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VOLUME 10
NUMBER 1
AUGUST 1956

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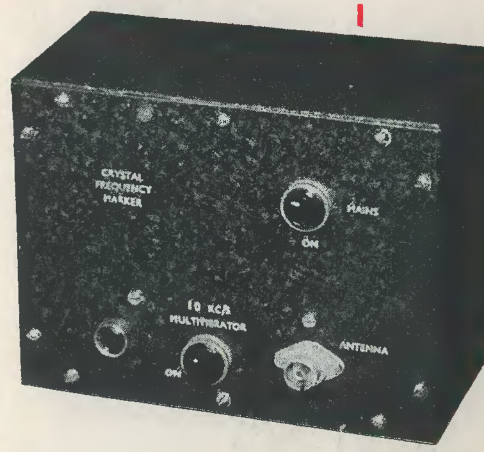

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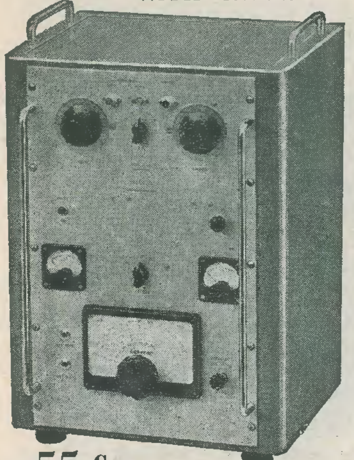

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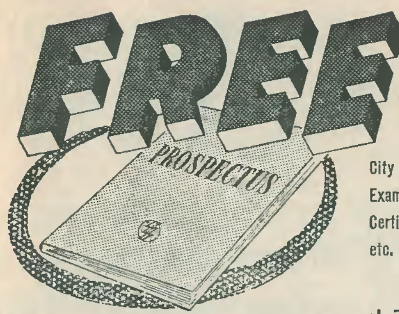

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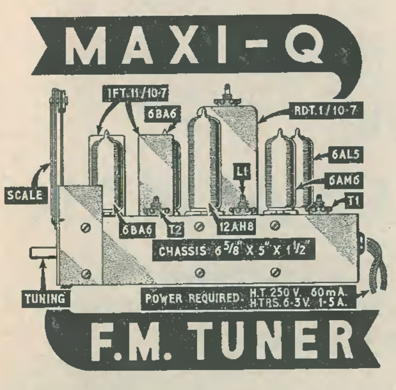

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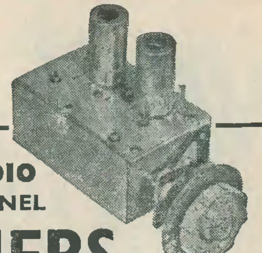

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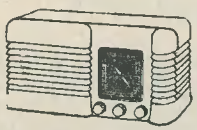

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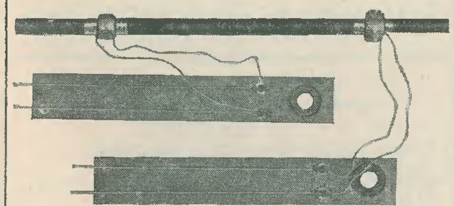

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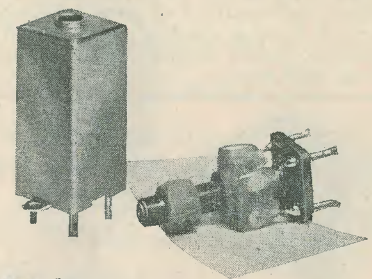

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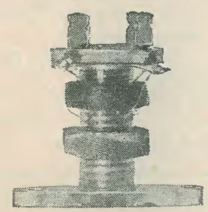

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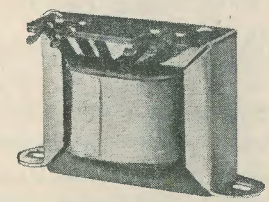

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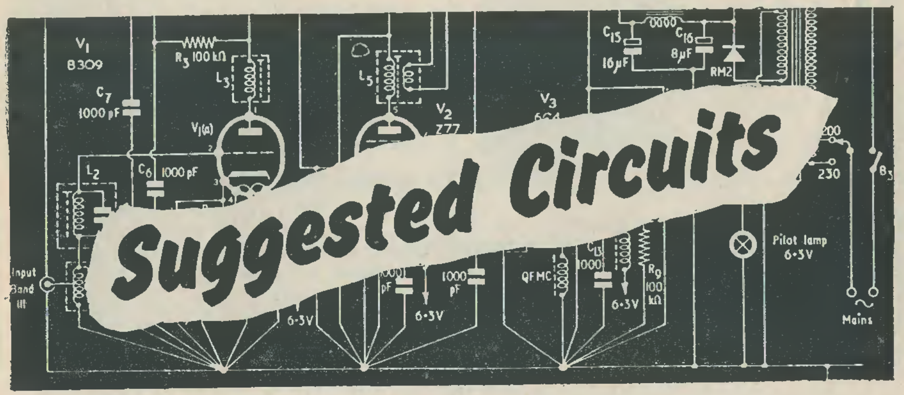

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No. 69. A NOVEL VOLUME LEVEL INDICATOR CIRCUIT

In *Suggested Circuits No.* 65 (published in the April issue of *The Radio Constructor*), the writer introduced a new technique to home-constructed a.f. amplifier systems. This technique consisted of heating the first valve or valves in an amplifier at r.f., thereby obviating one of the most prevalent sources of 50 c/s hum. The r.f. heater voltage had a frequency which could be made to lie anywhere between 40 and 100 kc/s, and was obtained from a specially-designed r.f. transformer. The transformer consisted basically of an oscillator winding closely coupled to a low impedance secondary, the latter supplying the requisite heater voltage. The transformer assembly was introduced and is now manufactured by the Teletron Co. Ltd., and has the type No. S.S.O.

The basic function of the circuit published in the April issue was that of providing a hum-free heater supply for the early valves of an a.f. amplifier. However, the design had the second advantage of being capable of providing a source of erase and bias voltages for the heads of tape recorders, thereby allowing it to serve a dual purpose in such equipment. In its original form, the transformer was intended to supply high-impedance heads directly. The writer has now been given to understand that the transformer may also be employed with low-impedance (200–300 Ω) heads as well.

A considerable amount of interest was shown in the April *Suggested Circuit*, and it appears that the tape-recorder application caught the imagination of many constructors. In the previous article the writer made a brief reference also to the use of the transformer as a supply of heater volts for a Magic Eye volume level indicator. As he has received quite a few queries concerning this particular application, he would like to give further details in this month's article.

The Circuit

The circuit of a magic eye volume level indicator in which the heater is supplied by an S.S.O. transformer is shown in Fig. 1. Whilst it has to be pointed out that this arrangement does not take full advantage of all the possibilities made available by the r.f. transformer, it nevertheless offers sufficient attractive features to make its adoption well worth consideration. One of these features is the fact that the volume level indicator provides an automatic check of the state of the erase and bias oscillator circuits, insofar that it becomes illuminated when the oscillator is functioning, and extinguished when it is not. Thus, the indicator valve carries out two functions. Secondly, the risk of accidentally running tape through the recorder with the controls in an incorrect position is considerably reduced. A third point, which is somewhat complementary to that just mentioned, is that the volume level indicator only functions at the time when it is needed, i.e. during recording sessions. A disadvantage which must be taken into account concerns the unavoidable time delay between the application of heater voltage to the magic eye indicator, and its full illimination; and between the cessation of heater voltage and the extinction of the indicator. With modern valves these delays should not be excessive.

further comment here. Briefly, h.t. is applied to the oscillator V_1 via R_7 and the decoupling condenser C_7. For the application illustrated in the diagram, approximately 240 volts should appear across C_7 when the oscillator is switched on. The oscillator coil L_1 is employed in a conventional Hartley arrangement, and a connection is taken from the valve anode to supply high-impedance bias and erase heads. (A separate tap, not shown in the diagram, can be employed for low-impedance heads.) The condenser C_4, connected across L_1, tunes the coil to whatever frequency is required. The oscillator valve may be any pentode or tetrode capable of developing 2.5 watts or more at 240 volts anode voltage. The oscillator cathode current will be approximately 16mA.

The secondary of the oscillator coil supplies the heater of the magic eye indicator. In the circuit a 6U5G is specified, although

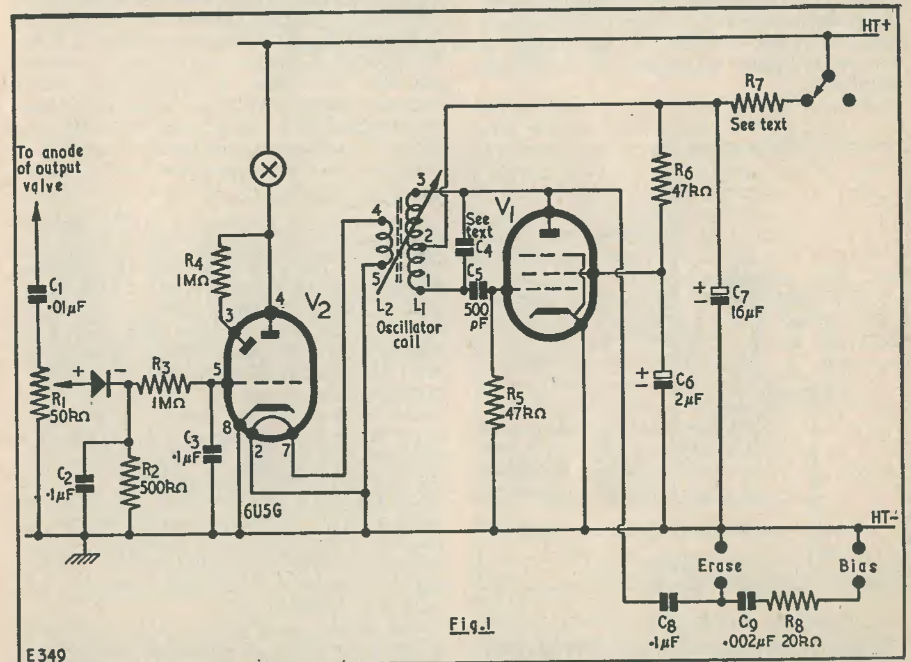


Fig. 1

It must be pointed out that the circuit is capable of supplying the heater of an a.f. amplifier valve in addition to that of the magic eye, if desired, so long as the total heater consumption does not exceed 0.3 amps.

Operation

The circuit consists basically of two distinct sections: the oscillator circuit and the volume level indicator circuit. The oscillator circuit is conventional and requires little most other tuning indicators should function equally well.

Volume Level Indication

When the use of a magic eye indicator is contemplated in a volume level circuit, it might appear at first sight that the simplest and cheapest method of operation would consist of applying the a.f. direct to its grid via a series resistor, the resultant leaky-grid action then providing the necessary grid control potential. Unfortunately, it is sometimes rather difficult to obtain a sufficiently low impedance in the a.f. source for efficient detection when this scheme is employed, with the result that a "fuzzy" image is given by the indicator. A more reliable method, and one which is applicable to all conventional recorder amplifiers, consists of rectifying the a.f. and of then integrating the detected voltage before application to the magic eye grid.

This process has been carried out in the simple arrangement shown here. A proportion of the a.f. appearing at the output anode of the recorder amplifier is tapped off by the potentiometer R_1. This voltage is then rectified by the crystal diode W_1. The rectified voltage (which is negative with respect to chassis), is then passed to the low-pass filter R_3–C_3, and thence to the grid of the indicator. The indicator thus provides a deflection proportional to the signal voltage, the potentiometer R_1 being adjusted such that a complete "closing" of the magic eye shadow indicates maximum a.f. amplitude permissible.

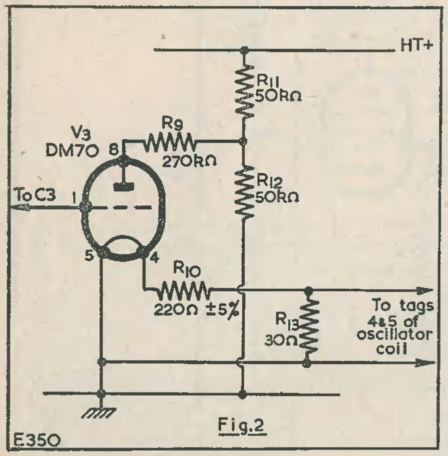


Fig.2

It will be noted that, in this arrangement, no "delay" voltage is applied to the indicator. It provides a deflection at all volume levels. To the writer's mind this may be an advantage over delayed systems in which overload can be represented by a sudden violent deflection of whatever indicating device is used, and in which it is consequently difficult to arrive at a comfortably controlled average volume level. The circuit shown here responds to peak a.f. amplitudes and, due to the presence of R_3 and C_3, has a fairly quick rise time and slow decay time.

Practical Points

As it stands, the circuit is almost completely self-explanatory, although there are one or two minor points which may require a little further explanation.

Since it is possible for large a.f. voltages to be applied to the crystal diode, a "high-impedance" type having a high turnover voltage is desirable here. Types GD5, GEX55, or OA71 should all prove to be quite suitable in the W_1 position.

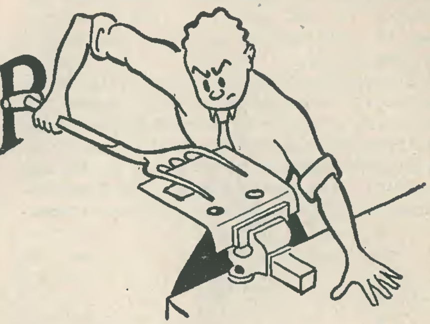
Although it is doubtful if such a case would occur in practice, there is the theoretical possibility that the a.f. present at the output anode of the tape recorder amplifier may not have sufficient amplitude to completely "close" the shadow of the magic eye. If such an instance occurs, the sensitivity of the latter may be increased by inserting a dropping resistor between the h.t. positive rail and the target, at the point marked in the circuit with a circled cross. The standing current flowing between cathode and target should remain reasonably constant for all shadow angles, whereupon it becomes possible to attain a sufficiently steady reduced target voltage without further stabilisation. A value between 10 and 100kΩ, chosen experimentally, would be adequate for the dropping resistor.

An Alternative Indicator

An attractive alternative to the conventional magic eye indicator is illustrated in Fig. 2. In this second diagram the indicator employed is the 1.4 volt Mullard DM70, the grid of this valve being connected into the circuit at the same point as was that of the magic eye. The anode circuit differs, however, this electrode being supplied from a potentiometer across the h.t. supply. The values for R_{11} and R_{12} shown in the diagram apply to an h.t. voltage of 250. If the tape recorder h.t. rail has a higher voltage, R_{11} should be increased accordingly. The filament supply is obtained via the dropping resistor R_{10}. It is important to ensure that the end of the filament so designated is connected to chassis. Although not entirely essential, additional filament voltage stabilising is provided by R_{13}.

