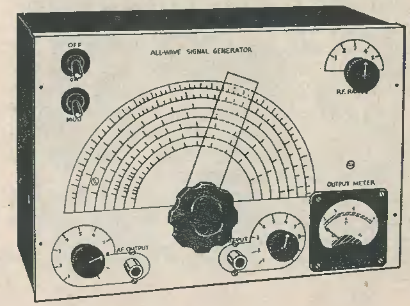
In addition to the above, one could not do better than join a predominantly S.W.L. society such as the I.S.W.L. (see Small Advertisements). This society publishes a monthly bulletin giving details of the current happenings on both Amateur and Broadcast frequencies. In addition to this, they operate a very efficient QSL Bureau, issue certificates for various achievements in the listening sphere and will also supply League notepaper, and even QSL cards for a comparatively small sum.

Conclusion

In this short series, we have tried to cater strictly for the beginner and in this respect we crave the indulgence of our more advanced readers; reference to our opening gambit in Part 1 of this series, giving our reasons for so doing. We do not claim to have succeeded completely in our aim, but at least we feel we have gone a long way in that most laudable of enterprises—helping the beginner over the first, and always the most difficult, stile.

TRADE REVIEW

R AND TV COMPONENTS (ACTON) LTD., 23, High Street, Acton, London, W.3



Signal Generator

The vast majority of home constructors have, at some time or another, felt the need for a signal generator—particularly those interested in constructing receivers and the servicing of them. Hitherto the average hobbyist with the traditional small pocket has had no other recourse than to build his own, with all the attendant difficulty of calibrating the instrument once construction was completed.

It is now, however, possible to obtain at a very reasonable cost (£4 19s. 6d, postage and packing 4s.) a completely built signal generator from the above company. As received by the purchaser, this instrument is factory aligned, accurately calibrated, and complete with valves and circuit diagram.

For review purposes we were invited to choose at random a model from the stock of the company at their premises. This we did, and subsequent tests by us have fully borne out the manufacturers' claim that the instrument has an accuracy of $\pm 2\%$ over the entire range of the instrument.

As may be seen by the illustration above, the unit is attractively styled, with a white panel and louvred black crackle metal cabinet, the whole unit being therefore completely screened. The frequency scale is clearly marked in black against the white background, the cursor being of clear perspex with a hair line making accurate readings easy to achieve. The generous scale also considerably assists in this respect, being $6\frac{1}{4} \times 3\frac{1}{4}$in.

The coverage is divided into 7 ranges, the 5 fundamental ranges covering: —120–320 kc/s; 300–900 kc/s; 900 kc/s–2.75 Mc/s; 2.75–8.5 Mc/s and 8.5–25 Mc/s. The other two ranges, although not shown on the panel range switch, are in fact harmonic derivatives of range 1. Thus range 1 × 2 covers the frequencies 17–50 Mc/s and 1 × 3 covers 25.5–75 Mc/s.

Two separate outputs are provided, r.f. and a.f., the r.f. output being continuously variable to 100 millivolts. The a.f. output is also variable, internal modulation of 400 c.p.s. to a depth of 30% being available from the audio oscillator. The r.f. may be modulated or left unmodulated by operating the appropriate switch on the front panel.

A very useful addition to such an item of test equipment is the output meter, designed to connect across the speech coil of the receiver, for which purpose two leads are brought out at the rear of the cabinet.

The instrument contains two valves and a metal rectifier, and is for use on a.c. mains 230–250 volts, the on/off switch being mounted on the panel. It is isolated from the mains by a double wound transformer. The two triodes are used as r.f. and a.f. oscillators respectively. The coil pack assembly includes iron dust cores and trimmers. The whole unit is compactly and rigidly built to withstand rugged workshop use, and the size —$10 \times 6\frac{3}{4} \times 4\frac{1}{2}$in—is ideal for the average workbench. The instrument is also available on terms of 34s. deposit and 3 monthly payments of 25s.

At the very low price involved, one would find it difficult to purchase components, construct and spend the time "rolling one's own"—let alone calibrate the unit—and still beat the cost of this signal generator. Altogether a very fine item of test equipment which we thoroughly recommend to our readers. Tested and approved by us, it is a worthwhile addition to any workshop.

RADIO—AND CONTROL

PART 1. *by* RAYMOND F. STOCK

REMOTE CONTROL BY RADIO IS NOT A major branch of electronics—shall we forget guided missiles?—but considerable development has been put in during the last ten years by enthusiastic amateurs. Some good (and many bad) ideas have been examined, and a process of natural selection has yielded an established technique to deal with almost any problem; this sweeping statement must be qualified by admitting that for certain control purposes the equipment may be rather more complex than is generally associated with the subject.

No one will regret the replacing of the crystal set by the modern superhet; similarly the problems set by advanced control methods serve to increase the inherent fascination of the subject, and will undoubtedly lead to a wider interest among those who like to experiment along unorthodox lines.

The purpose of these articles is to analyse some of the difficulties encountered and to describe methods of dealing with them.

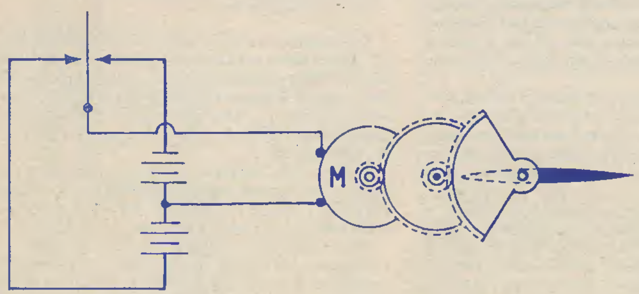


Fig. 1. M is a permanent magnet motor

S1

The principle of simple control equipment is now widely known, and informative articles have appeared from time to time in this magazine. Readers will appreciate that a typical system uses a single-valve receiver with a rather odd super-regenerative action, capable of operating a sensitive relay on receipt of a signal from the transmitter.

The relay has single-pole change-over contacts and *all* information must be sent via this simple switching action. Not a very promising circuit on the fact of it; since, however, such simple equipment has been obligatory in many cases for reasons of size, weight, cost or resources, a great deal of energy has been expended in devising ways to overcome the limitations of the radio.

With one or two exceptions, to be noted later, such methods involve arranging a preset sequence of events which must occur in a given order. Repeated command pulses cause these to be selected successively, and this is done either by some form of rotary selector switch or, more directly, by an escapement.

This kind of gear is best adapted to models having a large range of different function, where it is capable of giving at least an illusion of considerable control capacity. When applied to operating steering gear, which is (or should be) a precise function, its defects are very serious, and will become evident if we try to specify just what a good control should do.

Type of Control

We may assume that radio control will be applied to moving models only (for obvious reasons), i.e., aircraft, ships, or land vehicles.

The prime requirement is then to control the steering, while an ability to vary the speed of the model is hardly less important. These two requirements, being intimately concerned with manoeuvring, we can call Primary Controls; the inessential, if amusing, items such as working hooters, switching-on lights, firing guns, etc., can be referred to as Secondary Controls. In general they are amenable to very simple switching operations and do not require the same treatment as the Primary Controls.

Models moving in three dimensions such as submarines or aircraft may require other Primary Controls, possibly over hydroplanes, ailerons and elevators; it is not (fortunately!) necessary to consider these as separate cases, however, and a *Control Channel* can be designed without reference to its ultimate purpose. Thus, picking two random cases, the rudder of a cabin cruiser must be moved over an arc between say Port 20° and Starboard 20° via Amidships, while the speed control of a model car needs to be moved from full speed in reverse to full speed in forward, via Stop. The former is a symmetrical movement and the latter almost certainly not (or do you want to go as fast in reverse?) but this makes no difference; analysis of any primary control shows that the following precise, if long-winded, specification should apply:

It should be possible to rotate a shaft (or its equivalent) in the model to any angular position between two limits, by the simultaneous rotation of a similar shaft at the transmitter—or, as one generally says, "Proportional Control."

This is an unattainable ideal to aim at and even the exponents of telearchics (radio control, professionally) can approach it no more clearly than they can perpetual motion.

Our next step must be to see how near we can get within the limits of practical radio gear.

Practical Gear

First let us consider a system which is definitely not proportional control. Suppose we have a three-way lever key with which we can set a motor rotating in either direction—one way when the key is Left, the other way when the key is held Right, and stationary when the key is allowed to centre itself; the arrangement is shown in Fig. 1, and it will be seen that the motor drives a rudder via reduction gearing. With some manual dexterity and fair practice it should be possible to move the rudder to any angular position, provided we can see it. If the rudder is in a model, however, we are unable to do this, and the technically minded will observe that the feedback system (i.e., *vision* communicating rudder position, *brain* detecting error in position, and *hand* applying negative feedback) has broken down. This interesting electrical analogy shows that if the rudder could be made to feed back information as to its angle all would again be well; although it is not practical to do this via a radio link, the idea does give a clue which we can follow up later.

Progressive Control

For the moment we can consider Fig. 1 as the basis for a system generally known as Progressive Control. The rudder can obviously be started moving in either direction at will, but once the operator has started the model he will only be able to assess the rudder angle by observing the behaviour of the model. Since the ship must diverge appreciably from its course before any correcting action can be taken, the track will tend to be a series of curves due to overcompensation; with practice, however, surprisingly good results can be obtained provided the model is not too fast and the operator's reactions are quick enough. The whole model is now, in fact, providing a crude form of feedback information by its attitude.

It will be realised that the degree of helm applied depends upon a time factor, the angular movement of the rudder depending upon the time for which the lever key is held over. Various attempts have been made to

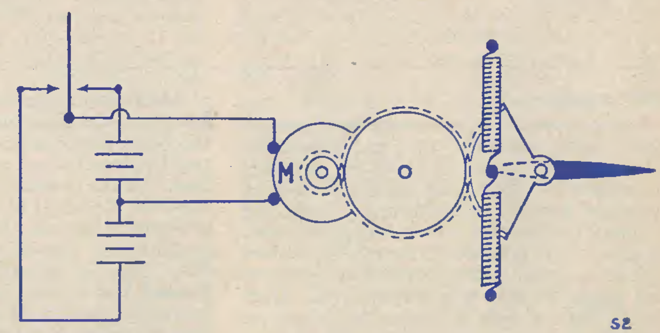


Fig. 2. Similar to Fig. 1, but with a lower gear ratio

S2

use this fact by an automatic keying device at the transmitter which holds the key over for an interval proportionate to the angle through which a steering wheel is turned. The idea is then that the motor runs for a proportionate time also, and turns the rudder through an appropriate angle. The snag is in keeping the motor in the model, and the timing device at the transmitter, in step.

Small motors are impossible to govern to an acceptable accuracy, and this method of attempting proportional control is, however attractive, doomed to failure; however the two driving devices are synchronised, the errors are likely to be cumulative.

The straightforward progressive system is therefore best accepted, with its failings, though there is a variation worth considering in certain cases. In Fig. 1 we assume that the gear ratio is high, or irreversible, so that the rudder stays quietly where it is put.

(relative to the gaps between them), a certain smoothing action occurring from the inertia of the moving parts. It must be noted that this effect is hardly to be recommended for cars, since, within the limits of tyre adhesion, a wheeled vehicle exactly follows the movements of its steering control and would pursue a decidedly odd course if the key were "blipped."

Mark-space

The discerning reader will have noted that progressive systems require the transmission of two types of information, and is probably wondering why the rudder cannot be spring-loaded to one side; only one sort of signal would then be required, and by suitably arranged "blips" the rudder could be moved (or oscillated) over the full range. One up to the discerning reader! This can be (and is being) done; it masquerades under the name

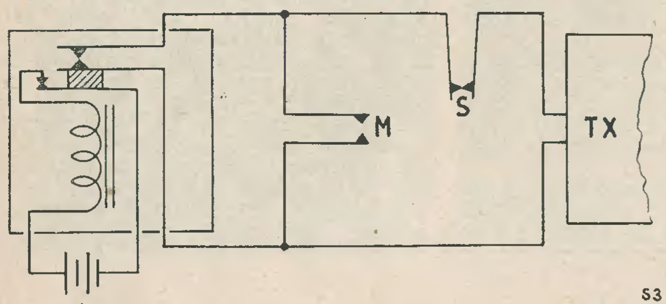


Fig. 3. Transmitter Control Circuit using a Vibrator

Self Centring

Fig. 2 shows a similar circuit but having a lower ratio—certainly not an irreversible drive—between motor and rudder. A spring is connected to the rudder head and tends to keep the control at amidships. Now, the action of the lever key will be rather different: whenever it is released to centre, the rudder will also centre, under spring tension, so to that extent the system is proportional. True, the rudder can now no longer be driven to, and left at, a given angle (except Hard Over against a stop) but the effect of partial rudder angles can be obtained in another way. The connection between rudder angle and the course of a craft moving in air or water is not an inflexible one; therefore, by "blipping" the key in the appropriate direction the rudder oscillates to one side of centre, its effective position being the mean of its total excursions either way.

Thus the effect of various rudder angles can be simulated by the length of the "blips" of Mark-Space, which refers to the "blip" as Mark and the gap between as Space. Varying the Mark-Space ratio obviously produces the required results and economises on information. Before considering all its ramifications, however, it should be noted that the progressive system has one invaluable asset in certain applications, namely its fail-safe characteristics. This is important in model aircraft. Should the motor break down (and small motors are usually the weakest link) the rudder will centralize; in a Mark-Space system it will return to one or other hard-over position, resulting in a spiral dive. Aeromodellers will know that this is not to be recommended!

A Practical Progressive System

Readers may care to try the progressive system outlined in Figs. 1 and 2. As noted, two types of signal are needed, to energise the motor in two directions; absence of a signal will, of course, be used to stop it. These two signals can be taken from the outputs of any multi-channel system (reed or filter), but there is also a popular method of obtaining the same results from a single-channel radio. Fig. 3 shows the idea.

Tx is any single-channel transmitter and its keying leads are connected to an interruptor circuit. As shown a vibrator is used, and this can be a self-rectifying car-radio component; most amateurs could also convert a simple buzzer. The frequency is not critical and the signal need not be exactly 50% Mark-Space, but both of these factors are best adjusted when the system is completed.

It is essential that this relay be a high-speed component capable of following the vibrator pulse rate. Alternate connection to A and B will energise units U1 and U2 (which might be relays, etc.) but owing to the high pulsing rate neither of these items will actually operate. If a Mark is transmitted, however, U1 will close, while a Space will similarly close U2. Whatever the nature of U1 and U2, they will be electromagnetically operated equipment and must be chosen or adapted to have a closing speed just too slow to cause them to work on the basic pulse rate. They might in

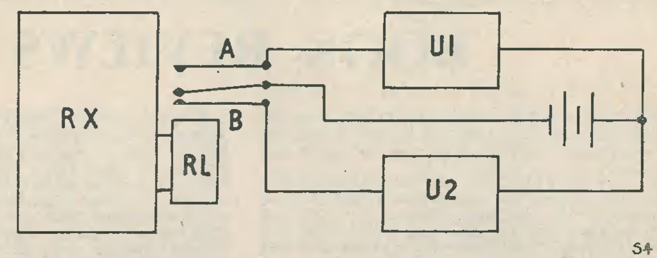


Fig. 4. Note that the current RL reduces on Mark

The interruptor, or vibrator, has its own local power supply and runs continuously while the model is in use. It will be seen that there are two contact pairs included in the circuit; M, in parallel with the vibrator, will send a continuous signal or Mark when closed, while S, series-connected, will break the circuit and cause a Space. Both M and S can conveniently be incorporated in a single lever key, self-centring, and moved to the left for a port command and to the right for a starboard command. This is all the essential gear required at the transmitter.

some cases be selectors or escapements giving control over two separate functions, such as steering and speed control. We are in general considering steering only, however, and for this purpose both channels can be used, one for each direction of our steering motor.

In this case the best circuit for most purposes can be based on Fig. 5. Here the receiver relay contacts (RL) are connected to opposite poles of a battery. The centre tap is returned to the relay RL moving contact via the relay RM, which is too slow to operate at the pulse rate. When a Mark *or* a Space is sent RM

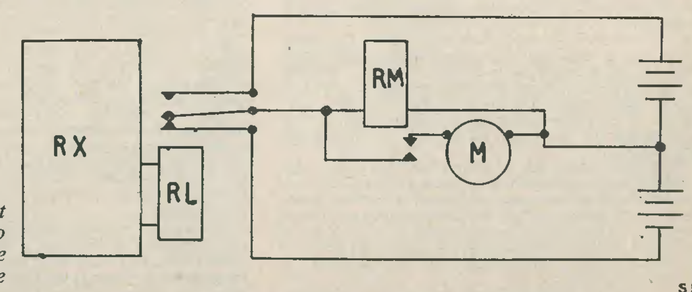


Fig. 5. Note that RM is too slow to operate at the pulse rate

Fig. 4 gives an intergear diagram to follow the receiver. RL is the receiver relay whose contact makes with either A or B when Mark and Space respectively are selected.

will close, since it is insensitive to polarity. In closing, the steering motor M is energised and rotates in the selected direction depending on which contact RL has closed.

It will be seen that this gear (which is in common use) gives virtually two-channel facilities with a minimum of equipment, and is ideal for control over a progressive system.

We have already noted that the only ideal control is proportional, this being particularly true for steering systems. It is, however, sometimes possible to relax the standards for other primary controls, such as speed control in a model car or sheet control in a yacht. In the latter case, especially, a progressive system is quite applicable and the circuit shown in Fig. 5 would do very well for hauling in and paying out the sheets, M being geared to the sheet winch instead of the rudder. Whether used for this purpose or for steering, the motor should be protected by inserting limit switches in the two battery leads, one operated at each end of the full travel.

If a progressive system is to be employed for two primary controls in one model, it is evidently necessary to provide either four separate channels, or two channels each capable of carrying the information required by the circuit of Fig. 5; thus the complexity of the radio equipment begins to multiply!

For the moment we will assume that more than one channel can be provided, and in the next issue we will try to determine which sort of intergear can give proportional results.

BOOK REVIEWS

OSRAM 912-PLUS. 54 pages. Published by the General Electric Co., Ltd., Valve and Electronics Department, Magnet House, Kingsway, London, W.C.2. Price 4s. 0d.

The Osram 912 amplifier is so well established that it needs no introduction here as a high-fidelity sound reproducer. The previous edition of this book did much to popularise the home construction of hi-fi apparatus by its presentation of stage-by-stage wiring diagrams.

The same basic amplifier forms the chief subject of this new edition, which has been enlarged and now includes details of equally good auxiliary apparatus. One of these is a passive compensating unit that can be added to the amplifier for use with a Collaro Studio "P" pick-up. Another is a pre-amplifier as an alternative to the passive unit. Either unit is fitted to the top of the chassis, and has a six-position switch for radio, pick-up and microphone inputs. Four of the switch positions provide compensation for different record characteristics.

Working drawings are given for constructing the main amplifier chassis and front panel, the sub-chassis for the input units, and an octagonal loaded-port cabinet suitable for housing a G.E.C. 8in metal cone speaker. Two circuits are given for radio feeder units, one for an a.m. tuner, the other for an f.m. tuner. Components for all the units are listed in detail and show the sources of supply.

HOME CONSTRUCTOR'S HANDBOOK. 70 pages. Published by Roding Laboratories, Bournemouth Airport, Christchurch, Hants. Price 2s. 6d. (post. 3d.).

It is not everybody who can produce what looks and works like a professionally-made piece of equipment from the bare bones of a circuit diagram. Human prodigies of this sort are far outnumbered by those of us who can, nevertheless, turn out pleasing work with the aid of all the necessary data. This wider field of radio endeavour is catered for in this very reasonable little booklet.

Within its pages are 22 sound and proved designs which include radio receivers from a simple crystal set to an 8-valve communications receiver, several radio feeder units and amplifiers, test instruments and a tape recorder. A full list of components for each item of apparatus is given, and a catalogue shows the prices of all items, which, incidentally, can be supplied by Roding Laboratories.

The "Easy-as-A.B.C." Construction Sheets that are, or soon will be, available for most of the designs, make construction clear and easy for the tyro. The publishers' claim that to build is to learn is true, and they include in this book some pages of useful information which the average constructor wants at his finger-tips.

This is a well-produced handbook which can be regarded as good value for the modest price asked for it.

RADIO AND TELEVISION SERVICING. 36 pages. Obtainable from Her Majesty's Stationery Office, York House, Kingsway, London, W.C.2. Price 1s. 6d. (post. 1½d.).

Young men of school-leaving age, their parents, teachers, and others interested in their future welfare, must of necessity need to know something about suitable careers. This booklet is No. 66 in a series of Careers Booklets prepared and issued by the Central Youth Employment Executive in consultation with several authorities.

It describes the training, qualities required, opportunities of employment and avenues of promotion for those seeking situations as service engineers. The information is factual, brief and clear. No attempt is made to glamorize a profession that calls for sound training in theory and practical work, concentration and determination.

THE A.R.R.L. ANTENNA HANDBOOK. 306 pages and Index. Obtainable from The Modern Book Co., 19–23 Praed Street, London, W.2. Price 18s. 0d.

It used to be said that one could W.A.L.P.D.* with a bit of string for an aerial, and get all the rare Dx if one wetted it. Which only goes to show that results depend on the efficiency of one's aerial. If you want to learn something about aerials and have the information readily to hand, then this is the book you need. Not only does it go into the theory of aerials, but it gives a tremendous amount of information on aerials and feeders for all bands and conditions of use.