One advantage of using a DM70 instead of a magic eye indicator is the fact that there is negligible time delay between the application of filament voltage and the appearance of the display. Similarly, the display disappears as soon as the filament supply ceases. A second advantage is the fact that the filament consumption is so low, at 25 mA, that any additional heater load up to 0.3 amps could be connected across the r.f. heater supply without upsetting the operation of the oscillator transformer. If additional heaters are connected, R_{13} should, of course, be taken out of circuit.

IN YOUR WORKSHOP



This month J.R.D. concludes his description of the "Challenger", the f.m. tuner designed especially for the home-constructor who wants superior results. In this article he gives full details of the alignment of the unit.

In the previous two articles, the circuit and construction of the Challenger f.m. tuner unit have been described at some length, It now becomes necessary to outline the procedure required for the alignment of the completed receiver.

As was mentioned in the first article, it will in many cases be possible to align the receiver with a signal generator providing only an output at 10.7 Mc/s capable of being attenuated. If the constructor resides in an area of reasonable signal strength, it should then be possible to align the r.f. and oscillator circuits on received signals.

Setting Up

After the receiver has been completed, and the wiring checked, it is possible to prepare for testing and alignment. To do this it is first of all necessary to connect the tuner to a power unit, and its a.f. output socket to an amplifier. The amplification given by the triode, output pentode, a.f. stages of a conventional broadcast receiver should be quite adequate.

A means of measuring the i.f. output voltage at the stabilising condenser is next required. This measurement is most conveniently carried out by reading the voltage between chassis and the negative end of the stabilising condenser. Ideally, a valve voltmeter should be employed here. However, such an instrument may not be available to the home-constructor; whereupon some other means of measuring the stabilising voltage is required. (A particularly useful "alignment meter" for service use was described by G. A. French in *Suggested Circuits No.* 55 and interested readers are advised to refer to this article.) A simpler type of alignment meter is shown in Fig. 12. Whilst this is not capable of very accurate quantitative results, it should still serve quite adequately for what is required in this particular case. The triode shown in the diagram may be any low-mu triode, and the meter may have an f.s.d. anywhere between 1 and 5 mA. A "straight" r.f. pentode, triode-connected, may be employed in place of the triode, if desired. The cathode lead of the triode is connected to that tap in the grid bias battery which causes the meter to read nearly f.s.d. when the two test leads are short-circuited together.

It is possible, also, to align the receiver with the aid of a conventional moving-coil voltmeter. However, such a procedure is only advisable if the meter has a resistance higher than some 2,000 ohms per volt.

Alignment

The receiver should now be ready for initial testing. V_1 should be removed, and the power unit switched on.

Before proceeding further, it is advisable to ensure that the oscillator, $V_{2(b)}$, is functioning correctly. This point may be ascertained quite easily by connecting a testmeter, switched to a low volts range, between chassis and the junction of R_8 and R_9. Any indication of negative voltage at this point, even if only slight, is sufficient to confirm that $V_{2(b)}$ is oscillating and that a bias voltage is being applied to the i.f. valves.

The i.f. strip may now be aligned. During this process it is necessary to measure the voltage between chassis and the negative end of the stabilising condenser, C_{39}. (The means used for measuring this voltage has just been discussed.) The i.f. test signal from the signal generator is applied to the grid of $V_{2(a)}$: preferably via a condenser whose value lies between 10 and 50 pF. This condenser must be positioned close to the valveholder tag; see Fig. 13.

The signal generator is now set to 10.7 Mc/s, modulated, whereupon its output should not only cause a voltage to be built up across the stabilising condenser but should also enable its audio modulation to be heard via the a.f. amplifier. The two i.f. transformers and the primary (top core) of the discriminator trans-

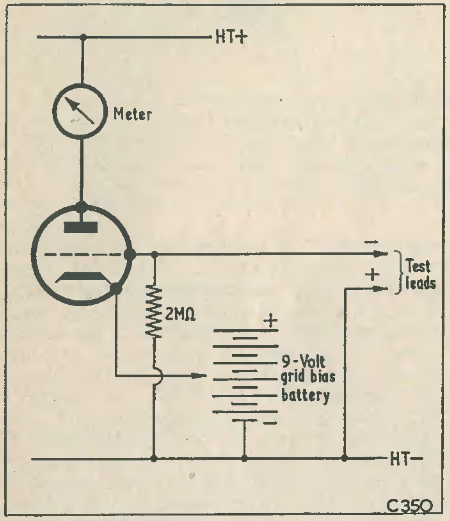


Fig. 12. A simple valve voltmeter circuit which may assist in the alignment of the receiver

former are next adjusted for maximum voltage at the stabilising condenser. The signal generator output should be attenuated as alignment proceeds, final adjustments being made with a potential of about 2 to 3 volts between chassis and the negative end of the stabilising condenser. It will probably be necessary to repeat the alignment process several times before final results are obtained.

It is possible to adjust the cores of the i.f. and discriminator transformers to approximately correct positions with the aid of a metal screwdriver; but final adjustments *must* be carried out with a screwdriver made of insulating material. Indeed, it may be found that the insertion of a metal screwdriver causes slight instability when the i.f. stages are nearly at their peak settings. An insulated screwdriver can be made quite easily from a plastic knitting needle or similar object.

After the i.f. stages and discriminator primary have been peaked, the signal generator should be rocked on either side of 10.7 Mc/s. Response, as shown by the voltage across the stabilising condenser, should then be reasonably flat for approximately 100 to 150 kc/s on either side of centre frequency, falling off symmetrically for further deviations.

The discriminator secondary core has now to be adjusted. The correct position of adjustment will be given when the voltage across C_{35} (i.e. between chassis and the audio take-off point) is equal to zero. When the test arrangement shown in Fig. 12 is employed, the bias battery tapping should be adjusted to give approximately half-scale reading in the meter when the two test leads are short-circuited. Zero voltage then corresponds to this reading.

The signal generator should now be reset to 10.7 Mc/s and the discriminator secondary (bottom) core adjusted, with an insulated screwdriver, for zero voltage across C_{35}. When this position has been found, the signal generator should be rocked on either side of centre frequency. Rocking the signal generator one way should cause a positive voltage to appear at the audio take-off point, rocking it the other way should cause a negative voltage to appear. If this does not occur, the discriminator secondary is probably right outside the i.f. pass-band, and its core should be adjusted again. It will be noted that there is a diminution in modulation a.f. from the amplifier loudspeaker as the discriminator secondary core approaches its correct position.

The fact that a.m. modulation may still be heard at the correct setting of the discriminator secondary core does not necessarily infer that the a.m. rejection properties of the circuit are poor. Many signal generators give an appreciable amount of f.m. in addition to their nominal a.m.

The alignment of the i.f. strip is now complete, and the transformer cores should not need to be touched any more. Any attempt to re-trim the i.f. stages on received signals will only upset the alignment and cause inferior results to be obtained from the receiver.

R.F. Alignment

The signal generator should now be disconnected from the receiver. The next section of this article describes the alignment of the r.f. circuits with the aid of received signals. The process of alignment with a signal generator will be discussed later.

The volume control of the amplifier to which the tuner is connected should now be turned to its maximum setting. V_1 should be inserted into the tuner unit and allowed to warm up. An aerial should next be connected to the aerial input socket. (In areas

of good signal strength, a few feet of wire laid on the bench may prove to function quite adequately as an aerial.)

It should now be possible to hear a quiet hiss from the amplifier loudspeaker. Trimmer C_6 should be set to approximately half-capacity, and the core of L_3 adjusted such that several threads are visible above the top surface of its can. The tuning condenser is next set to approximately half-capacity, and the cores of L_1 and L_2 adjusted for maximum hiss from the loudspeaker.

The tuning condenser should then be swung over its travel until a signal is heard. If no signal is picked up, the core of L_3 should be screwed in, several turns at a time, and the whole process continually repeated. Should nothing at all be heard when the core of L_3 has been inserted well into its coil, either the aerial pick-up is insufficient or a fault condition exists.

Once a signal has been picked up it should be identified. The core of L_3 is then adjusted until this signal occupies its proper position on the tuning scale; following which the tuning condenser should cover the correct frequency range of 88 to 100 Mc/s, with a comfortable margin outside the band at either end.

and the trimmer at the low-frequency end. It will probably be necessary to repeat the process several times before alignment is complete.

In areas of strong signal strength, final adjustments to the r.f. circuits should be made with a reduced input. This reduced input may be obtained with the use of a less sensitive aerial.

To assist the constructor in aligning his receiver, Fig. 14 shows typical frequency/scale readings for the prototype. The scale readings (0–100) are those given with the Jackson Bros. tuning dial. Due to the fact that relatively low tolerance condensers are employed in the oscillator circuit, individual receivers may not give frequency/scale readings *exactly* similar to that shown in this diagram.

Signal Generator

As will be readily understood, the process of r.f. alignment with received signals does not vary greatly from that needed for alignment with a signal generator covering Band II on fundamentals.

When a signal generator is employed, care should be taken to ensure that its output is sufficiently attenuated before being applied to the aerial input terminals of the tuner unit.

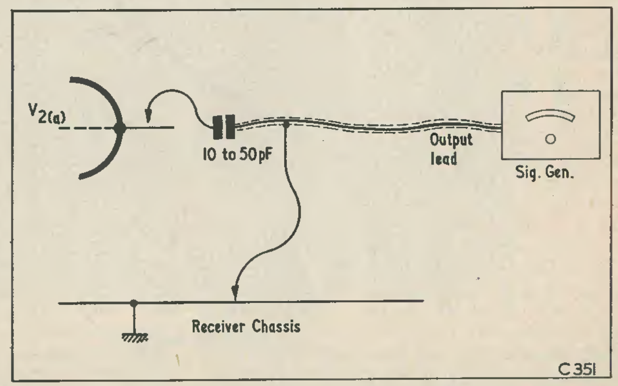


Fig. 13. Recommended method of connecting the signal generator output to the receiver when aligning the i.f. strip

After the oscillator coil has been correctly adjusted, the aerial coil, L_1, should be aligned. This is carried out by the simple process of setting the tuning condenser to mid-scale and adjusting the core of the coil for maximum hiss. Alternatively, if there is a signal near the mid-scale position, L_1 may be adjusted for maximum signal strength. The flat tuning of L_1 will then allow adequate gain over the band of frequencies being received.

The final process required is that of adjusting C_6 and the core of L_2. The best way of tackling this consists of adjusting the core at the high-frequency end of the band,

With the more inexpensive type of signal generator it frequently happens that it is impossible to obtain a sufficiently low output, owing to the inherent self-capacity of the attenuator network in the instrument itself. In such cases a low input to the receiver may be achieved by refraining from using a direct connection to the aerial circuits at all; sufficient coupling being given by positioning an unscreened wire, connected to the signal generator output, close to the receiver input wiring.

Many signal generators will exhibit an appreciable amount of f.m. at Band II frequencies, whereupon the r.f. stages may be aligned for maximum volume in the speaker. However, a more accurate method would, of course, consist of aligning for maximum voltage at the stabilising condenser. In all cases, the signal generator output should be kept as low as possible during alignment, to prevent the a.g.c. circuit, or the partial limiter valve, from affecting readings.

Care should be taken to ensure that the oscillator frequency is *above* the signal frequency. The procedure, just described, of commencing with the oscillator core protruding from its can should, however, ensure this point. L_1, L_2 and C_6 are aligned as in the previous instructions.

If a higher degree of a.m. rejection is required, it is necessary to replace R_{19} by a resistor whose value is found experimentally, whilst a signal which is both amplitude and frequency modulated is applied to the discriminator.

The simplest method of obtaining such a signal consists of injecting an a.m. signal into the receiver whilst it is tuned to an f.m. programme under normal conditions of reception. The a.m. signal may be obtained from a signal generator set to 10.7 Mc/s, whose output is connected to the grid of $V_{2(a)}$ via a condenser of 10 to 30 pF. (This method of connection should not prevent the receiver from working, although it might cause the strength of the received signal to drop slightly.) Alternatively, a source of a.m. interference, such as a buzzer, may be positioned close to the aerial input circuit.

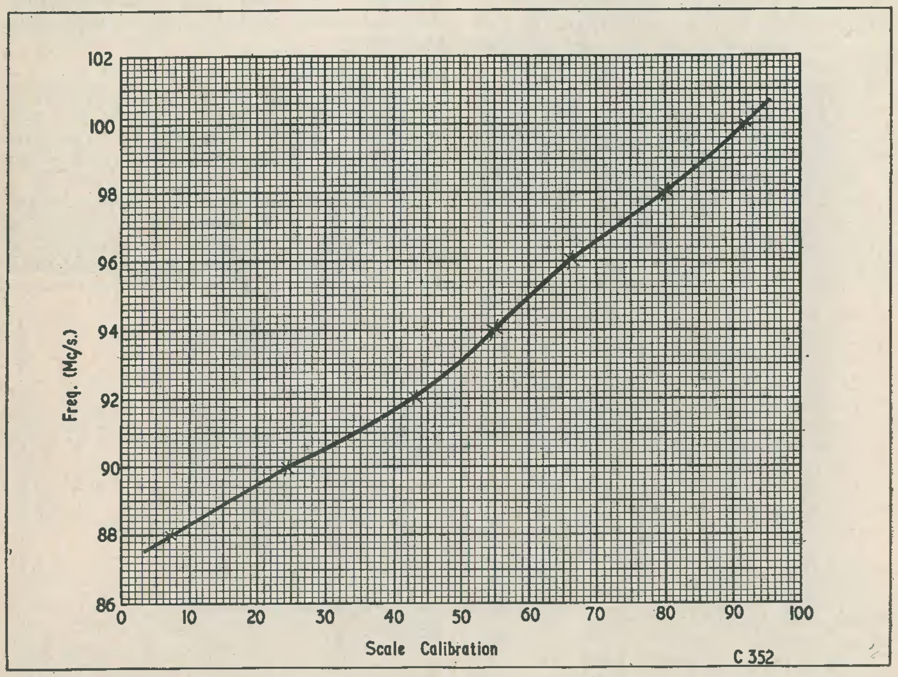


Fig. 14. Frequency/scale readings given by a typical Challenger f.m. tuner unit

Finally, it is advisable to use a signal generator which covers Band II on fundamentals. If a signal generator covering Band II on harmonics is employed, it is sometimes possible to waste quite a lot of time working with an incorrect harmonic.

A.M. Rejection

As was mentioned in the first article in the series, the discriminator stage, as it stands, gives quite good a.m. rejection. The rejection characteristic should certainly be adequate enough for good results in most areas of reception.

The resistor R_{19} is then replaced by a $5k\Omega$ carbon-track variable resistor. The latter is connected into the circuit by short, temporary leads; and is adjusted for maximum a.m. rejection. It is then removed from the circuit, and the resistance to which it has been adjusted is measured. A fixed resistor of the same value is then soldered permanently into the circuit.