The following list shows that full justice to the book cannot be done in this short review—one can only say that the subjects are dealt with in full detail, and that the book must be regarded as the best of its kind available to the amateur. In 15 chapters one finds practically all there is to know about wave propagation, antenna fundamentals, transmission lines, their construction and operation, standing wave measurements, harmonic reduction, multi-element directive arrays, resonant and non-resonant long wire antennas, multi-band antennas, aerials for all the amateur bands, VHF and UHF aerial systems, construction of masts and supports, rotary beams, direction finding, receiving aerials, mobile antennas, etc.

The text is liberally illustrated with clear drawings and diagrams, and though it has not been possible to study the book in any great length in the time available to appraise it, there is no hesitation in saying that it is excellently prepared and edited. It ranks as one of those books that must be in the possession of the keen amateur, if only for the fact that he is bound to derive benefit from any part of it he chooses to read and apply.

In a nut-shell, a really fine textbook at a really low price.

* Work All London Postal Districts.

W. E. Thompson

Query Corner

A *Radio Constructor* Service for Readers

Vibrator Service

I have a 6 volt car radio receiver with a non-synchronous type of vibrator. Recently, when switching on, the familiar hum from the vibrator has not been audible, and the set has not come into operation. A temporary cure has been to thump the side of the set, and the resulting shock on the vibrator has been sufficient to restart it. Is it possible to service these components or should I purchase a new one? B. Haynes, Leeds

As the vibrator is a device which incorporates moving parts, it has a limited useful life due to general wear taking place. The most important part of the unit is the vibrating blade with its contacts, the function of which is to transform the d.c. input into square wave alternating current. The blade oscillates at a frequency in the region of 88 movements per second, so that in a day it may easily have oscillated 2 million times. Little wonder that the contacts and blade suffer some wear after a period of use. The usual symptoms of a faulty vibrator are intermittent operation, or indeed no output at all. However, before jumping to the conclusion that the fault is definitely in the vibrator, it is first worth checking the input to it from the battery. The input current may well be in the region of 4 amps, and it only requires a very small increase in resistance in the supply circuit to drop the voltage to the point where the unit ceases to function. It is thus worth checking that the supply leads are in order, and that the accumulator terminal contacts are well made.

If this part of the circuit is in correct order the vibrator must be assumed to be faulty, most likely because the contacts are sticking together and preventing the vibrating blade from functioning. In some cases the unit can be serviced and a useful extension in life obtained. Having unplugged the vibrator from the receiver the case must be removed. To achieve this it is generally necessary to carefully bend back the spun over part of the can at the base end, when the whole may be lifted clear. If the assembly is found to be in good condition, apart from sticking contacts, these may be carefully cleaned. A very fine grade of sand-paper should be used for this purpose; alternatively, the author has found that the abrasive sides taken from a box of safety matches is ideal for the purpose. The sand-paper is rubbed lightly over the working surfaces of the contacts until a smooth shiny finish is obtained. All loose particles must then be brushed away with a small paint brush, and finally the contacts washed by soaking the brush in petrol or benzol. This washing is important as it removes grease from the contacts, and assists in preventing arcing. Care is necessary

Query Corner RULES

(1) A nominal fee of 2/6 will be made for each query.

(2) Queries on any subject relating to technical radio matters will be accepted, though it will not be possible to provide complete circuit diagrams for the more complex receivers, transmitters and the like. Queries relating to ex-W.D. surplus or commercial equipment cannot be accepted.

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

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

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

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

to avoid getting the spirit on any rubber spacing parts such as are found in some makes of vibrator.

Sync Pulse Polarity

Many readers have successfully made up composite television receivers using parts of designs published in this and other journals. The need for this practice arises largely to enable equipment or components which are on hand to be utilised to the full. Frequently the circuit of the complete receiver is first forwarded to this department for checking, during which time it is often found that the vision modulation from the chain of synchronising pulses. The picture tube modulator is also fed from the output of the video stage, so this is a good starting point from which to determine the final pulse polarity. If the picture tube is cathode modulated the sync pulses will be positive-going at this point. Conversely, if the tube is grid modulated the pulses will be negative-going. This will be obvious when it is remembered that the pulses are intended to blank off the trace during the flyback period. Reference to Fig. 1 shows a typical sync separator stage which is being fed with positive-going pulses

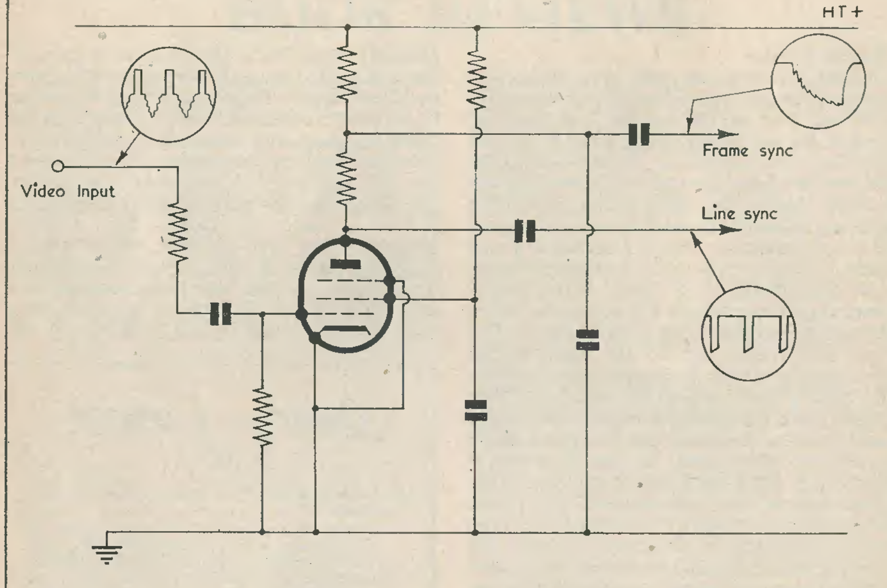


FIG. 1.

A TYPICAL SYNC SEPARATOR

The condition shown exists when the C.R.Tube is cathode modulated

sync pulse polarity at the trigger electrode of the timebase oscillator valves is incorrect. We feel, therefore, as incorrect sync polarity may easily account for very poor timebase lock that a few words on the subject may be of assistance.

In a television receiver the composite video signal is normally fed from the output of the video amplifier into the sync separator stage. The function of this stage is to remove the in the composite vision waveform and providing negative pulses at its anode. Quite frequently an elementary form of sync separator such as that shown in the diagram will be followed by further valves or filters to improve the interlacing and assist in preventing noise from reaching the timebase oscillators. Extra valves may reverse the phase of the sync pulses, depending upon the type of circuit in which they are employed.

The following serves as a general guide in this connection.

The phase will be reversed if the pulses are fed on to the control grid and taken off the anode or screen grid of a valve.

The phase will not be reversed if the pulses are fed on to the control grid and taken off the cathode (cathode follower). Nor will reversal take place over an interlace filter consisting of R and C combinations with or without diodes.

Thus, by starting with the known sync pulse polarity at the c.r. tube modulator, it is a simple matter to determine the pulse polarity as fed to the timebase oscillators.

The second part of the problem is to ensure that the pulse is correctly employed at the oscillator. The usual practice is to apply the pulse to one of the oscillator electrodes of the timebase generating valve. With all oscillators at least one electrode of the valve will travel positive and one negative during the flyback period. Generally the sync may be applied to any one of these oscillating electrodes, the golden rule being that the pulse polarity must be the same as the polarity of the pulse which appears on the electrode during the flyback period. For example, in the blocking oscillator circuit the anode of the valve travels negative producing the flyback stroke whilst the grid is driven positively by a pulse from the blocking transformer. Thus sync pulses may be applied negative-going at the anode or positive-going at the grid. It is seldom possible to apply sync to the cathode of an oscillator, but when this is done the polarity is the same as that for the anode.

TRADE NEWS

LABGEAR TELEVISION AERIALS FOR THE NEW PROGRAMMES

Labgear (Cambridge) Ltd. have introduced an interesting range of TV aerials for the new Band III programmes. These may be divided into two main categories viz.: (a) those which add on to an existing Band I installation, and (b) those which are combined Band I and Band III models. Clearly category (a) caters mainly for those who already have receivers, and (b) for new TV viewers.

In the first classification, model 303/AF is of especial note. This is a 4-element wide-spaced Yagi which provides outstanding signal pick-up and a particularly advantageous polar diagram to avoid spurious ghost images. This aerial is fitted with a cranked arm and adaptor to allow it to be clamped on the existing mast of the Band I aerial *from roof level.*

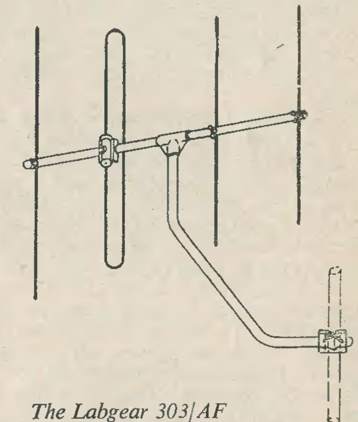
It therefore provides the following positive advantages over units which have to be attached to the actual elements of the Band I aerial:—

(1) Band I aerial does not have to be taken down.
(2) Elements of Band I aerial do not have to be scraped clean for good connection.
(3) Can be clamped in any direction, so is suitable for reception of Band I and Band III signals arriving from different directions.
(4) Much more signal pick-up.
(5) Far lower installation cost.

Furthermore, the assembly time of model 303/AF is remarkably low, being far less than many of the so-called "pre-assembled types." This is due to a most ingenious and unique method of element attachment.

This basic high-gain 4-element Yagi is also available with other fixings, e.g. wall mounting version (model 303/Z1); Chimney mounting with cranked arm (model 303/Z2); and also with various types of chimney lashings and straight masts (models 303/X1, 303/X2, 303/X3).

The range of outdoor aerials designed to receive both Band I and Band III transmissions is based on a Band I dipole which is fitted with a Band III attachment plus a Band III reflector. The extra gain and directivity on Band III will, in practice, be found very worthwhile.



The Labgear 303/AF Band III Aerial

The design of the aerial is such that no cross-over network is necessary, both signals being transmitted through a common 75 ohm co-axial feeder. Models having a wide variety of fixings are available.

Labgear indoor aerials use aluminium ribbed strip elements. This is found to be adequately robust for use in the loft and, moreover, gives a very satisfactory electrical performance. Semi-folded dipoles are used for optimum matching. Model 301 is for Band III only and is one of the highest gain indoor aerials available. Model CO2 is a combined Band I/III indoor aerial and uses a linear system coupling the Band I and Band III sections instead of the more usual cross-over network. This effects a saving in cost. Incidentally, the Band I dipole acts as the reflector for the Band III section (consisting of a semi-folded dipole plus director). It should be noted that model 301 is recommended for use with those sets or converters having two aerial input sockets and model CO2 for those having only one.

The Labgear cross-over unit model CN13 will either combine the outputs of separate Band I and Band III aerials for feeding into a common 75 ohm transmission line, or conversely will split the composite output of a single feeder into separate Band I and Band III signals for those sets requiring two inputs.

Radio Miscellany

WITH THIS NUMBER *The Radio Constructor* achieves its hundredth issue. The Editor and staff hope that the magazine and its readers will enjoy many more centuries together.

Only a small proportion of our present readership—certainly not more than a tenth—have been with us since the beginning, so it would be appropriate this month if we paused for a moment to look back over the years.

At the time of the magazine's birth, newsprint rationing was still in force, so for a year or two its light had to be hidden under a bushel. It is incongruous that a staff so proud of its production had to remain so reticent; if not, they would have suffered the embarrassment of having to explain to would-be new readers that the best they could do for them was to put their names on the bottom of a long waiting list. There never seemed to be any vacancies on the list—either the readers were all young and healthy or the subscription passed to a near relative by bequest! Thus it comes about that copies of our early issues are comparatively scarce, and it explains the occasional appearance of small-ads. offering a "reasonable price" for them. Just what a "reasonable" price would be has often puzzled me. If I had been a better business man perhaps I should have cornered a few as a long-term investment. Oddly enough, I once heard from a reader whose hobby was collecting first issues of every magazine he could lay his hands on. The activities, too, of one of our Balham readers, who has an amazing collection of all British and American radio periodicals, will be known to students of our small-ads.

Overflow

Paradoxical as it may seem, the appearance of *The Radio Constructor* was accelerated by paper rationing. A rather similar state of affairs, with a long waiting list, had arisen with our contemporary companion journal, the *Short Wave News*, later to become *The Radio Amateur*. Over-subscription, combined with an insistent demand for more constructional articles than the limited space could provide, hastened the birth. While it wasn't possible to get a small extra paper allocation for the *S.W.N.*, it *was* possible to get a similar ration (2 cwt per month!) for a new publication.

This solution helped to satisfy, in part, the demand for more technical publications, and helped to prepare for the day when the editorial staff could go ahead with plans for a much wider circulation.

However, the beginning of *The Radio Constructor*, although solving some problems, created another. It became immediately apparent that the staff were to be kept busy looking after two waiting lists instead of one. All of which was very annoying, especially in view of the fact that the bookstalls were then so heavily stocked with trashy publications.

Since rationing ceased, the readership has increased steadily month by month, and it is still rising (from 3,000 odd to 30,000 copies at present).

Progress

Observant readers will, from time to time, have noticed changes in the magazine; sometimes in major points, and sometimes in detail. The new cover last month, for instance, is but another step in the quest for the recipe for the perfect magazine, contriving as it does to combine eye-appeal with good taste. The continuing expansion in circulation suggests there is still scope for yet further increases. This is to the benefit of every reader, as it makes possible enlargement and other improvements.

Looking back, as we were, to the first issue, the only likeness we should find in appearance would be the page size. Cover, type-face, headings, layout, paper quality, "blue-print" circuits, addition of colour, etc., have all received attention. These changes may pass more or less unnoticed, but they all help to make *The Radio Constructor* look as up to date as its contents. It is obvious that many readers are as aware of this as the editorial staff. The many who write to praise or criticise can rest assured that close attention is given to their comments.

We have all got our own ideas of just how we should "balance" a magazine—how much space should be devoted to technical articles and theory, to construction, to topical and general articles, and just how much should be left in reserve for those with more specialised interests. My own experience suggests that it is normally a safe bet that newcomers to the hobby, if they had the choice, would make it 99 per cent constructional. As they become "old hands" they begin to appreciate the other contents more and more, tending to expect an increasingly greater proportion of space devoted to them. After all, there is a certain sameness about constructional articles taken from any magazine, dependent on whether they are intended for beginners or not, but it is chiefly the other features which give it "character."

It is an opportune moment on such an occasion as this to remind readers of these little points. If you have ideas on what should be included (or excluded) or on changes in appearance or policy, don't hesitate to put your ideas forward. They will be carefully considered, and even if they do not appear to have any immediate effect, they may well help to mould the progressive changes which will inevitably take place in the future.

CENTRE TAP *talks about* OURSELVES / ITA PROGRAMMES

The Second Look

Now that the I.T.A. has had an opportunity to settle down, it is possible to make some comparison with the B.B.C. In many respects, it is a case of simply another dose of the same sort of mixture served up by the latter, with a little more pep in the lighter entertainment. To that extent I.T.A. serves the excellent purpose of providing an alternative.

I take it for granted that readers in south-eastern England have equipped themselves to watch at least some of the programmes. They certainly will have if they built the highly successful converter described in the August issue. Its neat, shallow chassis makes its accommodation an easy matter in any t.v. cabinet. A simple throw-over switch enables either programme to be received at the flick of a finger. With my own converter I found it necessary to gang a second switch to reduce the h.t. to the converter. It was found that the very strong signal from I.T.A. caused a faint pattern when the converter was left running while looking in to the B.B.C. This was apparently due to slight radiation from the matching transformer which, although screened, is tuned to Channel I.

Readers from the Midland area, who will be soon having their own I.T.A. programmes, seem to be taking a lively interest in them. Well, they can get busy planning their converters now. It will be a good investment, apart from the fun of making them.

The Big Hand-out

The people who previously found parlour games bewitching have transferred their affections lock, stock and barrel to the "Give-Away" programmes. I found the first few very amusing and well done, but it was other people's reactions that fascinated me even more than the programmes. They sit in front of the screen and become so intrigued that they almost start giving advice to the contestants. You don't have to ask them if they enjoyed it. They get so absorbed with the excitement that they are unconsciously smiling approval, squirming with sympathetic embarrassment and positively gasping with pleasure as someone gets the big prize. If you don't believe it, look at their faces while they watch.

As for the advertising plugs, quite a lot of people seem to take a delight in guessing the name of the product before it is mentioned. Some of the ads. are entertainingly put over, while one or two have actually been informative. A Gallup survey shows that only a small percentage resented the advertising, and many of those, I should imagine, were "on principle" rather than because of actual annoyance. Personally, I have always imagined myself not susceptible to advertising wiles, but I must admit to switching my brand of cigarettes (following a mildly sore throat), and to trying out one brand of tinned food (which is likely to become an occasional item on the family menu). Other than that the advertising has had little conscious effect, and I certainly find it no more irritating than seeing "Hands at the Potter's Wheel," "Fingers plucking Harpstrings," "Waves on the Seashore," and other tiresome interval signals. (continued on page 251)

Let's Get Started 29:

THE CATHODE FOLLOWER

by **A. P. BLACKBURN**

In the last two articles of this series we have entered the realms of electronic circuitry, as distinct from those of pure radio. As you will have realised, there is little basic difference between these techniques, except that valves are used for purposes other than merely amplifying a signal.

As this is the last article of this series (another one is starting next month), a circuit has been selected which finds considerable application in both worlds; in fact it is useful in most applications where valves play a part.

The advent of television in the middle thirties demanded a circuit which would isolate valve amplifying stages from one another, and present a high input impedance to the output of the previous stage, and if possible a low impedance to the next stage. The invention of the cathode follower was the result of this requirement.

Coupling

Before getting involved with the circuit itself, we will quickly recap. the question of amplifier response.

You will remember that the stray capacities from the anode of a valve to earth are effectively in parallel with the anode load resistor. The decreasing reactance of this capacitance as the frequency rises causes a loss of gain at higher frequencies. Now this stray capacity is formed by the anode to earth capacity of the valve, the wiring, and the grid to earth capacity of the next valve. If the wiring were carried out with very great care, the wiring capacities may be considerably reduced. The anode to earth capacity may also be very small, but the grid to earth capacity of the next stage could be considerable, say 10 or 20pF.

At audio frequencies this would not be particularly important, but in television the frequencies contained in the video, i.e. the picture waveforms, may be as high as 3Mc/s. At 3Mc/s, 20pF represents a reactance of only 5kΩ. If the anode load of the valve driving this grid capacitance were 5kΩ also, the gain would be halved at 3Mc/s, because the anode load has been effectively halved. If we could insert a circuit between these stages which had a very low input capacitance, but had a very low output impedance to present to the strays, the required result could be achieved, without reducing the anode load. Reduction of the anode load would, of course, mean a level response at higher frequencies, but a lower gain at all frequencies.

The cathode follower has the attributes of high input impedance and low output impedance. Its basic circuit is shown in Fig. 1.

Gain

The circuit is certainly simple, but it is not immediately obvious why it should operate as suggested above. It has also, in common with every other device, a snag. In this case it is gain. The gain of the circuit shown in Fig. 1 can never be more than one, and in practice is always less than one.

This comes about in the following way:

The current in the valve is:

$I_a = gmV_{gk}$, where gm is the mutual conductance of the valve

but $V_{gk} = V_i - V_o$

$$\therefore I_a = gm\,(V_i - V_o) \qquad (1)$$

The output voltage is the product of valve current and R_k, across which the output is taken, i.e.:

$V_o = I_aR_k$, and substituting for I_a from (1) above:

$$V_o = gm\,(V_i - V_o)R_k$$

$$\therefore V_o\,(1 - gmR_k) = gmV_iR_k$$

and the gain $A = \frac{\text{output voltage}}{\text{input voltage}} = \frac{V_o}{V_i}$

$$\therefore \quad A = \frac{gmR_k}{1 + gmR_k} \qquad (2)$$

Now A, the gain, can never be greater than one, because whatever value gm and R_k have, the additional plus one in the denomination will always make it larger than the numerator. However, if we could make gmR_k much larger than 1, the gain would become

$$A \simeq \frac{gmR_k}{gmR_k} = 1$$

So the larger gmR_k becomes, the nearer the gain will be to one. A high gm value is obviously desirable; but a gm above 10 mA/volt is rare, so to make gmR_k large enough to ignore the additional one in the denominator of expression (2), R_k would have to be, say, 10kΩ. This would represent a gain of 0.99. There is, however, one little difficulty. In the circuit of Fig. 1 a 10kΩ cathode resistor would produce a rather excessive grid bias. If we were to choose a more reasonable resistor, from the bias point of view, of, say, 500Ω, it would reduce the gain to 0.83.

(Admittedly, "gain" is hardly the word when dealing with cathode followers; "loss" would be more appropriate, but everyone is so used to calling the output-input ratio of voltages in valves "gain," that the idea has stuck.)

A more practical form of cathode follower in which the bias conditions are correct, and the gain may be nearly unity, is shown in Fig. 2. Here the grid leak is returned to a point down the cathode load. In this way, R_k may be made reasonably high, but the bias voltage developed across R_b is correct for class A operation of the valve.