TELEVISION for the HOME CONSTRUCTOR

PART 2 *by* S. WELBURN

This month S. Welburn, our popular writer on television topics, introduces a discussion on frame scanning problems, paying particular attention to the question of non-linearity. He approaches his subject from the point of view of the amateur designer as well as from that of the constructor

Since the author of this article commenced to write for *The Radio Constructor* he has been impressed by the keen interest shown by readers in all matters relating to television. Quite a few of these readers have corresponded with him and he has been able to gain an insight into the topics which hold most interest in practical construction circles.

As is to be expected, a considerable amount of amateur work centres around the scanning circuits of television receivers, many experimenters either employing components which are well-known in the home-constructor market, or which have been obtained from normal domestic receivers or similar sources. A point that is raised frequently in readers' letters concerns frame scanning techniques, it being pointed out that these are usually given rather less space in the constructional press than are such things as line circuits. On reflection, it does appear that frame scanning circuits are not extensively featured these days, and the writer would like to attempt to make up for this deficiency by devoting some time to them in this and next month's contribution.

What it is intended to discuss in these two articles are the basic circuits which appear in almost all frame scanning arrangements, together with an examination of the several faults which can appear in such circuits. Of these faults, the most difficult to clear is frame non-linearity, and much of the present article will deal with this point.

The Frame Output Stage

In its basic form, the conventional frame output stage can be represented by the simplified circuit shown in Fig. 1. In this diagram a discharge valve, shown here as triode V_1, is controlled by the frame timebase; and it provides a sawtooth waveform by initially discharging the condenser C_1 at the arrival of each frame sync pulse. After this discharge, V_1 becomes cut off again, and the condenser C_1 commences to charge up, via the series resistor R_1, until the arrival of the next sync pulse results in V_1 discharging the condenser once more. As was just mentioned, the discharge triode V_1 is controlled by the frame timebase (whose frequency is, in its turn, controlled by the frame sync pulses), and it can even, itself, be an integral part of that timebase. However, for our purposes here it is sufficient to consider it in the light of a discharge valve only.

Due to the slow rise in voltage across C_1 as it charges up, and the quick fall as it is discharged, a sawtooth voltage appears across this condenser. This sawtooth voltage is applied to the grid of the frame output valve V_2, whose function it is to amplify the waveform and provide sufficient power in its anode circuit to allow it to be applied via the frame output transformer L_1, L_2, to the frame deflector coils L_3, L_4.

Problems

At first sight it might seem that the circuit of Fig. 1 has quite a simple job to do, and that little trouble would be experienced in making it work efficiently in practical form. Unfortunately, such is by no means the case, and it is a fact that one of the most difficult circuits to design in a television receiver is the frame output stage. There are several reasons for this; probably the most important being the necessity of obtaining good frame linearity. (By frame linearity is meant the degree of accuracy with which the frame circuits deflect the electron stream of the c.r.t. during the frame scan. Perfect frame linearity would be given when all the vertical dimensions in the picture corresponded exactly to those presented to the camera.)

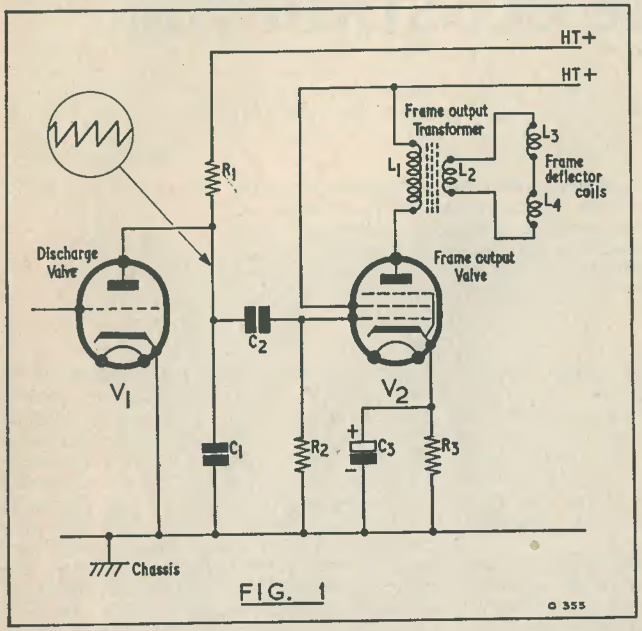


Fig. 1. Simplified diagram illustrating a basic frame output stage

The accuracy of frame linearity may be ascertained quite easily when Test Card C is being transmitted, it being checked by comparing the heights of the individual squares. Whilst the circle at the centre of Test Card C is of advantage for quick checks of frame linearity, it does not enable an examination of the top or bottom of the picture, where frame non-linearity is frequently most prominent, to be made. As readers will appreciate, non-linearity at the top of a picture can be especially annoying, since it frequently happens that more attention is given here, where performers' heads may appear, than elsewhere. Thus, it is always worth while to finally confirm the accuracy of frame linearity by checking the heights of the squares rather than by relying entirely on the circle of the Test Card.

Frame Non-linearity

Before proceeding with an examination of possible causes of frame non-linearity, let us first consider the sawtooth waveform which is applied to the frame output grid, i.e. that appearing across C_1 in Fig. 1.

As we have just seen, this waveform is generated by the quick discharge and slow charge of C_1. Fig. 2 (*a*) represents the case in greater detail. At point A in Fig. 2 (*a*) we assume that the frame timebase has been triggered by a sync pulse, and that the discharge valve has become conductive. The voltage across C_1 rapidly drops until it reaches point B. The discharge valve then becomes cut-off by the action of the frame timebase, and the voltage across C_1 commences to rise slowly until it reaches point C. At point C the discharge valve conducts once more and another cycle commences.

It is interesting to note what would happen if C_1 were allowed to charge up to the full h.t. energising voltage available. If this were to happen the voltage across C_1 would continue to rise at point C instead of dropping, and it would follow the dotted line of Fig. 2 (*a*), until it finally approached the full energising voltage at point D.

The shape of the dotted line C–D of Fig. 2 (*a*) is, of course, part of the well-known exponential curve given by the voltage across any condenser when it is charged up via a series resistor. Line B–C is the first part of this exponential curve and it is, in consequence, non-linear by definition. However, if we arrange things such that line B–C occupies only a small amount at the beginning of the exponential curve we can obtain a result

which approaches perfect linearity.

A snag which has to be considered, so far as linearity is concerned, is caused by the necessity for having a frame height control. One of the most convenient ways of controlling frame height consists of varying the amplitude of the sawtooth waveform developed across C_1. This amplitude can be varied by adjusting the energising voltage applied to the series resistor R_1. A commonly-used frame height control circuit is shown in Fig. 2 (*b*).

The arrangement of Fig. 2 (*b*) has one or two rather weak points, the more obvious being that, as the slider of R_4 is adjusted, the amount of resistance between the top plate of C_1 and the h.t. supply is altered also. In consequence, although the height control varies sawtooth amplitude, it can also vary the proportion of the total exponential curve occupied by the slow rise section of the sawtooth waveform. Most designs, both commercial and home-constructor, employ

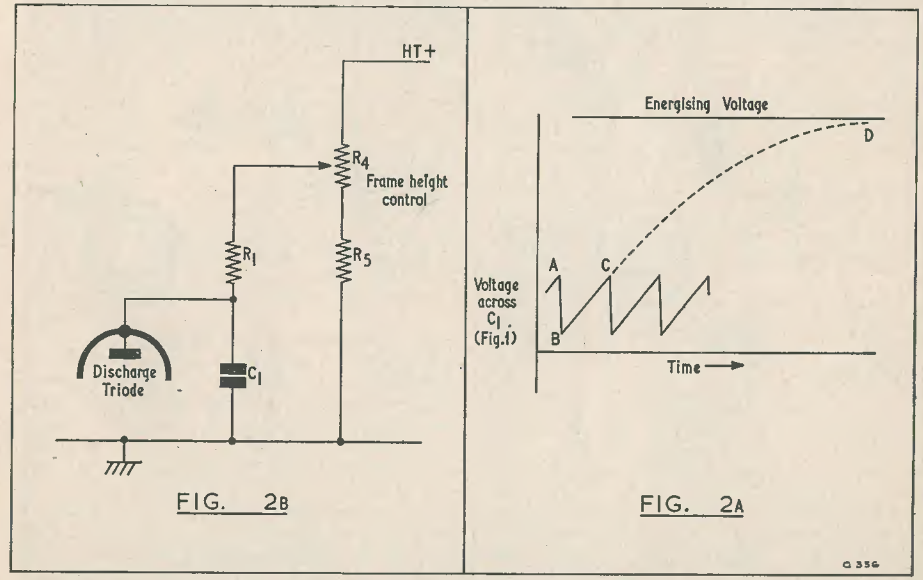


Fig. 2 (a). An analysis of the sawtooth waveform appearing across C_1 of Fig. 1.

Fig. 2 (b). A typical frame height control

potentiometers having values around 1 to 2MΩ for the R_4 position of Fig. 2 (*b*), with resistors of 250 to 750kΩ in the R_1 position. Such a choice can cause the linearity of the sawtooth waveform to alter as the height control is adjusted.

Summarised, it may be said that the waveform applied to the grid of the frame output valve is not perfectly linear, although it may frequently be made to approach this state. Also, the linearity of the sawtooth waveform can be affected by the conventional circuits for frame height control.

The Frame Output Transformer

Having passed our sawtooth waveform (which may, itself, be non-linear) to the grid of the frame output valve, we now require this valve to amplify the waveform without introducing too much distortion on its own account, and to apply it, still undistorted, to the scanning coils via the frame output transformer. In practice, it is rather unfair to expect a single-ended output stage to perform this feat perfectly because, amongst other things, the dynamic mutual conductance of the frame output valve depends upon the load which is presented to its anode, and the reactance of the conventional frame output transformer primary can hardly be described as being that of a linear device.

The frame output transformer, in its turn, is expected to transform the sawtooth waveform appearing at the anode of the frame output valve to the impedance of the frame deflector coils, again with the introduction of as little distortion as possible. It might be said that this task really calls for a component made on the lines of the output transformer of a high fidelity amplifier, but such a choice would be unwelcome here owing to the high cost involved. In conventional televisors a compromise is made, and the frame output transformer is designed to have a high primary inductance; whilst the saturating effect of the d.c. component in its primary on the permeability of its core is minimised by using laminations assembled in butt-joint fashion. A butt-joint transformer assembly simply infers that all the "E" laminations are fitted on one side of the coil, and all the "I" laminations on the other. (The same would apply if "U" and "T" laminations were used.) A small amount of "gapping" is then allowed between the junction of the "E" and "I" laminations, this preventing the formation of a complete magnetic circuit. A butt-jointed transformer does not normally have as high an inductance at a.c. as does an "interleaved" transformer (where the "E" and "I" laminations are fitted alternately), but its core permeability does not drop so readily when d.c. flows through its windings.

non-linearity into the waveform applied to the frame output grid (the waveform itself not being above suspicion), it would appear on the face of things that the provision of a really linear frame scan is liable to be an extremely difficult matter indeed.

In practice, this is not very far from the truth! Indeed, a considerable amount of television design and development time is devoted to improving frame linearity alone. From the point of view of the constructor-designer, some of the techniques employed for this purpose should prove to be of interest.

There is, usually, a large amount of spare power available in the frame output stage, and it becomes possible, in consequence, to use negative feedback for purposes of linearisation to quite a considerable extent.

The simplest method of applying negative feedback is from the anode of the frame output valve to its grid, via an R–C network. It is

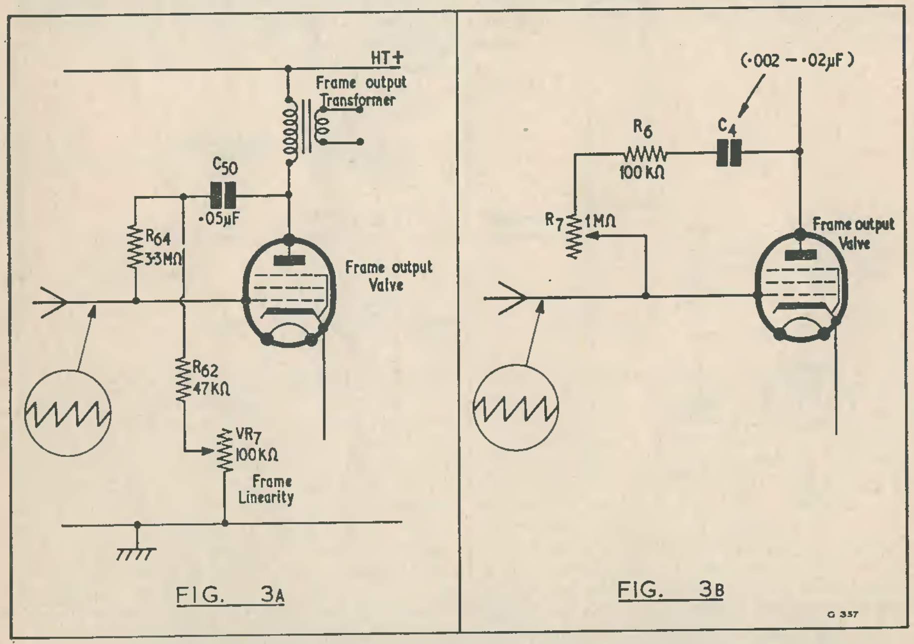


FIG. 3A FIG. 3B

Fig. 3 (*a*). *A negative feedback linearising arrangement, which is discussed in the text. The circuit is that employed in the "Universal" televisor, and the component references apply to this receiver. Fig.* 3 (*b*). *An experimental linearising "add-on" circuit which may often be successful in correcting non-linearity at the top of the picture. In this and Fig.* 3 (*a*), *it is assumed that a grid leak of conventional value is fitted*

Improving Frame Linearity

Since, as we have just seen, the average frame output stage employs components which can introduce a considerable amount of possible to choose the values of components employed in this network such that their time constant becomes a function of the frame scan cycle itself, whereupon, with a little juggling of component values, the feedback loop can be made to modify one part of the scan more effectively than the rest.

A typical n.f.b. arrangement is illustrated in Fig. 3 (*a*). In this circuit feedback is applied to the grid of the frame output valve via C_{50}, linearity control being effected by VR_7. This circuit, incidentally, is part of that employed in *The Radio Constructor* "Universal" receiver, and it affords a good insight into normal practice. As it stands, the circuit of Fig. 3 (*a*) should be capable of application in principle to quite a number of frame output circuits, even when these employ different components to those used in the "Universal." Since the time constant of the circuit can be made such that the amount of negative feedback varies during the frame scan cycle, the most useful field of experiment in alternative applications is afforded by varying the value of C_{50}.