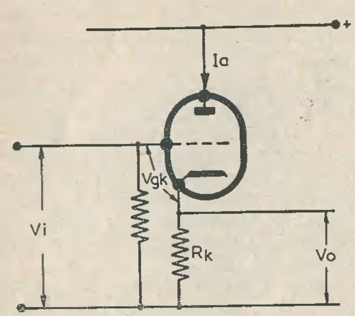


Fig. 1

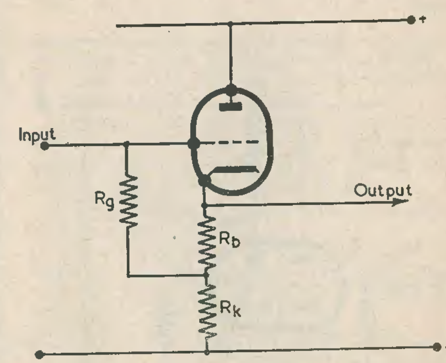


Fig. 2

E230

Input Impedance

Now to the real point of the circuit; the input impedance. First we will consider the input resistance. To demonstrate the improvement let us assume the following values: $R_g = 1M\Omega$, $R_b = 1k\Omega$, $R_k = 20k\Omega$; $I_a = 5mA$, $gm = 5mA/volt$.

If an input signal is applied which changes the grid to cathode voltage by one volt, the change of volts across R_b will be equal to the gm × one volt × R_b = 5 volts. Similarly, the change across R_k will be 100V. The input V_i to produce this must be 100+5+1=106 volts. But the change of voltage across R_g will be 106−100=6 volts. The current flowing in R_g will therefore be 6μA. This current must be provided by the input signal, i.e. 106 volts. The apparent resistance as seen by the input voltage supply will be $R_i = \frac{106 \text{ volts}}{6\ \mu A} \simeq 18M\Omega$.

Therefore, in spite of the fact that a one megohm resistor is clearly connected in the circuit, the input resistance is 18MΩ. The gain of the circuit is $\frac{105}{106} \simeq 0.99$. Fig. 3 shows all these voltages around the circuit.

The input capacity is dealt with in rather a similar manner. The voltage across this capacitor is very small and the current taken by it is small also. The reason for the small voltage across it is of course that the cathode "follows" (hence the name) the grid. We have seen that the gain may be very nearly one. The cathode to grid voltage hardly changes, therefore, and the output is in phase with the input, unlike a normal amplifier where there is a 180° phase shift.

Returning to the input capacity (Cgk in Fig. 3), an improvement in input capacity of 10 or more times is easily achieved. From the input standpoint, the cathode follower is obviously useful. The input resistance is increased, and the input capacity decreased.

Output Impedance

There is another useful feature of this circuit, and that is the low output impedance. This can be shown to be approximately $\frac{1}{gm}$

In our original valve, the output impedance would be 200Ω, therefore. This is particularly useful because relatively high capacities may be placed in parallel with the output without ruining performance at high frequencies.

Fig. 4 shows a cathode follower between two stages of a video amplifier. The anode load of V_1 is now relieved of the grid capacities of V_3, and only has to feed the low input capacity of the cathode follower, V_2. At the same time, the grid capacities of V_3 are fed from the very low output impedance of V_2. The high frequency performance will be considerably improved, as a result.

The bias resistor in V_2 may be decoupled if required, but little is gained by this. Another way of regarding the cathode follower is as an amplifier with heavy negative feedback. This, of course, implies that the circuit is very stable and comparatively free from changes in operation, due to valve deterioration and changes in supply voltages.

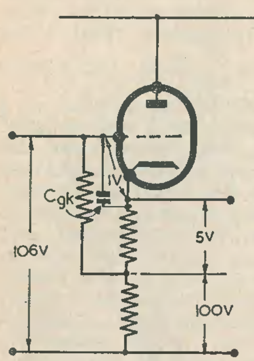


Fig.3

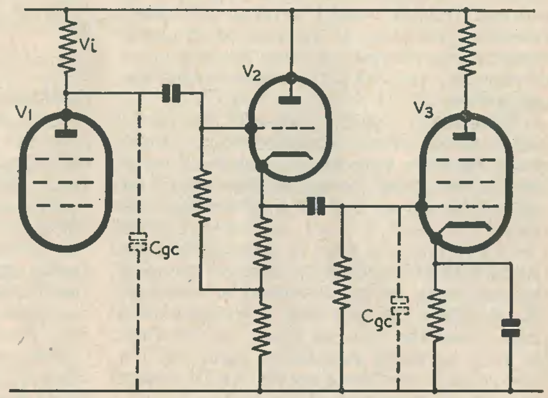


Fig.4

E231

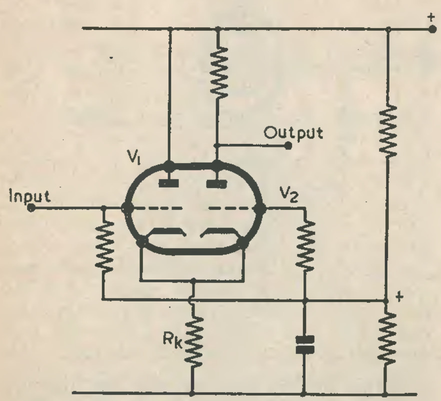


Fig.5

E232

Applications

As already mentioned, there are many applications of the cathode follower. A useful one is feeding an amplifier from a high impedance microphone or pick-up when the two are a considerable distance apart. It is often found that screened lead is ineffective in avoiding hum pick-up in a case like this, especially if the microphone or pick-up are of the crystal type.

The cathode follower input is, of course, connected to the microphone and the output to the long lead of the amplifier. As we have seen, the loss of signal may be very small, provided R_k is 10 to 20kΩ, and the impedance presented to the microphone is very high and does not therefore load it. It is worth mentioning that the cathode follower is essentially a wideband circuit, that is its frequency response is very good. A transformer could be used in a case like this one, but the large step-down ratio required to match the crystal into the lead would be very great. There would be a considerable loss in signal, therefore. The cathode follower achieves the same result without loss of signal.

Sometimes, in television work particularly, an amplifier is required which produces an output in phase with the input. The circuit of such an amplifier is shown in Fig. 5. V_1 is a cathode follower, the output of which (R_k) is connected to the cathode of V_2. Imagine a signal is applied to the grid of V_1. A signal of approximately the same amplitude will appear across R_k. If the signal were to make the grid of V_1 more positive, the cathode would become more positive also. The cathode of V_2 would become more positive, therefore, and the current in the valve V_2 would decrease. This would mean a smaller drop in voltage across its anode load, the anode becoming more positive. The output is, therefore, in phase with the input.

Of course, the same result would be achieved if a signal were connected to the cathode of any valve providing the cathode bias resistor were by-passed. The difficulty would be that the impedance at the cathode is so low that the anode load of the previous valve would be shunted by it and very little gain would be obtained in that valve. That is where the cathode follower comes into use, in matching the output of the previous valve into the cathode of V_2.

Finally, a very stable valve voltmeter may be designed using the cathode follower. The circuit is shown in Fig. 6. V_1 and V_2 are cathode followers. If these two valves are similar, R_1 and R_2 are of the same value, and the currents in the valves the same; the voltages at the points to which the meter is connected will also be the same. The meter will read zero, therefore. If a d.c. potential of −1V is applied to the grid of V_1, the cathode will also drop approximately 1 volt, and the meter will be deflected.

The input impedance is, of course, high, which s essential in a valve voltmeter. The right-hand valve, V_2, is also a cathode follower in effect, but its main purpose is to provide a balancing potential for the meter to be returned to. A resistor could be used in place of V_2, but thermal changes in V_1 would unbalance the meter and zero drift would result. By using V_2, thermal drifts should be cancelled.

An advantage of using the cathode follower principle is that range changing may be carried out by switching R_3. The grid base of V_1 is very long, because any voltage applied to the grid causes an almost equal change at the cathode. The *grid to cathode* voltage therefore changes very little.

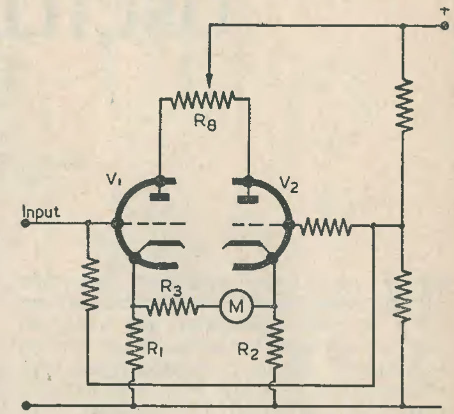


Fig.6

E233

So quite a large voltage may be applied to the grid before the grid-to-cathode voltage becomes near to cut-off.

The two grids are returned via their grid leaks to a potential slightly negative with respect to the cathode, so that correct grid operating conditions are obtained.

Initial balance or zero setting is achieved by adjustment of R_8.

These are a few of the applications of this versatile and useful circuit, but many more will be found in the pages of radio and electronic books everywhere.

This concludes the present series, "Let's Get Started". A new series for the beginner will commence shortly.

RADIO MISCELLANY

(*continued from page 247*)

Technically the transmissions are excellent, and on occasions the camera-work has been the best I have ever seen. At other times (perhaps when too many trainees are on at the same time) it has been as uninspired and patchy as the B.B.C.'s after their best men had deserted to I.T.A.

Best of all I like the complete freedom from car ignition. At Centre Tap Villa we get a better signal from Upper Norwood than from A.P. This, free from interference, gives us contemporary t.v. at its best. For the statistically minded I have kept an approximate record of family viewing time. The I.T.A. scores 65 per cent and the B.B.C. 35 per cent, but oh! how I wish both would shorten their hours.

A 7Mc/s CLAPP OSCILLATOR

by G. A. TIEL

THE OSCILLATOR HEREWITH DESCRIBED has been in use for some years driving a 10 metre transmitter, and has given every satisfaction. It cost the writer nothing to build, as all the components had been obtained from the spares box. It proved that it was quite possible to build a stable oscillator from surplus components, provided you had a reasonable selection, as such an oscillator called for good quality material in order that it remained stable and free from drift. Consequently great care was exercised in the original sorting of the bits and pieces.

The cathode network and drive condensers were all of the silver mica type, and therefore not likely to give much trouble. The air-spaced tuning condensers were from surplus units, and these were suitably stripped down to cover the band. As the writer had plenty of ML6 and 807 valves available, the former was chosen for the oscillator and the latter for the buffer, particularly as it required low drive. It is not at all necessary to use these valves, as they are wasteful and heavy on the power supply. Smaller ones such as a 6J5 and, say, a TT11 ought to be quite satisfactory. As there was plenty of power available from the d.c. mains, it was cheaper to use the first-mentioned types rather than purchase a more suitable and economical pattern. To stabilise the power supply an NS2 was used because there were plenty of them in the box.

The large ex-Navy slow motion drive, a precision piece of apparatus, was mounted on the front panel and flexibly coupled to the oscillator variable condenser. The writer can thoroughly recommend these as very fine, accurate drives.

The coil, its padders and variable condensers were mounted in a box behind the panel, so as to be completely screened from the rest of the set. Do not mount the coil less than a diameter from any side of the box. The oscillator valve was mounted underneath the chassis on its side, and the 807 vertically above. The large NS2 stabiliser comfortably fitted in at the rear of the box, lying horizontally along the chassis.

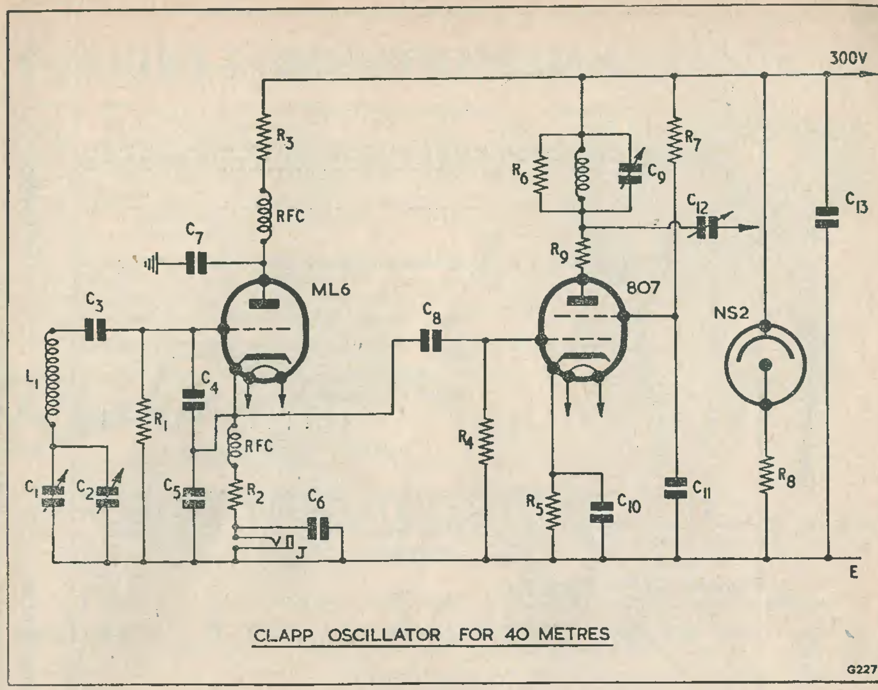
On the front panel was carried the 807, buffer pre-set variable condenser, pre-set variable grid coupling condenser (output), keying jack, switches, and co-axial plug, and the lot was built into a box $8\frac{1}{2}'' \times 7\frac{1}{2}'' \times 8''$.

Calibration and Operation

The frequency band was adjusted to cover the dial, and extending as close to each end as possible. This was done by first setting the padder condenser to the band edge and then pulling out vanes in the bandspread condenser as necessary. Calibration was against a BC221 frequency meter, and the curve (dial degrees against frequency) was plotted. To flatten out the buffer amplifier a 50kΩ resistor was paralleled across the anode coil to render retuning unnecessary when the frequency was altered. The drive to the transmitter was taken via a screened co-axial cable from the socket in the front, and the variable output condenser adjusted for the minimum amount of required drive.

As stated earlier in this article, the oscillator has been operating for several years without trouble of any kind; not bad considering that the complete job was built out of the spares box.

For those who prefer to purchase new components, or have very little surplus available, a list of components giving suitable makes is included.



CLAPP OSCILLATOR FOR 40 METRES

COMPONENT LIST

R_1	100kΩ ½ watt Dubilier
R_2	500Ω 1 watt Dubilier
R_3	3.3kΩ 1 watt Dubilier
R_4	50kΩ ¼ watt Dubilier
R_5	1,000Ω 5 watt Dubilier
R_6	50kΩ ½ watt Dubilier
R_7	25kΩ ½ watt Dubilier
R_8	15kΩ 10 watt Dubilier
R_9	50Ω ½ watt Dubilier
C_1	100pF Eddystone airspaced variable
C_2	25pF Eddystone airspaced variable
C_3	100pF silver mica T.C.C.
C_4	100pF silver mica T.C.C.
C_5	500pF silver mica T.C.C.
C_6	0.01μF condenser T.C.C., 500V wkg
C_7	0.001μF condenser T.C.C., 500V wkg
C_8	50pF silver mica T.C.C.
C_9	100pF Eddystone airspaced variable
$C_{10, 11}$	0.002μF T.C.C., 500V wkg
C_{12}	100pF variable padder Eddystone
C_{13}	8μF 500V wkg electrolytic T.C.C.
R.F.C.	2.5mH chokes Eddystone
L_1	27 turns 18 gauge enamel 1½in dia. former
L_2	17 turns 18 gauge enamel 1½in dia., former
1	Eddystone slow motion dial and coupler
1	Bulgin jack socket
1	Bulgin indicator lamp
1	Bulgin d.p. toggle switch 230V 0.3A
1	Co-axial socket Belling Lee.

VIBRATOR DATA

PART 4. *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
5463	550	T50	5035120	724	—	222	—	—	18156 SP61	—	—	6	6	115	S
5464	—	—	8619	—	—	—	—	—	SL51	—	—	6	6	115	S
5468-2	—	—	—	—	—	—	—	—	—	MV2S	—	2	2	115	S
5469-2	—	—	—	—	—	—	—	—	—	MV2	—	2	2	115	S
5500	324	TU3S	5052538	—	PJ3S	901M	409	—	NP482	—	—	6	9	115	NS
5501	324	TU3S	5052538	—	PJ3S	901M	409	—	NP482	—	—	6	9	115	NS
5503-12	—	—	—	—	—	—	—	—	12NP489	V6087	—	12	6	115	NS
5504P	337	—	8521	—	—	506P	—	—	NP64	—	—	6	6	115	NS
5506	—	—	—	—	—	—	—	—	—	—	—	6	10	115	NS
5510	—	—	—	—	—	—	—	—	—	35KN	—	6	10	115	NS
5511-12	—	—	—	—	—	—	—	—	—	36KN	—	12	6	115	NS
5513-12	—	—	—	—	—	—	—	—	—	—	—	12	3	180	NS
5514-4	—	—	—	—	—	—	—	—	—	—	—	4	5	180	NS
5515	—	—	—	—	—	—	—	—	NP48	V6648	—	6	9	115	NS
5516	—	—	—	—	—	—	—	—	—	—	—	6	9	115	NS
5517-12	—	—	—	—	—	—	—	—	—	—	—	12	3	180	NS
5518	—	—	—	—	—	—	—	—	—	—	—	6	6	115	NS
5519	—	—	—	—	—	—	—	—	—	—	—	6	6	115	NS
5560	—	—	—	—	—	—	—	—	—	117XH	—	6	4	60	NS
5604	506	—	8620	—	—	271HD	—	—	—	—	—	6	6	115	NS
5605	—	—	8632	—	—	—	—	—	—	—	—	6	10	115	S
5607	—	—	—	—	—	—	—	—	—	—	—	6	5	180	S
5609-12	—	—	—	—	—	—	—	—	—	—	—	12	3	115	S
5610	562	—	—	—	—	743	786	—	NP65	35ZH	—	6	6	115	S
5614-12	—	—	—	—	—	—	—	—	—	—	—	12	4	115	S
5615-12	—	—	—	—	—	—	—	—	—	—	—	12	3	180	S
5616	—	—	—	—	—	—	—	—	—	—	—	6	5	180	S
5620	—	—	—	—	—	—	—	—	—	V6941	—	6	6	115	S
5621	—	—	—	—	—	—	—	—	—	6756	—	6	10	115	S
5622	—	—	—	—	—	—	—	—	—	—	—	6	5	100	S
5623	—	—	—	—	—	—	—	—	—	—	—	6	6	115	S

*S=Synchronous. NS=Non synchronous. (*Conclusion*)

G2AK THIS MONTH'S BARGAINS G2AK

Talking *of* TABLE TOPPERS

The Ideal Power Transformer for the Table Top Rig.
This Parmeko-made Transformer has the following conservative ratings. Primary, 230V 50c/s. Secondary, 620/550/375/0/375/550/620V. Rated at 275vA. It will give 620 or 550 volts at 200mA simultaneously with 375V at 250mA. All the HT you require for RF and Modulator. Also 2-5V 3A windings for suitable rectifiers such as 5R4GY, 5Z3, 83, 5U4, etc. Weight 24½lb. Size 6¾" x 6¼" x 5½" high. Worth at least £7. **Our price £3 only, carr. paid.** C.W.O. only. No C.O.D.

We regret that orders from EIRE or ABROAD cannot be accepted.

For the New MOBILE
12V miniature rotary transformers. Output 360/310V, 30mA c.s or 70mA, I.C.A.S. Only 4½" x 2½" overall. ONLY **17/6** each, or **30/-** for 2, post and packing 1/6.

POWER UNITS in black metal case. With input and output sockets. For 200/260V 50c input. Output 200/250V 60/80mA fully smoothed and fused. Also gives 31V 0.3A DC and 6.3V 3A AC fitted with 6X5 rectifier. **50/-** each, carriage paid

FISK SOLARISCOPES. Complete with Charts, give world time, light and dark paths. Invaluable to the DX man. List 21/-. **Our price 7/6 post free.**

PANL HOME CRACKLE. Black, 3/- tin, postage and packing 8d.

H.S. KEYING RELAYS (*Siemens*). 1700 x 1700 coils, **12/6**.

TWIN FEEDER: 300 ohm, twin ribbon feeder, similar K25, **6d.** per yard. K35B Telcon (round), **1/6** per yard: Post on above feeder and cable, **1/6** any length.

AIRSPACED COAXIAL CABLE 150 ohms (normal price 3/11 per ft), 20-yd coils only, **£1** per coil, post free

PI CIRCUIT OUTPUT TUNING CONDENSERS. Made by E. F. Johnson Co., U.S.A. Max. cap. 500pF 1,500V rating. Ceramic insulation, size 5" long x $2\frac{9}{16}$" wide x $2\frac{9}{16}$" high, excluding spindle projection. **Our price only 15/- post free**

DROP THROUGH MAINS TRANSFORMER with voltage tapping strip. Primary 200/250V. Output 275/275V, 100mA, 6.3V, 3A, 5V, 2A, **18/6** only, post and packing **1/6**

COPPER WIRE: 14G, H/D 140ft, **15/-**; 70ft, **7/6**, post and packing **2/-**. Other lengths pro rata.

RACK MOUNTING PANELS: 19" x 5¼", 7", 8¾" or 10½", black crackle finish, **5/9, 6/6, 7/6, 9/-** respectively, postage and packing 1/6.

ABSORPTION WAVEMETERS: 3.00 to 35.00Mc/s in 3 switched bands. 3.5, 7, 14, 21 and 28Mc/s. Ham Bands marked on scale. Complete with indicator bulb. A **must** for any Ham Shack. **Only 15/-** each, post and packing 1/-.

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MODULATION TRANSFORMERS (ex 522 TX). Useful to 15W audio. Very limited quantity. 7/6 each, postage and packing 1/-

XTAL HAND MICROPHONES in silver hammer case with polished grille, handle and 4ft screened lead, **21/-**.