Non-linearity at the top of the picture may sometimes be cleared by employing a feedback circuit containing a relatively low value of capacity. A typical arrangement, which could be *added* to that of Fig. 3 (*a*), or to any other existing circuit, is shown in Fig. 3 (*b*). Suggested values are given, but it might be necessary to diverge from these in individual cases. Whilst no guarantee of performance is offered for the circuit of Fig. 3 (*b*), it is one that is well worth trying for difficult cases of non-linearity. A high value for R_7 is shown in the diagram, but this may be needed only in the first experimental stages. When the optimum position for R_7 is found, the value of this component can be reduced to allow a smoother control, and that of R_6 adjusted accordingly.

It must always be remembered, when attempts are made to improve frame linearity by the application of n.f.b., that such feedback reduces the gain of the frame output stage. Because of this, whilst additional feedback may be apparently beneficial at first sight, it can necessitate an increase in the amplitude of the waveform at the frame output grid. The linearity of this waveform may, as was mentioned above, then alter due to its increased amplitude, whilst there is also the risk of over-running the frame output grid. Because of these points, *too* much feedback may introduce more non-linearity than it cures. As frequently occurs in radio and television design, a compromise has to be reached; but this should normally be fairly easily arrived at by experiment.

Next Month—and a Review

We have only just superficially examined the question of non-linearity and other frame scanning problems in this month's article, but it appears that we have now reached the end of our available space. Next month, therefore, we shall continue with this subject; and it is hoped to introduce some aspects which do not normally appear in constructional articles.

Before finally concluding, however, the writer would like to review a particularly useful little device which has now become available. This is the Osmor Band I Filter, a single high-Q tuned filter capable of being adjusted to reject any frequency in Band I by means of its own self-contained trimmer. The device is contained in a neat metal case, the latter being fitted with a 75 Ω coaxial plug at one end, and a similar socket at the other. The filter is intended to prevent Band I signals being passed through the circuit of a Band III–Band I converter; although it could also, of course, reject the passage of Band I interference signals in the reverse direction. It should be plugged into the Band III aerial socket of the televisor-converter combination, and the Band III aerial plugged into the socket of the filter. The filter trimmer is then adjusted for minimum Band I interference on vision and sound.

The writer has tested this filter under semi-laboratory conditions. He has found that it is capable of offering a very high degree of rejection indeed at any Band I channel to which it is tuned; whilst attenuation to Band III signals is negligible in all cases. Unfortunately, the equipment available at the time of the check did not allow an absolute measurement of Band I rejection to be made, although it may definitely be stated that this is well in excess of 30 db. The writer would not be surprised if the actual rejection figure was greater than 40 db. Such figures definitely provide a commendation for the efficiency of the device.

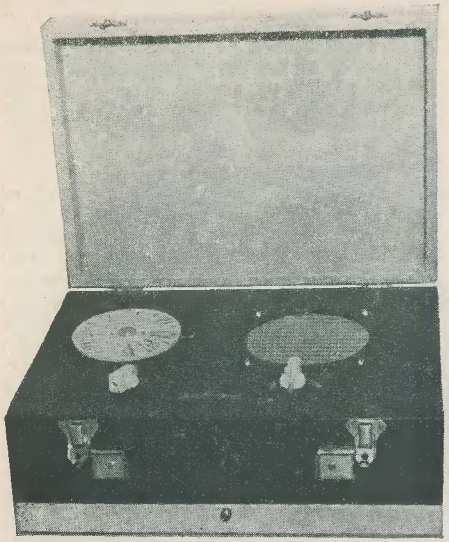
A Useful New Wavemeter

The GM.3121 absorption wavemeter now available from Philips Electrical Limited can be used for measuring frequencies between 2.5 and 260 Mc/s, and also as a test oscillator with or without internal modulation at 100 c/s.

There are seven overlapping frequency ranges, each covered by means of a plug-in coil unit; accuracy is better than 2%.

The tuning scale is directly calibrated in frequency. Resonance is indicated by neon tube, and there are also sockets for plugging in a head-set or valve voltmeter.

The individual coils are housed in the lid which, like the case, is black plastic. Measuring 9¼in long × 3¼in wide × 3½in deep (including lid), the GM.3121 weighs 3 lb complete. It operates from 110 or 220V, 50 c/s mains.



Building The HIWAYMAN PORTABLE

PART 2

by **P. VERNON**

IN LAST MONTH'S ISSUE OF THE MAGAZINE we covered the assembling of the component parts and also stages one and two of the actual wiring process. In this final instalment, stages three and four are fully described together with the lining-up details.

Having first carefully checked the wiring in both stages one and two, proceed to wire the next two stages as described below.

Wiring Instructions—Stage 3

Solder pin 2 of V_4 to tag A of the output transformer via the grommet G_3, and also wire tag 1 of S_1 direct to tag 3 of the tag strip. From tag 2 of the tag strip, solder a length of wire direct to tag B of the output transformer (see Fig. 5).

Solder R_{11} between pin 6 of V_4 and tag 5 of the tag strip, following this by wiring R_{10} between tags 3 and 5 of the tag strip. Note the layout of these components from the point-to-point diagram.

Connect a length of wire from tag 5 of tag strip to pole A of S_2. Connect pins 4 of the Long and Medium Wave coils together and from there connect these to pin 3 of V_2. Insert and solder C_{10} between middle tag of R_6 (potentiometer) and pin 6 of V_3.

To fit the battery leads, proceed as follows: solder the blue lead to pole D of S_2, the black lead to pole C of S_2, the red lead to tag 2 of tag strip and the green lead to tag 4 of tag strip.

Solder the other ends of these respective leads to the battery plugs, as shown in Fig. 5, by taking the bared end of the wire through the end of the plugs and soldering them at the tips. The battery plugs on the diagram are viewed from the flat end, i.e., opposite the tips.

Mount the paxolin ferrite-rod aerial fitments above and to the rear of the chassis and insert in each a rubber grommet. Insert into the rubber grommets each end of the ferrite-rod aerial, ensuring that L_2 is nearest the speaker (see Fig. 6). Having done this, apply a coat of "Durofix," or other similar fixative, to the ends of the ferrite rod material and to the rubber grommets, thus ensuring that the whole assembly will remain firmly in place. Allow the fixative to dry thoroughly before proceeding with the wiring of the aerial connections.

Components—Stage 3

Resistors
R_{10} 820Ω ¼ watt
R_{11} 2.2MΩ ¼ watt
Speaker Fret Material 5in × 5in.
3-pin battery plug
2-pin battery plug
Condenser
C_{10} 0.001μF, Ceramic
Repanco Ferrite-Rod Aerial
5in Speaker, Elac
Insulated Wire and Sleeving

To complete the wiring of the ferrite-rod aerial, solder the red wire to pole C of S_1, the blue wire to pin 2 of S_1, the green wire to pole A of S_1 and the black wire to pole B of S_2. With this completed, wire the loudspeaker to tags C and D of the output transformer.

This completes the wiring for stage 3, and readers constructing this stage should again carefully check the instructions above,

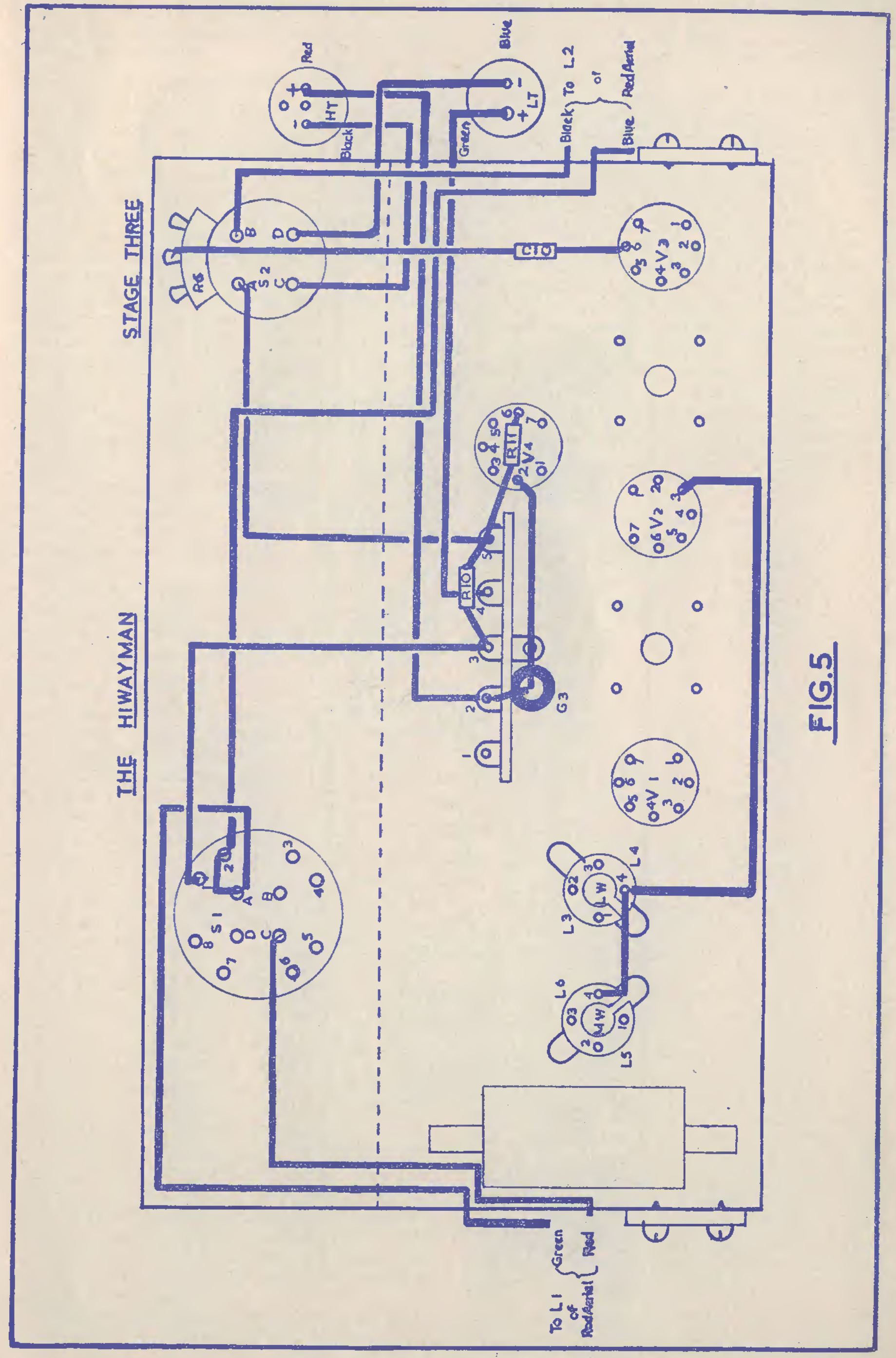
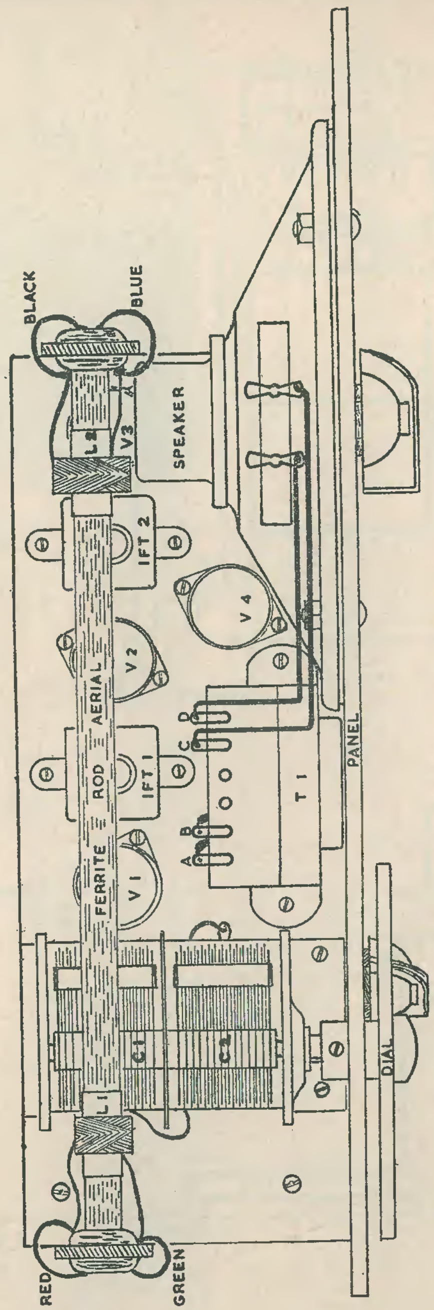


FIG.5



THE HIWAYMAN

FIG.6

TOP VIEW

together with the diagram and their own work, before proceeding on to the next phase of construction.

Stage 4—Fitting the Control Panel

In the first instance, remove from the chassis the two nuts which hold the wavechange switch and the volume control. Now, fit the front panel over the threaded portion of these two components, taking care not to turn or push either the switch or the volume control out of position. Having done this, secure the front panel with the nuts previously removed from the components.

To fit the dial on to the spindle of the tuning condenser, proceed as follows: fully open the moving vanes of the condenser and, while holding the vanes in this position, fit the dial to the spindle by means of the grub screw provided, at the same time ensuring that the dial is set reading the Third Programme, just below 200 metres. Secure the dial in this position.

The loudspeaker should next be fitted to the case by means of four 4BA chrome nuts and bolts, with the speaker mesh material placed between the speaker itself and the control panel.

Insert the valves as follows: V_1, 1R5; V_2, 1T4; V_3, 1S5 and V_4, 3V4. Having done this, plug in the h.t. and l.t. batteries, proceeding with the alignment details as described under.

Alignment Procedure

As previously stated in Part 1, the i.f. transformers have been aligned at 465 kc/s by the manufacturer and the cores secured, and no further adjustment should therefore be required.

1. Switch to the Long Wave band and turn the dial to the Light Programme, i.e., 1,500 metres. Adjust the Long Wave oscillator coil core until the programme is heard.

2. Slide the Long Wave aerial coil (L_2) along the ferrite rod until the volume is at maximum strength.

3. Turn the dial to Luxembourg on the Long Wave band (1,287 metres) and adjust the trimmer TC_4 until the programme is heard.

4. Adjust the aerial trimmer TC_1 to obtain maximum volume.

Having completed the above instructions, repeat the procedures 1 to 4 until no further improvement in volume can be made.

5. Switch to the Medium Wave band and choose a local station between 400–500 metres. Set the dial to this station wavelength and adjust the Medium Wave oscillator coil core until the station is heard.

6. Slide the Medium Wave aerial coil (L_1) along the ferrite rod until the volume is at maximum strength.

7. Select a local station lying between 200–300 metres. Set the dial to this station wavelength and adjust the trimmer TC_3 until the station programme is heard.

8. Adjust the aerial trimmer TC_2 for the maximum volume.

Repeat the procedures 5 to 8 until no further adjustments are necessary.

Having obtained the best results on both of the wavebands, secure the aerial coils to the ferrite rod material by applying a little "Durofix" or other similar fixative.

Due to the high performance and selectivity of this receiver, it was found necessary to move the trimmers and cores very slowly, it being an easy matter to miss the required stations used in the lining-up process should the adjustments be carried out rather quickly.

The alignment completed, it only remains to fit the batteries into the case in order to complete the job. To do this, the batteries should be fitted into the right-hand side of the carrying case, with the h.t. at the front and the l.t. at the rear. The batteries themselves are secured into position with the clips provided with the kit.

Components—Stage 4

Portable cabinet with control panel
H.T. Battery, Vidor type L.5512
L.T. Battery, Vidor type L.5040
$\frac{3}{8}$in wood screws (4)
$\frac{1}{2}$in RH chrome bolts and nuts (4)
Battery Clips

Valves

V_1	1R5
V_2	1T4
V_3	1S5
V_4	3V4

Conclusion

The construction of this portable receiver, as outlined in the two instalments published in this and the previous issue of the magazine, is undoubtedly an easy matter for the average home constructor. Indeed, the whole project has been so designed to this end. Even the veriest beginner, by carefully following the instructions and the point-to-point wiring diagrams presented here together with the photographs, should find no difficulty whatsoever in building and aligning this very attractively styled portable receiver.

The purchase of the kit of parts is made easy by virtue of the fact that several retailers are currently offering these—see advertisements. It is supplied complete down to the last nut and bolt and, being easy to assemble, with the chassis, cabinet and front panel being pre-punched, no tools are required other than a soldering iron, cutter/pliers and a screwdriver in order to completely build the entire receiver in a matter of hours.

Errata. Tag 6 of I.F.T.2, Fig. 1, p. 773, July issue, should be connected to H.T.+.

TRANSISTORISED A.F. TEST PROBE

by **R. J. CABORN**

An instrument which can be particularly useful in both service and amateur workshops is provided by the a.f. oscillator, or tone generator. Such an instrument can be employed to check new amplifiers and receivers, to test faulty equipment, and to assist in many other commonly encountered tasks. Unfortunately, many a.f. oscillators, even in their simplest form, tend to be bulky and expensive; these facts rendering them less attractive to the radio engineer than would otherwise be the case. So far as this bulk and expense are concerned, the former is usually caused by the necessity for a power supply, whilst the latter is the result of the relatively large number of components required by even an elementary oscillator.

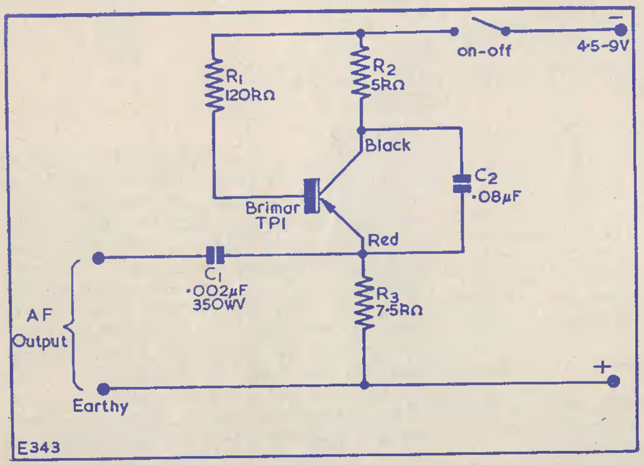


Fig. 1. The complete circuit of the transistor a.f. oscillator

The two disadvantages just quoted can be obviated almost entirely nowadays, owing to the release on the home-constructor market of relatively inexpensive and reliable transistors. The writer has undertaken a number of experiments with these devices and, amongst other things, has developed a transistor a.f. oscillator circuit which is, he feels, just about as simple as it possibly can be. The circuit is particularly applicable to a.f. signal injection technique, and all the components involved could be fitted into a container little larger than a "fountain-pen type" flash lamp. The device should prove to be especially attractive for those who carry out servicing work away from their workshops, although many other uses can be visualised as well.

Circuit Details

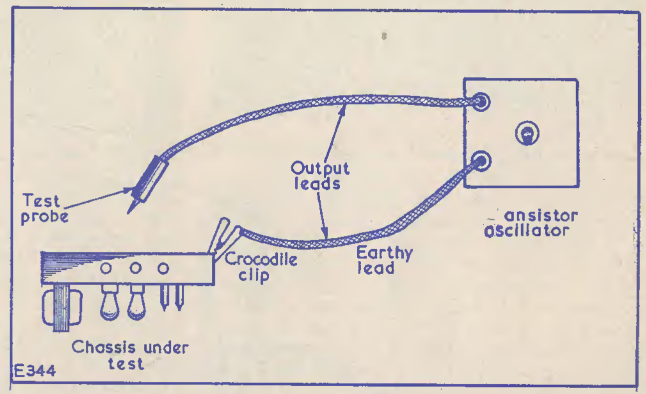
The circuit of the a.f. oscillator is given in Fig. 1. As will be noticed, a Brimar point contact transistor type TP1 is employed, this having been found by the writer to give best results in this particular application. The remainder of the components consist of two condensers and three resistors, all of which may be miniature types. The battery supply should have a potential lying between 4.5 and 9 volts, 6 volts being that recommended for best all-round results. The reason for specifying this particular voltage is that increases in battery potential above 6 volts cause little increase in a.f. output and, therefore, provide no advantage. The circuit ceases to oscillate below 4 volts approximately, and the current drain at 6 volts is only 0.4mA. Deaf-aid cells would be an excellent choice for providing the operating potential if it was decided to make the oscillator a truly miniature instrument.

The circuit operates as a relaxation oscillator. All the transistor elements are "floating," the transistor being intended to function mainly as an earthed emitter amplifier. Bias is applied to the base of the transistor via the 120kΩ resistor R_1. Due to the fact that resistance is inserted in the emitter circuit, it is possible for an a.f. voltage to appear at the emitter as well as at the collector. Unlike the grid and anode of a valve, the emitter and collector work in the same phase; i.e. when the emitter goes positive so also does the collector. The emitter and collector are coupled together via the condenser C_2, this providing sufficient coupling to enable the device to function as an oscillator. The a.f. output of the oscillator is taken from R_3, and its waveform is largely saw-tooth in character. (It will be noted, incidentally, that the output of the oscillator is at quite a low impedance, this being an advantage for many applications). The frequency of oscillation depends mainly upon the values of R_2, R_3 and C_2, together with the internal resistance of the battery and the inherent resistance in the transistor itself. Since the latter changes with applied battery voltage, the frequency of the note generated changes also if the battery voltage is altered. However, the note remains constant during long periods of use, the only possible variation which could be caused being that given by an exhausted battery.

The circuit of Fig. 1 was developed entirely along experimental lines. Several "text-book" arrangements were checked, but did not provide sufficient amplitude of oscillation for the low battery voltages that the writer wished to employ. The component values shown in Fig. 1 were determined experimentally also, and gave optimum performance with the particular transistors available to the writer.

The component which provides greatest control over the frequency of the tone generated by the oscillator is the condenser C_2. The value shown in the diagram for this condenser, 0.08μF, allows a note of approximately 1,000 c/s to be obtained with a 6 volt supply. It is possible that some transistors may give differing results than those employed by the writer, in which case slightly different values for C_2 may be used to give the oscillation frequency desired. (This point is discussed in more detail later in this article). If a single 0.08μF condenser is not available to the constructor, two or more condensers may be combined in series or parallel to obtain the requisite capacity.

Fig. 2. A suitable method of connecting the oscillator to a chassis under test



Operation

In use, the oscillator may be connected up to the gear it is intended to check in the manner illustrated in Fig. 2. In this diagram the "earthy" output lead of the oscillator is connected to the chassis of the amplifier or receiver under test, the "hot" lead then being employed to prod the appropriate points in the amplifier chain.

The output of the oscillator is just sufficient to actuate a loudspeaker if it is connected to the primary of the speaker transformer. Thus, if the prod of Fig. 2 is connected to the output anode of the amplifier or receiver under test, a tone will be heard from the loudspeaker. Applying the probe to the grid of the output valve should cause a loud tone to be heard. The probe may then be applied to earlier stages until the faulty section has been located.

Setting Up the Oscillator

Since transistors need to be handled with a little care, it is advisable to take a few more precautions when testing the oscillator after construction has been completed than would be necessary if a valve were employed.

Before connecting up to a battery, the wiring to the transistor should be checked for mistakes, etc. The oscillator output should then be connected to any convenient a.f. amplifier. Ensuring that correct polarity is observed, the battery may next be connected up and the oscillator switched on. An a.f. tone should at once be heard from the loudspeaker of the amplifier. The current taken by the transistor oscillator may than be checked, if desired, by inserting a milliammeter in series with either of the battery leads. The consumption at 6 volts should not be greater than 0.6mA if all is working correctly.

As was mentioned above, the frequency of the tone generated may be varied by altering the value of C_2. Increasing C_2 will cause the tone frequency to be lowered. It is possible to lower the frequency to 1 c/s or less by fitting a sufficiently high-value condenser in the C_2 position; but there is the possibility that such a low frequency may cause high current surges in the transistor during each cycle. In consequence, it is advisable to guard against this condition by altering the value of C_2 in small steps only.

It is important to remember that the battery supply should always be disconnected when making any adjustments to components in the oscillator circuit. Otherwise, surges may occur due to handling, with possible damage to the transistor.

A Miniature Probe

The writer has made his own particular oscillator up in a small box with two output test leads; but there is no reason why the device could not be made even more compact than this, if so desired.

A particularly attractive idea, and that which influenced the choice of title to this article, is suggested in Fig. 3. In this diagram the transistor, with its components, is mounted in a small insulated tubular container, miniature deaf-aid cells being fitted at the top. In use, the fly lead of the probe is clipped to the chassis of the equipment under test, and the probe applied directly to the circuit point to be tested. The oscillator can then be switched on as desired by means of a small switch at the top of the assembly.

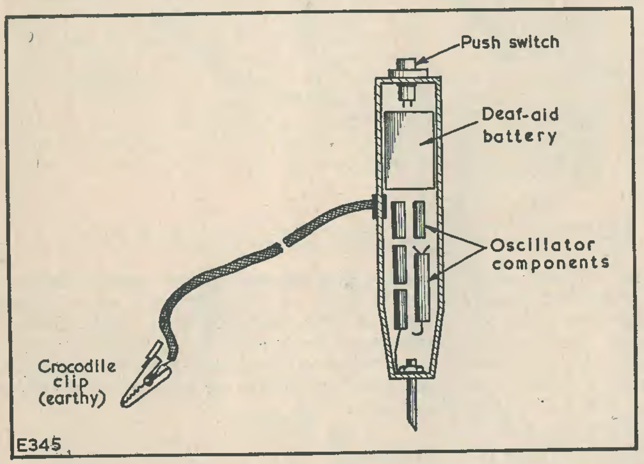


Fig. 3. Cross-section, showing a suggested method of fitting the oscillator into its own probe case

New Miniature Components

Constructors who are interested in experimenting with miniature apparatus using transistors will be glad to learn of two new items now available. The first is a miniature two-gang condenser, type O, by Jackson Bros. This has a maximum capacity of 365pF per section, and measures $1\frac{7}{16}$in wide, height above chassis 1½in, and depth behind panel 1⅞in. The spindle is ¼in diam. and ⅝in long. It lists at 11s.

The second item is a range of miniature electrolytic condensers by Daly, the smallest of which is ¼in diam., by 1¼in long; this size covers capacities up to 25μF 25V wkg., with smaller capacities at higher working voltages. Examples are 50μF 6V at 1s. 6d., 5μF 12V at 1s. 4d., 25μF 25V at 1s. 7d., and 2μF 150V at 1s. 6d. The complete range comprises 35 different combinations, all 1¼in long, and the largest diameter ½in.

New Approach to Equalisers

by **R. V. COATES, B.Sc.**

Reason for Equalisation

All modern records are cut with a velocity/frequency characteristic of the general form shown in Fig. 1. In the bass the velocity is reduced at a rate tending to a maximum of 6 db/octave in order to restrict the groove-deviation amplitude to a constant amount; in the treble the velocity is increased at a rate tending to 6 db/octave to increase the signal/noise ratio, and hence extend the recorded frequency range. The characteristic is thus composed of two constant-amplitude sections, shown dashed, with a smooth transition between them. These two constant-amplitude sections cut the 0 db axis at f_b and f_t, the bass and treble turnover frequencies respectively. At f_b and f_t the practical curve is either 3 db below the reference level, or 3 db above it.

There is no general agreement on the actual values of f_b and f_t, nor on the rate at which the maximum slopes are reached. Table 1 gives a list of most characteristics to be met in practice, including those for older 78 r.p.m. records.

the inverse of the recording characteristic. It would appear that two switched controls could accommodate all the bass and treble turnover frequencies required, but the data given is only an average for each type; individual recordings may vary due to microphone placings, the engineer's criterion of balance, and the type and duration of the recorded work. It is thus necessary to make small deviations from the set equaliser characteristics.

Tone Controls

In addition to the above "trimming," individual listening conditions and tastes demand further variations: a carpeted, cushioned room will need treble boost; a certain speaker assembly may need bass-cut over a limited range of frequencies. These variations are usually done by a tone-control circuit of the type shown in Fig. 2, which gives independent cut and boost of treble and bass. Alternatively, a feedback loop may be used between two stages of a pre-amplifier.