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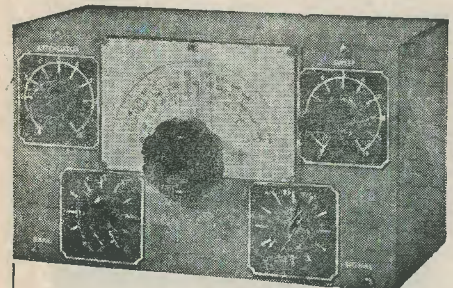

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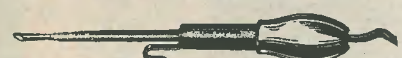

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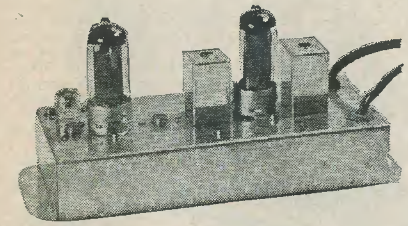
BAND 3 CONVERTERS



Teletron Mark I Converter Kit. Complete kit of parts, including coils and valves, etc., **£2 9s. 6d.**, 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., **£3 2s. 0d.**, post 6d. Mk. 2 Kit, less valves, **£2 3s. 0d.**, 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 I Coil Set, complete with wiring diagram, circuit and alignment instructions, 15/-, post 3d.

Mark 2 Coil Kit, complete with wiring diagram, circuit and alignment instructions, 17/6, post 3d.

Chassis, pre-punched with bottom screen, 3/9, post 3d.

AM/FM Signal Generator (this issue) and **"Meteor"** Rx. Cabinet, chassis and panel, as specified, 10/6, post 6d.

Valves, AM/FM Signal Generator: 12AT7, 9/-; 6AM6, 7/-, post 6d. each

We have a Large Selection of perfect C.R. Tubes. Every Tube carries a 6-week guarantee. Callers can see picture on premises

9"	...	£4 0 0
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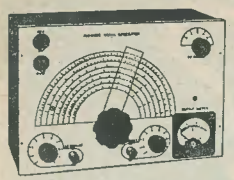
COMPLETELY BUILT SIGNAL GENERATOR



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 4½". 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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★ *SPECIAL OFFER* — *7-VALVE PUSH-PULL AC MAINS 200/250V* ★

3 wave band, coverage short wave 16-50m, medium wave 187-550m, long wave 900-2,000m. 4 controls, volume control, on-off, tone control, tuning and wave change with gram position. Valve line-up: X79, W727, two DH77's, two EL41's and EZ30. Output 7 watts. Size of chassis 16" x 7" x 2¾". Size of scale 12" x 4". Overall height including back plate 7½". BRAND NEW. Fully guaranteed. P. & p. 7/6. **£9 19 6**

USED 9" TUBE 22/14C with ion burn, **17/6**. Post paid. Mazda CRM92A, used with heater cathode short, guaranteed for 3 months. P. and p. 7/6. **£2 17 6**
Used Mullard 9" tube 22/17 and 18 ion burn, **25/-**, p.p.

Three-speed automatic changer B.S.R. Monarch, current model. Will take 7", 10" or 12" records mixed. Turnover crystal head. Cream finish. **Brand new.** AC mains, 200/250, **£7 15 0**, p. & p. 3/-

Line and EHT Transformer, 9kV. Ferrocart core. EY51 heater winding, complete with scan coils and frame output transformer and line and width control. P. and p. 3/-. **35/-**
As above but complete with line and frame blocking transformers, 4 henry 250mA choke, 100 mfd and 150 mfd 350 wkg 380mA AC ripple. P. and p. 3/-. **£2 9 6**
Standard Wave-change Switches. 4-pole 3-way, 5-pole 3-way, 3-pole 3-way, **1/9** each. 9-pole 3-way, **3/6** Miniature type, long spindle 4-pole 3-way and 4-pole 2-way, **2/6** each. 2-pole 11-way twin wafer, **5/-**; 1-pole 12-way, **5/-**. P. and p. 3d.
USED Metal Rectifier, 250V 150mA, **6/6**
Combined 12" Mask and Escutcheon perspex. New aspect, edged in brown. Fits on front of cabinet, **12/6**. As above for 14" and 15" tubes, **17/6**
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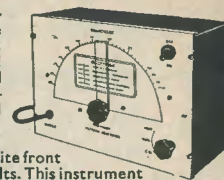
Ion Traps for Mullard or English Electric tubes, **5/-**, post paid.

PATTERN GENERATOR



40-70 Mc/s direct calibration, checks frame and line timebase, frequency and linearity, vision channel alignment, sound channel and sound rejection circuits and vision channel band width. Silver-plated coils, black crackle-finished case 10" x 6¾" x 4¾" and white front panel. AC mains 200/250 volts. This instrument will align any TV receiver, accuracy ±1%. Cash price **£3 19 6** or **29/-** deposit and 3 monthly payments of **£1**. P. and p. 4/- extra.

←Both generators guaranteed for 12 months↑

COMPLETELY BUILT TV CONVERTER

for the new commercial stations, complete with 2 valves. Frequency can be set to any channel within the 186-196 Mc/s band. IF will work into any existing TV receiver between 42-68 Mc/s. Input arranged for 80 ohm feeder. EF80 as RF amplifier, ECC81 as local oscillator and mixer. The gain of the first stage RF amplifier 10dB. Required power supply of 200 DC at 25mA, 6.3V AC at 0.6 amp. Input filter ensuring freedom from unwanted signals. Simple adjustments only, no instruments required for trimming. Will work into any TRF or superhet. Incorporating band switch and wire-wound gain control. Fully screened in black crackle finished case, size 5¾" long, 3¾" wide, max. overall height 4½", **£2 19 6**, p. & p. 2/6. As above with built-in power supply, **£3 19 6**, p. & p. 2/6. AC mains 200/250V.

40 watt Fluorescent kit, AC mains, 230/240. Comprising choke, power-factor condenser, 2 tube holders, starter and starter-holder. P. and p. 3/-. **17/6**

20-watt AC or DC 200/250V. Fluorescent kit, comprising trough in white stove enamel, 2 tube holders, starter, starter-holder and barreter. P. and p., 1/6. **12/6**
TV Coils, moulded former, iron cored, wound for rewinding purposes only. Ali-can 1⅜" x ⅞", **1/-** each; 2 iron cores Ali-can, 2⅜" x ⅞", **1/6** each. Suitable for Band III Converters.
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RF EHT Oscillator Coil. 6-9kV with EY51 rectifier winding and circuit diagram, **15/-**
As above but complete with 6V6, EY51 and associated resistors and condensers. Circuit diagram. **37/6**
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16+16mfd, 350 wkg	3/3
50mfd, 180 wkg	1/9
65mfd, 220 wkg	1/6
8mfd, 150 wkg	1/6
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50mfd, 50wkg	1/9
Miniature wire ends moulded, 100pF, 500pF and 0.001, each	7d.

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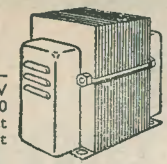
23 HIGH STREET ACTON LONDON W3

Where cost and packing charge is not stated, please add 1/6 up to 10/-, 2/- up to £1 and 2/6 up to £2. All enquiries SAE. Lists 5d. each.

TRANSFORMER SNIP



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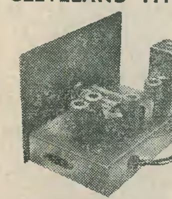
Post 2/-
Fully shrouded—standard 200-250V primary. 280-0-280 at 80 mA, 6.3V at 3 amp., 5V at 2 amp.

TELETRON BAND III CONVERSION KIT

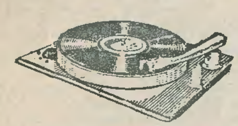
Complete kit of parts to make this very successful converter includes valves, prepared chassis, coils, etc. Price **£2 15 0** plus 2/6 p. and p. Coils only **15/-** per set.

THE CLEVELAND FM TUNER



This tuner is based upon the very successful circuit published by Data Publications. We have made up models at all branches and will gladly demonstrate. Stability is extremely good and making and aligning most simple. Cost of all parts including valves, prepared metal chassis, wound coils and stove enamelled scale, slow-motion drive, pointer, tuning knob, in fact everything needed, is **£6 12 6.** Data is included free with the parts or is available separately, price **2/-**. Extra for fringe area model **20/-**.

RECORD PLAYER £4 10 0



3-speed Induction Motor
3-speed motor with metal turntable and rubber mat. Latest rim drive with speed selection by knob at the side. No auto. stop, but there is a stop position on the selector. Small mod. makes speed variable for special effects and dance work.

Hi-fi Pick-up
Using famous Cosmocord Hi-G turnover crystal. Separate sapphire for each speed. Neat bakelite case with simple adjuster for weight compensation.

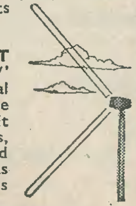
Special Snip Offer this Month
The two units for **£4 10 0,** or **30/-** deposit and four payments of **18/-**, post and insurance **5/-**, **or made up on unit board as illustrated, £5 10 0, carr. and insurance 7/6.**

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.
Price £7 10 0. Midlands Version Now Available.

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

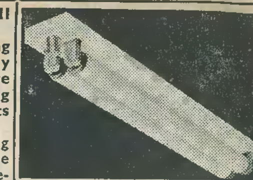


Known as the Folded 'V' this is directional, signal strengthening and noise reducing. Complete kit including alloy elements, plastic centre piece, and fixing bracket. Mounts anywhere. Price **8/6** plus 1/6 post.

WIRELESS WORLD BAND III KIT

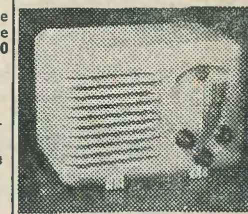
One of the most successful circuits for Band III conversion was published in the *Wireless World*, May 1954. We consequently offer a complete kit of parts, including the specified EF80 valves, wound coils, drilled chassis, in fact, everything including a copy of the circuit diagram. Price only **42/6**, post 2/6 extra. Mains components if required, **25/-** extra. Ready to work models **69/6** plus 2/6 post.

THE TWIN 20



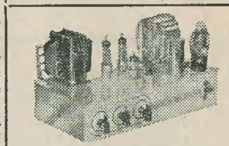
This is a complete fluorescent lighting fitting. It has built-in ballast and starters—stove enamelled white and ready to work. It uses two 20-watt lamps. Price, with two tubes, **39/6.** Post and insurance **5/-**. Extra 20-watt tubes, **7/6** each

MAINS—MINI T.R.F.



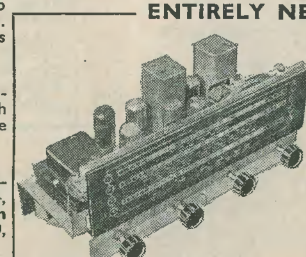
Uses high-efficiency coils—covers long and medium wavebands and fits into the neat white or brown bakelite cabinet—limited quantity only. All the parts, including cabinet, valves, in fact, everything, **£4 10 0,** plus 3/6 post.