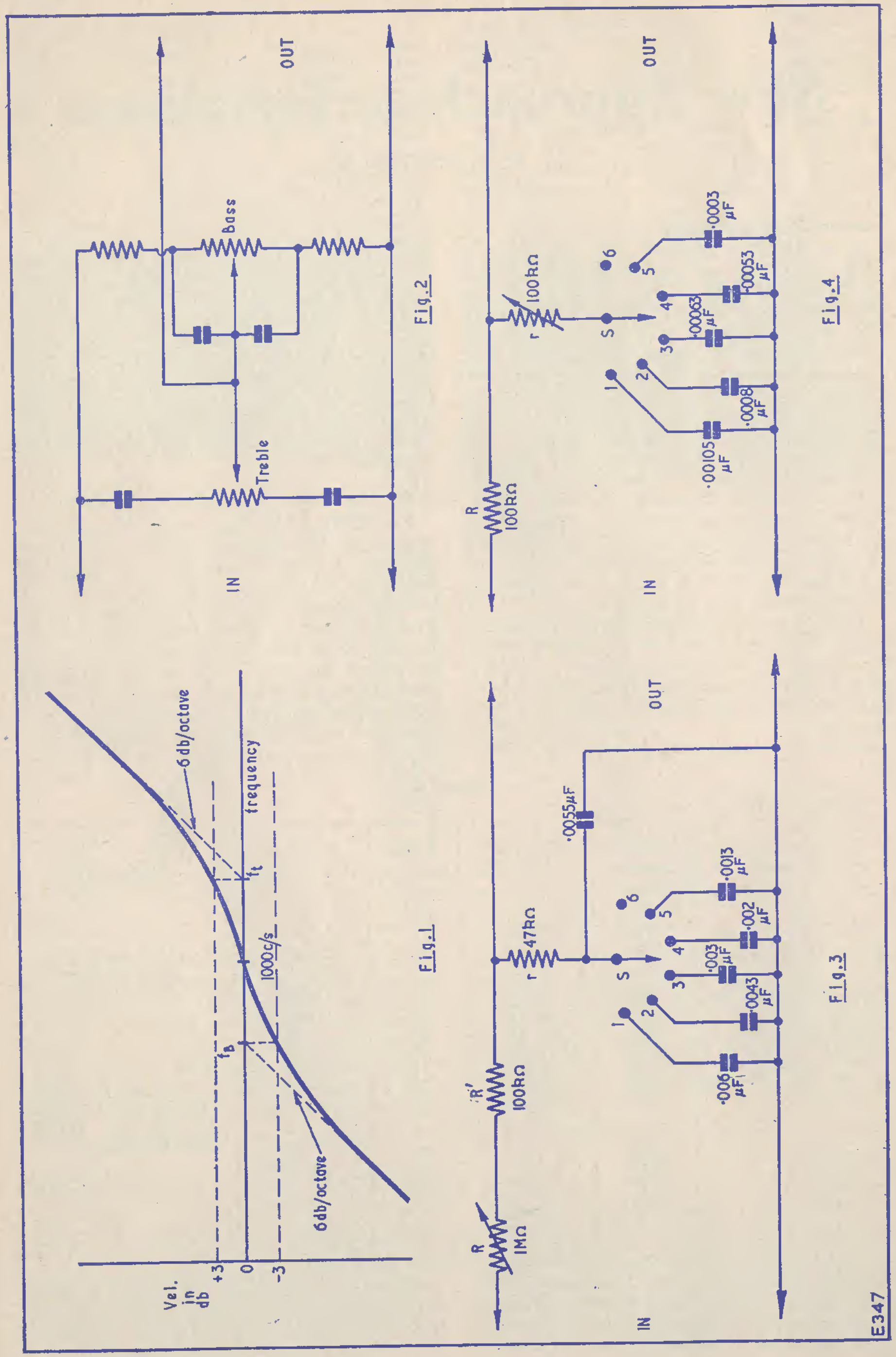
TABLE 1

Type	*Bass Turnover*	*Level at 50 c/s in db*	*Treble turnover*	*Level at 10 kc/s in db*	*Remarks*
	c/s		*kc/s*		
E.M.I. 78	300	−16	—	0	
f.f.r.r. 78	400	−18	5.0	+6	3 db/octave; flat above 10 kc/s
N.A.B.	400	−18	2.0	+16	
A.E.S.	400	−18	2.5	+12	
U.S. Col. L.P. ..	400	−13	2.0	+16	
London	400	−13	3.0	+10	
R.C.A. New Ortho	450	−24	2.5	+12.5	
R.I.A.A.	450	−14	2.5	+12	Replay curve peaks at 50 c/s; roll-off below 50 c/s
Decca L.P. ..	450	−13	2.5	+10.5	
E.M.I. L.P. ..	500	−14	2.0	+14	
U.S. 78	600	−18	2.0	+14	

Most hi-fi pick-ups—ribbon, moving coil, variable reluctance—give a voltage output proportional to their stylus velocity. Hence, an amplifier requiring a linear input must be preceded by an equaliser whose response is

New Approach

The term "boost" is misleading; a boost circuit merely attenuates all frequencies outside the required "boost" range. Hence, all correction circuits introduce loss in some way,



either as a direct attenuation or as a decrease in gain of a feedback regulated valve. The normal system of separate equaliser and tone-control introduces two stages of loss, often unnecessarily; consider the treble range—first the signal passes through a treble attenuator to give a level output, and then through a bass attenuator to re-emphasize the treble, in order to compensate for room absorption. It would have been far more economic not to have equalised fully in the treble attenuator, and dispensed with the bass attenuator altogether.

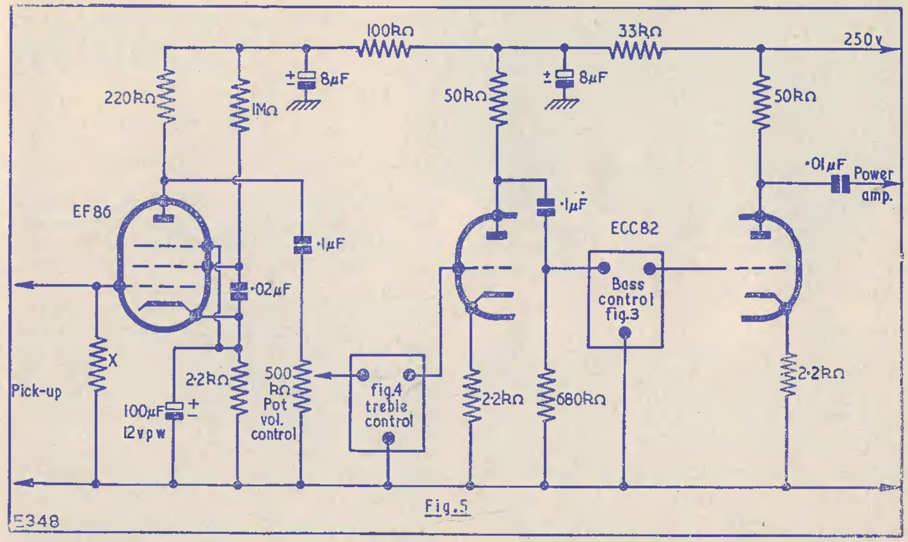


Fig.5

Similar arguments can be applied to other conbinations of cut and boost, and it was from these arguments that the circuit described hereunder was designed.

Equaliser

Most velocity pick-ups generate only a few millivolts of output, and should therefore feed directly into a high-gain stage before any form of attentuator is applied. It is also desirable that this first stage should have a cathode-resistor bypass capacitor of at least 50µF, this precluding any feedback loops between the anode of the second stage and the cathode of the first.

The bass section of the equaliser is shown in Fig. 3, and the treble in Fig. 4. In both, a simple step circuit is used, with a switched capacitor bank to obtain the various turnover frequencies. One resistor in each circuit has been made variable to control the height of the step, and hence the extent of the equalisation.

Bass

Switch S in Fig. 3 selects the bass turnover frequency, f_b; the frequencies for each position are given in Table 2. When the variable resistor R is at maximum, the step depth is 26.5 db, and when it is at zero, the depth is reduced to 10 db. Hence, more or less boost than the "correct" amount can be given, resulting in an overall bass emphasis or attenuation respectively. Further emphasis can be obtained by setting S to a higher value of f_b, thus commencing the boost before the cut begins on the record. Similarly, setting S to a lower value of f_b will delay the boost, and hence give attenuation.

This latter method can, by suitably choosing the f_b and R settings, give a peak or trough in response to overcome absorption or resonance occurring over a limited frequency range.

Treble

In Fig. 4, switch S controls the treble turnover frequency, f_t; values are given in Table 3. When the resistor r is at zero, the response falls continuously at a rate of 6 db/octave. When r is at maximum, the response is a step of only 6 db depth.

An overall treble emphasis is obtained by having the value of r greater than zero, with S set either to the correct f_t or to a higher frequency. Treble cut can be obtained only by setting S to a lower value of f_t: if r is at zero, the response will at first fall and then remain level as the recorded pre-emphasis comes in; if r is greater than zero, a trough will be produced, after which the response will rise at a rate depending on the departure of the cut from 6 db/octave.

It will be noted from Table 1 that pre-war 78's had little or no treble pre-emphasis; hence, no boost is possible, and instead a full cut of 6 db/octave can be obtained if required. Position 6 of S removes the cut entirely to pick-up used; if the pick-up delivers more than 200mV, the single resistor shown should be replaced by a resistor-divider giving an output not greater than this amount. An input of 10mV will give an output of about 2V at full volume. To avoid reducing further such small signals as 10mV, the volume control follows the first stage, and feeds into

TABLE 2

S:	1	2	3	4	5	6
f_B:	300	350	400	450	500	600 c/s

TABLE 3

S:	1	2	3	4	5	6
f_t:	1.5	2.0	2.5	3	5	out kc/s

cater for these discs. The absence of a definite boost is no disadvantage since these recordings have little content above 5 kc/s, and the high surface noise usually necessitates some amount of treble cut.

Application

The two circuits given can be used with any existing equipment, although their output should feed into a load of at least 1MΩ. A complete pre-amplifier is shown in Fig. 5.

The input load, X, is chosen to match the the treble control of Fig. 4. Treble equalisation is done before bass in order to avoid the pre-emphasis from overloading the following stage. Both halves of the ECC82 valve have unbypassed cathodes; this assists not only to linearise their gains, but also to present higher input impedances to the control circuits. The bass control of Fig. 3 is connected between the two halves of the ECC82. The output from the third stage should be fed into a 1MΩ load, either of the power amplifier or of a steep-cut filter.

CLUB NEWS

Details for insertion in this section should reach us not later than 7th of the month of publication. Insertions are subject to space being available.

TOPS C.W. CLUB

The club is celebrating its tenth anniversary with a Topsfest to be held at the Swan Hotel, Lichfield, Staffs., on Sunday, 12th August. Non-members of the club, both licensed and SWL, will be welcomed. Tickets, to include tea, will be 7s. 6d., and may be obtained from either G3ABG, School House, 24 Walhouse Street, Cannock, Staffs., or from GW8WJ, 2 Ffordd Ty Newydd, Meliden, Prestatyn, Flintshire, N. Wales, before 8th August. Those not requiring tea may pay a 2s. admission fee at the door. Further details as to time and programme may be had on request from either of the above named.

CRAY VALLEY RADIO CLUB

This club recently celebrated its tenth anniversary, and following a change of policy membership is now extended to non-transmitting radio amateurs. All those interested in any aspect of amateur radio are cordially invited to meetings of the club, which are held at 8.0 p.m. on the fourth Tuesday of each month at the Station Hotel, Sidcup, Kent. Details from the Hon. Sec., S. W. Coursey, G3JJC, 49 Dulverton Road, London, S.E.9.

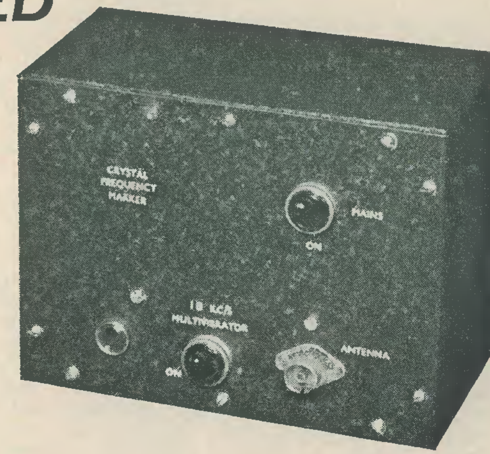
CLIFTON AMATEUR RADIO SOCIETY

Meetings are held every Friday at the clubrooms, 225 New Cross Road, London, S.E.14, when visitors and new members will receive a warm welcome. Hon. Sec., C. H. Bullivant, G3DIC, 25 St. Fillans Road, Catford, London, S.E.6.

EAST KENT RADIO SOCIETY

Meetings are held on Tuesdays at 7.0 p.m. in the basement of the Technical College, Longport Street, Canterbury. Visitors always welcome. Hon. Sec., D. Williams, Llandogo, Bridge, near Canterbury.

MINIATURISED CRYSTAL FREQUENCY MARKER



PART 1

by **W. E. THOMPSON,** *A.M.I.P.R.E.*

THE POSSESSION OF A FREQUENCY STANDARD which has a high order of accuracy can be of great value to the constructor and experimenter. Several uses for such apparatus could be mentioned, though calibration of receivers and test gear such as signal generators, grid-dip oscillators, etc., will doubtless spring to the reader's mind. Licensed amateur transmitters will also recognise the need for a frequency standard in order to check carrier frequencies to the required limits.

There must be many readers of this journal who have attempted the construction of an r.f. signal generator, and having made a first-class job of the constructional work have found, to their dismay, that this is the least of their troubles. The calibration of the instrument can present a formidable task (in the sense that it is difficult rather than fearful!) unless there is access to a standard of known accuracy. This, to put it colloquially, is the snag; the home-constructor's chief stumbling block. The instrument to be described in this article can, it is fondly hoped, satisfy the needs of those who yearn to have a frequency standard of their own, one that they can make for themselves and at the same time achieve reliable accuracy, albeit at a reasonable cost. Even if all new parts are used, the outlay should not burn too big a hole in the pocket one usually reserves for those rare oddities, to wit, banknotes.

Whilst touching on this question of monetary outlay somewhat facetiously, it is as well to give due thought to the fact that if one wants high accuracy one must pay for it. As this instrument relies entirely upon the quartz crystal employed in order to achieve dependable accuracy, it follows that the crystal must needs be of reputable make, ground to fine limits, and possess long-term accuracy. If you can afford it and have enough influence, you might persuade the Post Office to produce one of their masterpieces in their research laboratories for a few thousand pounds, but as this is perhaps beyond your immediate means, you will seek something cheaper if not more cheerful. There are, of course, "bargains" to be had for a matter of a few shillings, and if you are content with a frequency accuracy as wide as a barn door this is your line of attack.

Somewhere between these ludicrous extremes one finds that less laughable acquisition, the happy medium, the crystal which has a certificated accuracy of a fraction of 1% for less than £3. The author chose a Brookes type G crystal. This is a 100 kc/s quartz bar mounted in an evacuated B7G envelope, the stated accuracy being not more than ±0.005% of nominal frequency at 20°C, and the frequency-temperature co-efficient being better than 2 parts in 10^6 per 1°C over a temperature range of −20°C to +70C°. Under normal room temperatures, therefore, this crystal will oscillate at 100 kc/s and be no more than 5 *cycles per second* high or low of this frequency. If circumstances are such that it is oscillating at one or other of these extremes of frequency calibration and at the extremes of the temperature range, it will be no more than 15 c/s higher than, or 13 c/s lower than, the nominal frequency. Such accuracy is well worth the price charged, and it certainly allows some latitude in the operating conditions.

The next consideration is what the instrument produces from the crystal now we have it. Briefly, the oscillator stage runs at 100 kc/s controlled by the crystal, and produces lots and lots of harmonics. The hackneyed term for this condition is "rich in harmonics"—you must have seen it many times. It means that the output of the oscillator contains multiples of the fundamental frequency. This instrument produces harmonics beyond the 300th, so that there are detectable multiples of the fundamental at every 100 kc/s right up through the spectrum from 100 kc/s to beyond 30 Mc/s. By adding a multivibrator as a refinement, so that it runs at 10 kc/s controlled by the crystal, it will have a frequency accuracy of the same order as the crystal, and produce 10 kc/s subdivisions of the 100 kc/s harmonics. These can be heard as "pips" on a receiver, the 10 kc/s ones being slightly weaker than those at 100 kc/s intervals. One can liken these "pips" to the divisions on a rule, with inches divided into tenths, the long inch marks being the 100 kc/s "pips" and the short 10th-inch marks the 10 kc/s "pips." Imagine a rule more than 300 inches long, and you get some idea of the range of this crystal frequency marker.

You can possibly see now that if a receiver is tuned over the range of frequencies produced by the frequency marker, a "pip" will be heard at every 100 kc/s over the tuning range due to the harmonics of the crystal, and further pips every 10 kc/s if the multivibrator is switched on. In many cases a very close approximation of the frequency of a received transmission can be obtained by noting the positions on the dial where these "pips" are heard, but a more accurate indication can be obtained by means of a simple calculation. This will be explained later when discussing the instrument in actual use.

If the discussion so far has conjured in the reader's mind some idea that this instrument is a sort of magic box, as full of pips as a pomegranate, I would seek to disillusion him by making reference to the circuit diagram depicted in Fig. 1, wherein is exposed the fact that there's practically nothing in it. Despite the previous mention of crystals and "happy mediums" there is no magic, nor even anything that is mildly awe-inspiring so far as circuits go. The oscillator stage, V_2, uses a Brimar 6AM6 r.f. pentode (a type that was previously coded 8D3). Component values are such that the necessary harmonics appear at the anode, the drive being from the crystal in the grid circuit. The function of the preset capacitor VC_1 will be referred to when initial calibration of the instrument is explained.

The multivibrator stage V_1 employs a Brimar 12AT7 double triode. Component values for this stage determine the relaxation frequency of 10 kc/s, the variable resistor VR_1 providing the means of adjusting frequency so that it locks to the 100 kc/s crystal frequency via the concentric air-spaced trimmer C_3. The resistor VR_1 is a pre-set component and alteration to its adjustment is needed normally only at the initial calibration stage; for this reason it is not brought out as a panel control. Experiments carried out when developing this instrument showed that an air-spaced concentric capacitor was the most suitable type to use in this position, for silver-mica capacitors were found to be rather warm to the touch after some running time. This indicated change of power factor in the capacitor under working conditions, and it resulted in some unbalance in the multivibrator stage which, in turn, affected its stability.

A toggle switch S_1 enables the multivibrator to be switched on and off as required. From the point of view of the schematic, a more elegant position for this switch would be in the common cathode lead of V_1, but placing it in the h.t. feed has some advantage because it provides convenient anchoring points for the resistors R_2, R_3, R_5 and R_6.

The outputs of the two oscillator stages are passed via C_3 and C_5 to the co-axial socket labelled "Antenna" mounted on the front of the instrument. The actual antenna can be a short length of small-diameter coaxial cable terminated in a suitable plug at one end, the other end being left unterminated. The outer plastic covering can be stripped off for a few inches to expose the screen braiding. By pushing the braiding along and securing it in position with a crocodile clip, a ready means of adjusting the strength of radiation is attained, for in most cases only a very loose coupling is required when using the frequency marker.

A Brimar 6X4 rectifier is used for V_3. The use of a two-stage R-C smoothing filter R_9, C_7—R_{10}, C_8 in this full-wave rectifier circuit provides hum-free h.t. feed which compares very favourably with the more

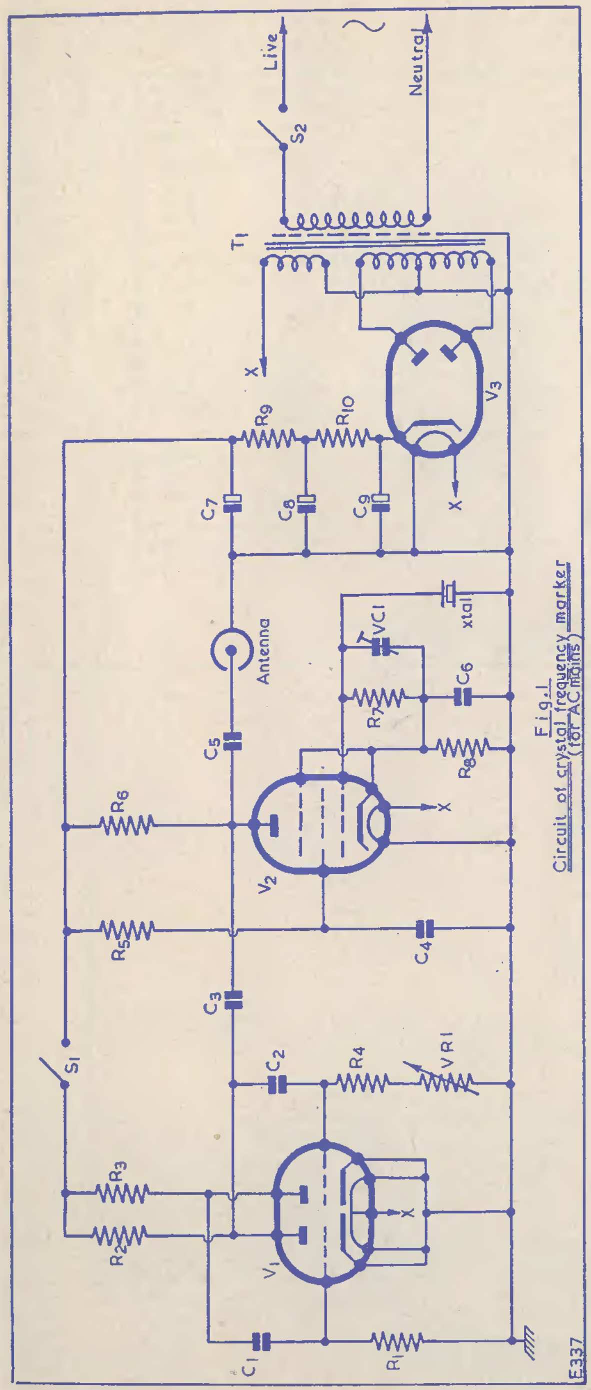


Fig. 1
Circuit of crystal frequency marker (for AC mains)

Parts List

R_1, R_6—22kΩ ½W
R_2, R_3—47kΩ ½W
R_4—20kΩ ½W
R_5—100kΩ ½W
R_7—470kΩ ½W
R_8—10kΩ ½W
R_9, R_{10}—2.5kΩ 5W wire wound
VR_1—5kΩ miniature pot. (Dubilier)
C_1, C_2, C_6—0.001μF 350V paper
C_3—3/30pF concentric trimmer (Philips)
C_4—0.1μF 350V paper
C_5—50pF ceramic
C_7, C_8—32+32μF 350V electrolytic
C_9—8μF 350V electrolytic
VC_1—100pF trimmer
V_1—Brimar 12AT7
V_2—Brimar 6AM6
V_3—Brimar 6X4
Xtal—100kc/s Brookes type G
S_1, S_2—Single pole toggle
T_1—200-250V prim., screened 250-250V 30mA, 6.3V 2.5A secs. (Radio Supply Co., Leeds)
2 B7G v/holders (V_2, V_3)
1 B7G valve screen (V_2)
1 B7G ceramic v/holder (Xtal)
1 B9G v/holder and screen (V_1)
1 L.604 socket (Belling & Lee)

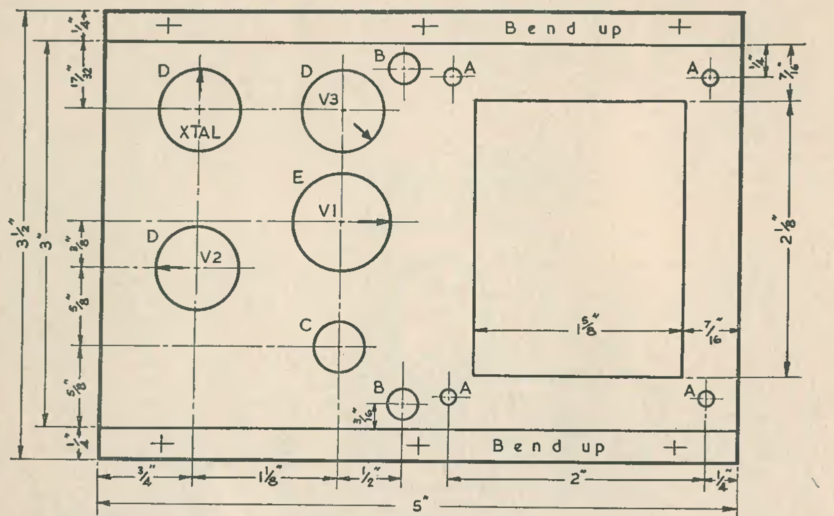


Fig.2
Dimensions & drilling details underside of chassis deck

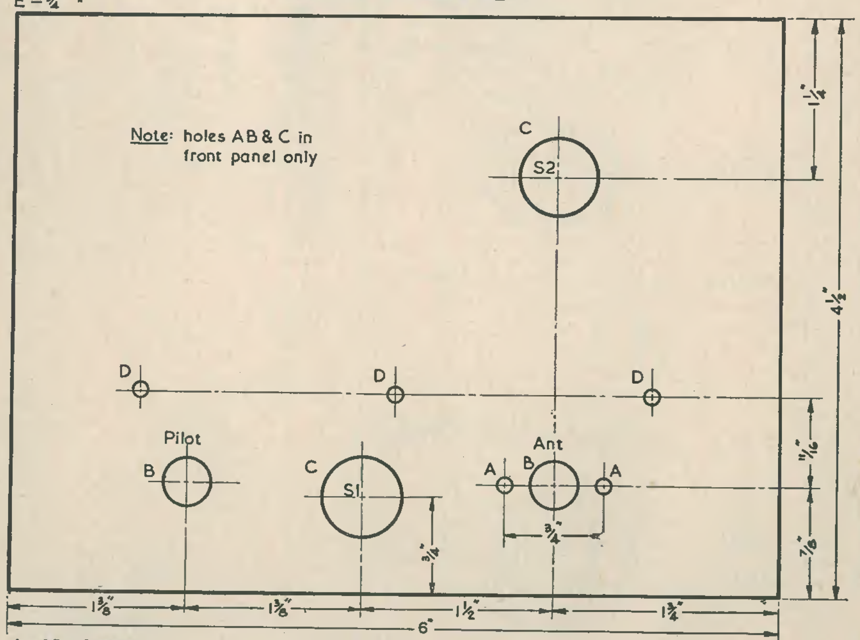


Fig.3
Dimensions & drilling details front & rear panels

E338

conventional single-stage L-C filter. Moreover, it does away with a bulky component. A useful feature of the 6X4 valve is the high heater-cathode insulation; rated to withstand 450V peak between these electrodes, one is able to run the heater from the same winding that feeds the other valve heaters, and save a winding on the mains transformer.

Resistors R_9 and R_{10} are purposely of higher wattage rating than calculation and operating conditions necessitate; cooler running of these resistors therefore keeps heat dissipation from them to a minimum.

In wiring the heater of V_1, it should be noted that pins 4 and 5 are joined together and wired to the 6.3V "live" feed from the heater winding, pin 9 being taken to chassis by joining it to pin 8. This latter is, of course, common to pin 3 for grounding the two cathodes.

Correct placement of the valveholders is necessary if the short wiring of the prototype is to be emulated. Note particularly that the position and spacing of V_2 valveholder and the crystal socket is such that the variable trimmer VC_1 can be soldered directly to pin 2 of V_2 and pin 7 of the crystal socket. In the sketches giving the dimensions of the metalwork for chassis and case, the arrow indicates the position of pin 1 of each valveholder. The valveholder should be placed in this position and the location of its mounting holes marked with a scriber. This will ensure that each valveholder takes up the correct position for keeping wiring short and components neat and compact.

The dimensions and drilling details for the chassis deck are shown in Fig. 2, while the front and rear panels are dealt with similarly in Fig. 3. These are made from