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.

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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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AMATEUR disposing of meters, etc. SAE for list. Box No. D171.

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FOR SALE 17in Mullard CRT, £11; Allen Wide Angle TV components, line output transformer complete with EY51, £2; focus coil, 15/-; scan coil, £1 10s.; frame output transformer, 10/-; frame oscillator transformer, 5/-; 6CD6G valve, 10/-; 6U4GT valve, 10/-; mains transformer, primary 210-250V, secondary 300, 250, 200-0-200, 250, 300V, 250mA, 2-6.3V, 6A, 1-5V, 2A, £5 10s.; oak standard lamp, £3; shade, colour cream with maroon fringe top and bottom, £1 10s. All components had very little use, guaranteed in excellent condition. Box No. D174.

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FOR SALE R1155 with power pack and output stage; d.c. Multimeter; "Pifco" a.c./d.c. radiometer; 300V power unit; clockwork gramophone; host of radio magazines, valves, components, etc. Bargain at £23 the lot. G. A. Farrall, 94 Cheadle Old Road, Edgeley Park, Stockport, Cheshire.

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FOR SALE Cossor oscilloscope, model 1039, 2¾ tube, timebase frequency 10c/s to 50kc/s. High gain amplifier, mains input 220-240V a.c., complete with instruction book, good condition, £16 10s. or part exchange for 12in or 14in television. Sephton, 16 Bloemfontein Avenue, Shepherds Bush, London, W.12.

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REAL BARGAIN Portable O.V.1 S.W. Battery Receiver, will cover all bands; fitted bandset, bandspread, calibrated, very economical, excellent condition, very cheap. SAE for particulars. Box No. D161.

(continued on page 263)

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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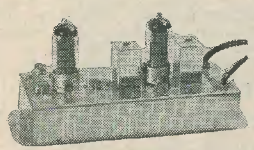
BAND III CONVERTER KIT



Complete kit of parts for "W.W." and "Teletron" Converters, including Teletron or Osmor Coils, two EF80 valves, drilled chassis and wiring diagram. Suitable for T.R.F. and superhet receivers. Power required: 200-250V, 20mA, 6.3V, 0.6A. Band coverage 42-68Mc/s. **45/-**. Post and packing 2/-.

Drilled Chassis 3/9

Teletron and Osmor Band III Coils 15/- per set with circuit. Post and packing 6d.

VALVES

NEW TESTED AND GUARANTEED

1R5	7/6	6F8G	8/6	12AX7	8/6	EF36	7/6
1S5	7/6	6G6G	4/9	12K8GT	8/6	EF37A	14/6
1T4	7/6	6J5GT	6/6	12K7GT	8/6	EF39	7/6
3S4	7/6	6K7G	5/6	58	7/6	EF80	11/6
3V4	7/6	6K8G	8/-	5763	7/6	EF85	11/6
5U4G	8/6	6L6G	9/6	954	2/6	EF91	7/6
5Y3GT	9/6	6Q7GT	8/6	9006	5/6	EF92	4/6
5Z4G	8/6	6SN7	8/6	AZ31	10/6	EL32	7/6
6AG5	6/9	6SJ7	8/-	DAF91	7/6	EY51	12/6
6AM6	7/6	6SK7	8/-	DF91	7/6	EZ35	8/-
6AL5	6/6	6SL7GT	8/-	DL63	8/6	KT66	11/6
6BE6	8/-	6SS7	6/9	DL94	7/6	UI42	9/6
6BW6	8/-	6V6G	7/6	EB91	6/6	PL81	12/6
6B8	7/6	6U5G	7/6	EBC33	8/6	PL82	10/6
6B8G	7/6	6X4	8/-	EBC41	8/6	U78	8/6
6BA6	8/6	6X5GT	8/-	ECH42	11/6	UCH42	11/6
6SA7	8/-	12AH7	7/6	ECL80	12/6	PCC84	11/6
6F6G	8/6	12AT7	9/-	EF22	7/6	UY41	8/6

Matched Pairs KT66, **25/-**; 6V6G and GT, **17/-** per pair; 6K8G, 6Q7G, 6V6G, 5Z4G, 6K7G, **34/6** per set; 1R5, 1T4, 1S5, 3V4 or 3S4 **27/6** per set.

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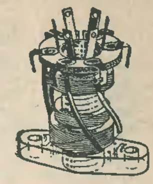

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Dual range miniature Crystal Set Coil with circuit, type DRX1 **2/6**

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.**

Standard I.F. Transformers, type SE, 1¼" x 1" x 2¼", pre-aligned 465 k/c **13/6 Pr.**

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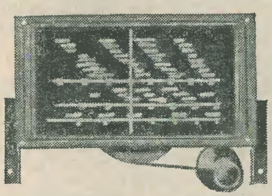

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Complete with 3-wave band glass scale 9" x 4½—27/6

The S.L.8 Spin Wheel Drive gets easy control through a ratio 24:1. Fitted with constant velocity coupling, it eliminates strain on the Condenser, providing mechanical and electrical isolation from vibration and noise.

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SMALL ADVERTISEMENTS

(continued from page 261)

PRIVATE

FOR SALE "Vitavox A" M/C mic, desk stand, oxy black, new, £4. Transformers: 250-0-250V, with two 4 volt fil. windings, 10/-; 400-0-400V, 250mA, 2.5A, 6.3V, 12V fil. windings, £1; smoothing choke, 500mA, £1; 8in speaker in wooden cabinet, £2; variable capacitors, Eddystone type 832 2,500V, 50-50 transmitting, new, 10/-; charging transformer with metal rectifier, 6V, 2A, 15/-; rotary 12V in at 3.8A, 400V at 0.04A out, £1; 12V, 10A in, 275V at 110mA and 500V at 50mA out, £2; Eddystone morse key, new, £1; playing desk with crystal pick-up, £3; headphones, 2,000 ohm, 7/6; ex-W.D. moving coil, 10/-. All plus postage. "East Keal," Romany Road, Oulton Broad, Lowestoft, Suffolk.

XTAL SET, brand new, Medium wave, ideal gift, latest iron dust triple wound coil, contained in metal case, complete less phones, 17/6. Box No. D175.

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(continued on page 264)

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1R5	8/6	6G6G	4/-	25L6GT	10/-	EF54	5/-
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1A3	4/6	6J5M	7/6	80	9/6	EF91	6/-
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2X2	3/6	6K7M	6/6		7/6	EL91	5/-
3A4	6/6	6K8G	8/6	832	30/-	EM80	9/-
3D6	5/-	6L7M	7/6	866A	12/6	EY51	12/6
3Q5GT	9/6	6Q7G	8/6	954	5/-	EZ40	8/6
3S4	8/6	6SA7M	8/6	955	5/-	EZ80	8/6
3V4	8/6	6SC7M	9/6	956	5/-	PCC84	12/6
5U4G	8/6	6SG7M	7/6	9001	5/-	PCF80	12/6
5Z4G	8/6	6SK7M	7/6	9003	5/-	PCF82	12/6
6AB7M	6/-	6SL7GT	7/6	9006	5/-	PL81	13/6
6AC7M	6/-	6SN7GT	7/6	CBL1	10/-	PL82	9/6
6AG7M	10/6	6SS7M	6/6	CV286	7/6	R12	12/6
6AK5	6/6	6SJ7M	8/6	CV287	7/6	R19	12/6
6AL5	6/-	6SQ7M	10/6	DL33	9/6	TZ40	30/-
6AM6	6/-	6U5G	7/6	DAF96	9/6	SP61	3/-
6AQ5	9/-	6V6GT	7/6	DF96	9/6	UCH42	10/6
6AT6	8/-	6X4	7/6	DK96	9/6	UL41	10/6
6AU6	8/6	6X5GT	7/6	DL96	9/6	UY41	8/6
6B8M	7/6	6Z4	5/-	EA50	2/-	VS110A	4/6
6BA6	8/6	7B7	9/-	EAF42	9/6	VR105/30	
6BE6	7/6	7C5	9/-	EBC3	10/-		7/6
6BJ6	7/6	7C6	9/-	EB91	6/-	VR150/30	
6BS7	7/6	7Y4	9/-	ECC81	10/6		7/6
6BR7	11/6	12A6M	7/6	ECC82	10/6	VT62	10/-
6BW6	7/6	12AU7	8/6	ECH35	10/-	W77	5/-
6C4	5/-	12BE6	7/6	ECH42	10/-	X66	7/6
6CH6	6/6	12J7GT	9/-	ECL80	11/6	Z77	6/-
6F6G	7/6	12K7GT	9/-	EF37	7/6	220P	3/-
6F7	8/6	12Q7GT	9/-	EF5	7/6	5Y4G	7/6

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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.

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IR5	7/6	6K8GT	9/–	80	8/6
IT4	6/6	7S7	8/6	VU39	
IS5	6/6	7B7	8/–	(MU12/14	8/6
3S4	7/6	7Y4	7/6	UY41	8/–
3V4	7/6	7C5	8/6	UL41	9/6
5U4G	8/6	7C6	8/6	EY51	12/6
5Z4G	8/6	12K7GT	8/6	EF80	10/–
5Y3G	7/6	12Q7GT	8/6	ECL80	11/–
6X5G	6/6	12K8GT	9/–	PL81	11/6
6V6GT	7/–	25Z4GT	8/6	6AM6	7/–
6K7/GT	5/6	35Z4GT	8/–	6AL5	6/6
6Q7	9/–	35L6GT	8/6	6SN7	8/–

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Gold sprayed expanded metal fret up to 24" x 24", ½d. per sq. in, post and packing 1/–

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74 FRANCHISE STREET : WEYMOUTH

SMALL ADVERTISEMENTS

(continued from page 263)

TRADE

JOIN THE ISWL. Free services to members including QSL Bureau, Translation, Technical and Identification depts. DX certificates, contests and activities for the SWL. Monthly magazine "MONITOR" duplicated, containing articles of general interest to the SWL and League members, 12s. 6d. per annum, post free. ISWL HQ., 86 Barrenger Road, London, N.10.

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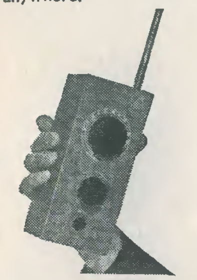

Send 2/– for layout, Wiring diagram and Components Price List.

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All Fixed Condensers	... 9/–
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Panel and Chassis ...	... 3/6
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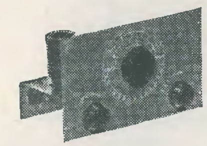

This 1 valve S.W. receiver can be built for 30/–, from our list of components, which can be purchased separately. It includes valve and 1 coil covering 20–40 metres. Provision is made to increase to 2 or 3 valves if required, and all components are colour-coded so that the beginner can build this set quite easily. *Send 2/– for specification, wiring diagram, layout and price list.*

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