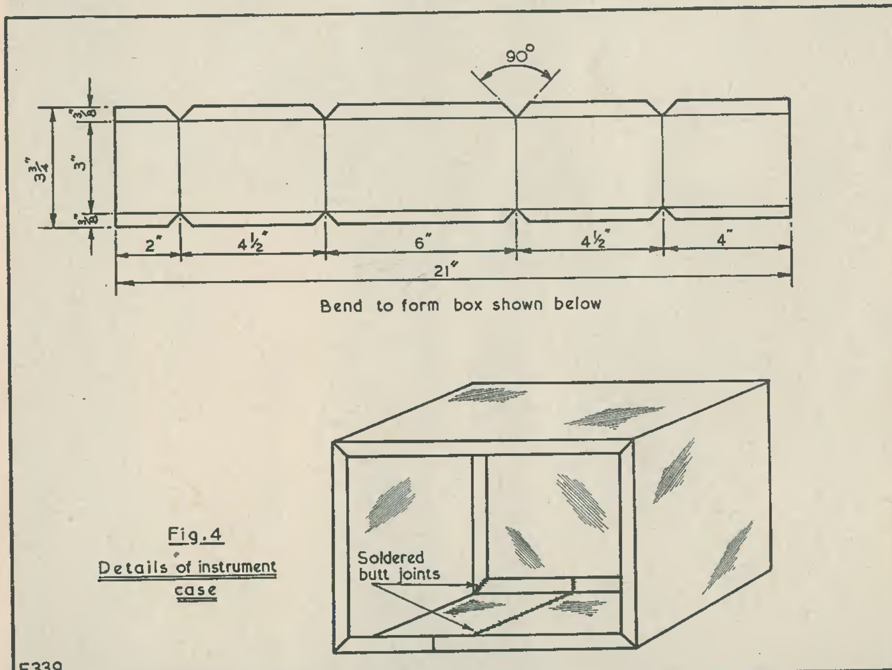
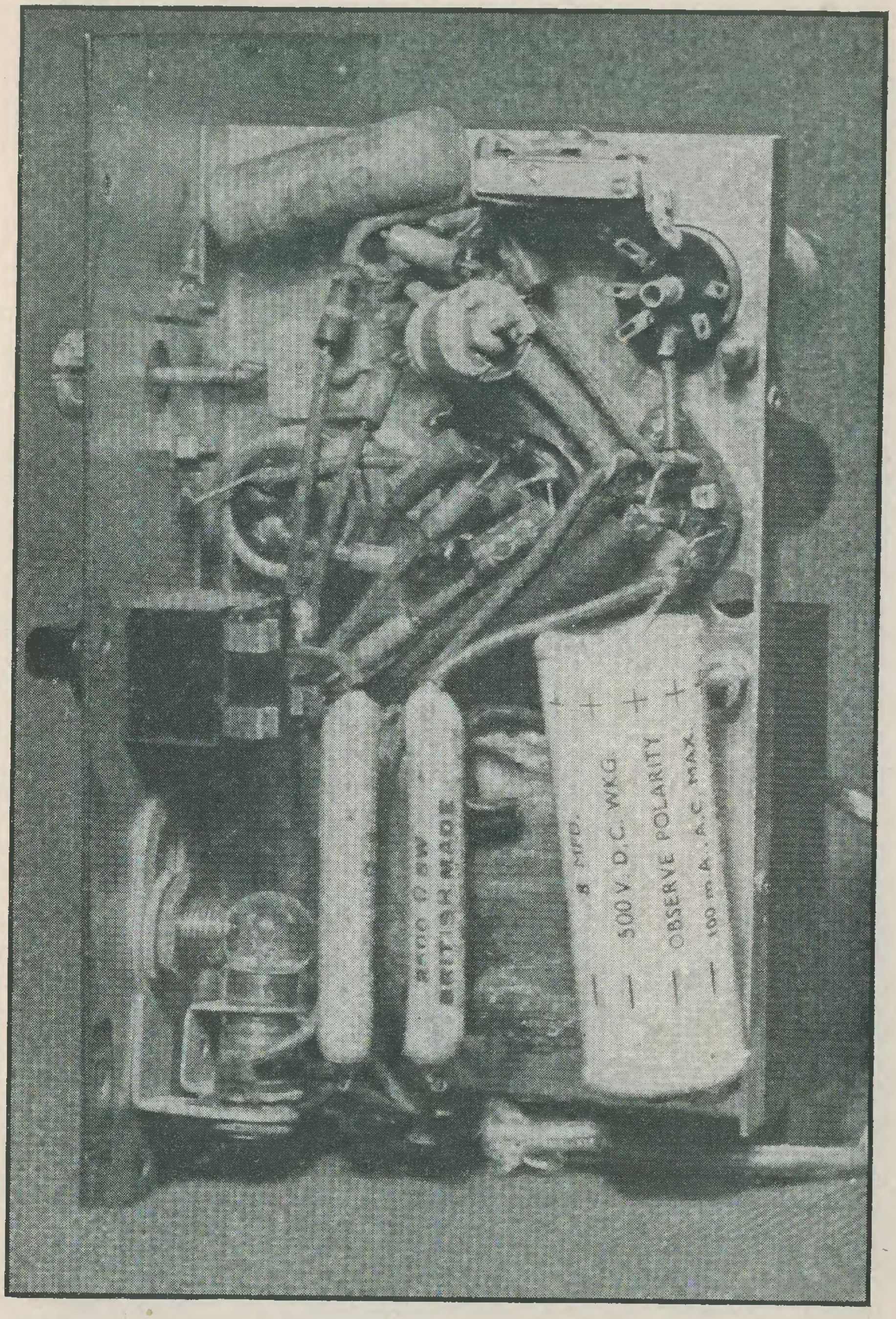


Fig.4
Details of instrument case

E339

As can be seen from the photographs, the construction of the instrument has been miniaturised and the layout made very compact. Most of the components associated with each valve can be grouped around it, and for this reason very small resistors and capacitors are employed. Some care and thought in placing and soldering these components is necessary if a neat job is to result. The photographs will no doubt give a fairly clear indication of the layout and can be used as a guide.

aluminium sheet; 20 s.w.g. is quite strong enough and is very easy to work. The instrument case, shown in Fig. 4, is made from 24 s.w.g. tinplate, and provided that some care is taken to make the bends squarely there should not be any difficulty in fabricating a neat and presentable box. It has been found advantageous since the prototype was made to make a few holes along the top and bottom of each side of the box for ventilation. Strips of perforated zinc or copper gauze can be soldered on



Under-chassis layout of A.C. Mains version

the inside of the box to maintain the screening but still allow air to flow through the holes.

The panels are secured to the chassis deck and the outer case with small self-tapping screws. The position of these are not shown with dimensions since it is better to locate them when the metal work is finished.

For finishing, the metal work can be given an application of Panl crackle paint, and the lettering carried out with Panel-Signs. These transfers are obtainable from the publishers of this journal. Where the actual words required are not supplied, they can be made up from individual letters, a goodly supply of which is included in the set of transfers.

If the constructor does not wish to go to the trouble of making his own tinplate case, any suitable box of comparable dimensions can be used. This may involve altering the size of front and rear panels, but the drilling of the chassis deck should conform to the layout in Fig. 2. *(to be continued)*

Can Anyone Help?

Requests for information are inserted in this section free of charge; subject to space being available

A. P. Buchanan, 12 Carrick Park, Ayr, would be grateful for the circuit diagram or any other gen, on sale or loan, concerning the Hallicrafters S20R Sky Champion.

* * *

F. Barnett, 2 Andersons Place, Hounslow, Middx., would like to buy or borrow the circuit or handbook on the 21 Receiver, and particularly wishes to know modification data to cover amateur bands and details of rear connections.

* * *

James Atherton, 29 Park Road, Wigan, Lancs., wishes to purchase or borrow the service manual or circuit for the Peto Scott ARG101.

* * *

L. Hutchins, 119 Stillness Road, Forest Hill, London, S.E.23, has an ex-Service receiver and power pack for battery/mains input, No. 3 Mk. 2, and wishes to obtain information and circuit of these, particularly the metal rectifier circuit.

* * *

J. Dinwoodie, 143 The Boxhill, Stoke Aldermoor, Coventry, Warwicks, wishes to purchase the circuit and data on the ex-A.M. Radar Indicator type 157, reference 10Q/16002, the final 2 in this number being suspect.

* * *

T. Walkden, 15 Higher Barn, Horwich, near Bolton, Lancs., is willing to pay for any information available on the International Marine Radio Corpn. London's transmitter/receiver type TS3-A, serial No. 173, 24 volts input.

* * *

R. K. Woodman, 39 Veda Road, London, S.E.13, wishes to borrow or buy copies of the *Radio Amateur* for June and July, 1952, giving details of a 28 Mc/s converter for the R1155.

* * *

John M. Manus, 1 Bann Street, Portadown, N. Ireland, wishes to borrow or purchase the circuit of a good class oscilloscope.

C. H. Hood, 10 Bramley House, London, W.10, wishes to purchase a copy of the pre-War Admiralty Handbook of Wireless Telegraphy.

* * *

B. N. Gregory, G3DNT, 100 Mettesford, Matlock, Derbyshire, wishes to beg, borrow or buy a manual for the Bendix transmitter type TA.12.C.

* * *

L. Lanzon, 13 Kidderminister Road, West Croydon, Surrey, requires information on the R.1124C, especially on the power socket and also a suitable power pack. He is willing to pay for same.

* * *

L. Cooper, 42 A.M.Q. Gatenby, R.A.F. Leeming, near Northallerton, Yorks, requires help in obtaining the circuit diagram for the American G.E. portable superhet, model LB-673, frequency range 540-1,700 kc/s.

* * *

D. Waugh, 33 Lawnswood Drive, Clifton, York, requires the circuit and servicing data for the Ectronic R.A.640 receiver.

* * *

T. A. Clayton, 43 Stoke Hills, Farnham, Surrey, would like to buy or borrow any data and valve equivalents for the Danish set Nester 45, made by Telefunken, valve line-up: UCH.11, UBF.11, UF.11, UBL.1, half-wave rectifier and magic eye.

* * *

The Technical Staff of the *Radio Constructor* requires the circuit and alignment data for the National NC-40 communications receiver. Can you help?

* * *

P. Ashdown, 7 Alexandra Drive, Liverpool 17, wishes to know the frequency range of the Frequency Meter B.C.906D. It carries a calibration chart with figures from 14.5 to 23.5, but there is no indication of the significance of these. A rough check with lecher wires appears to show the range as 145-235 Mc/s.

Radio Miscellany

ONLY TOO FREQUENTLY ONE HEARS OF fatalities resulting from electric shock, even amongst the most experienced of amateurs. Indeed, I always watch the black-bordered panel in the R.S.G.B. *Bulletin* headed "Silent Keys" with a dread that the name of an old acquaintance might appear there. Morbid as it may seem, this was the theme of a discussion at a recent club meeting, only happily this was occasioned by a member who had caught a packet, while adjusting a home-built t.v., which didn't prove fatal. It merely threw him across the room, producing bruises which made it uncomfortable for him to sit. Naturally, everybody in turn related their experiences of when they had had an unforgettable tingle run up their sleeves, and there was a great deal of speculation about the prospect of shocks being lethal. The effect of electric shocks varies considerably, depending on the health of the individual and just what sort of path the current makes through the body. A path from, say, the thumb to a finger of the same hand might only result in a nasty burn, but the same current from hand to hand, forming a path through the heart, would probably prove fatal. Hence the electricians' tip—Keep one hand behind your back when touching live circuits.

There are numerous instances of people being killed by shocks from low voltage circuits, and equally as many of the failure of high voltage circuits to prove fatal. At times, too, the electric chair has failed to produce instantaneous death.

In the 'twenties there was an important case where a firm at Bridgend, Glamorgan, electrified a wire fence to prevent pilferage of coal. One night in drizzling rain, a collier, running, touched one of the strands and fell on to some corrugated zinc. He could not let go, and a friend who tried to pull him off received a lesser shock through his damp clothing. The victim died, apparently a healthy young man (I believe he was only 18) and the firm were charged with manslaughter and "setting a man-trap calculated to destroy human life, etc., etc."

I cannot recall what the voltage of the circuit was, but the case was successfully defended, it being held that the effect of unexpected shock when already alarmed and running away was out of proportion to the current.

Hot Seat

At the other end of the scale we have judicial electrocution which has been in use for over 60 years in the United States. In one well-known case the victim was still not dead after being subjected to a shock of over 1,250 volts for 50 odd seconds! Whatever views we hold about hanging, it is difficult to believe that electrocution is any more humane. The preliminary ordeal of being firmly strapped in the chair and having the electrodes secured to the head and to the calf of one leg is grim enough without the paralysing agony of a shock which fails to kill instantly.

The cases quoted are admittedly extreme ones, but death by low voltages and escapes after accidental contact with high voltages are almost daily occurrences. So much depends upon the individual and the circumstances. Most of us have received sharp shocks at some time, and after a while one is apt to become less cautious until one gets a particularly unpleasant dose, which even if it doesn't really scare leads to damaged gear from violent body movement. I once smashed several valves and an expensive meter that way! However careful you are about keeping the other hand out of harm's way, there is always a risk of touching some part of the circuit with another part of your body. So as an additional precaution it is policy to make sure that some other person knows just where to switch off and what to do in case of accident. It is, as in the case at Bridgend, useless to try to drag the victim of a shock away until the circuit is broken. To do so simply passes the shock on, and the intending helper may also not be able to let go.

Sort of Oil-skin

It is several years since we touched upon the question of soldering of aluminium in this column. Several readers then wrote of their experiences, and a couple sent specimens of the results achieved by their methods. Now T.W.H., of Sedgeford Road, W.12, in an interesting letter reopens the subject and describes a method he has been successfully using for several years.

The soldering of aluminium by normal means is prevented by the immediate oxidisation of the surfaces. To overcome this, T.W.H. places a spot of light oil on the point to be soldered and the surface is cleaned through the oil, using the abrasive with a slow movement in order to prevent air contact. A blob of hot solder then applied (again through the oil) will be found to "take" immediately and a strong permanent joint results.

This method, as he points out, may sound a tricky process, but in actual practice proves quite simple, and he has not yet had a single failure in soldering on soft aluminium chassis.

Hi-Fi News

Hi-Fi is in the news with a clamorous advertising campaign in the national press. When you get down to the smaller type you find it is for a new brand of face-powder! However, there is Hi-Fi News of a much greater significance to audiophiles—a new, nicely-produced monthly magazine of that name selling at 1s. 6d.

In recent years long-playing and high quality records, the popularisation of serious music, and the spread of f.m. broadcasting have all contributed to building up a widespread interest in realistic reproduction, and the army of fans are well served by a wide range of good equipment. An outstanding feature of the hi-fi fraternity, even those of twenty years ago, has been the willingness with which they will spend money on almost every new development as it is introduced. I used to joke about the way they cheerfully spend pounds for a few more c/s at either end of the musical register. On the other hand, the pure and simple radio amateurs are a mixed lot. Some of them must have the classiest of everything regardless of expense, while others will never buy a thing until they have been through the junk-box twice to make sure it doesn't contain a usable substitute.

The *Hi-Fi News* is not primarily intended to be of a highly technical or constructional character, although a schematic and parts list is promised for the No. 2 issue for intending constructors of a new portable player, the HFN1. This is designed for 45 r.p.m. discs and runs from four dry cells. It is claimed to be the lightest all-electric portable and measures only $8\frac{1}{2} \times 11\frac{1}{2} \times 5$ inches.

This lively and nicely printed magazine will be of great interest, not only to collectors of No. 1's (of whom there are at least two among my small circle of correspondents) but to all lovers of quality musical reproduction. A good buy and a promising start—I look forward with great interest to seeing subsequent issues.

Becoming Monotonous

When the Russians first came up with the story that Popov was the "inventor of radio"—as if it could have been invented by one man!—it was mildly amusing. As the claim became more and more frequently made, apparently to make sure nobody missed it, it became irritating. Nowadays it seems to be impossible to find any Russian-inspired publication which fails to repeat the claim, usually with reports of celebrations and homages in honour of the "Inventor of radio—A. S. Popov." Apparently they have borrowed a page from Goebbels text-book and hope that by repeating the same story enough times it will eventually become accepted as true.

Personally, I can scarcely recall hearing of Popov's work until the Russians very belatedly "discovered" him a few years back.

CENTRE TAP	*talks about*	ELECTRIC SHOCKS SOLDERING ALUMINIUM HI-FI NEWS POPOV

He died over a half-century ago and very little can be found about him in reference books. Like all decadent democrats I learned to accept that scientists and physicists of many nationalities shared in the discovery and development of the knowledge that enabled Marconi to successfully undertake his practical work.

Possibly Popov did add something of value, or he may have even made some vital discovery independently without knowing he had been preceded, but if so he seems to have been mightily secretive about it. To allege, as it has been, that his ideas were pirated can only be acceptable to those who have been indoctrinated into swallowing the party line on all matters. Even they must be puzzled why so little was known about his work until some forty years after his death.

MUSICAL ELECTRONICS with a HAWAIIAN GUITAR

PART 1. *by* **G. F. WEBSTER**

This Home-made Guitar is easy to construct and can be played through your home radio.

One instrument in the fascinating field of electronic music that is easy for radio amateurs to make is the Hawaiian steel guitar. It is also easy to play, as no fingering is required. Any enthusiast with an itch to experiment should try this interesting method of producing music. A special amplifier is not essential unless great volume is required. Full details are given for making the guitar, and the pick-up unit has been simplified for ease of construction. Also fully simplified to the last degree is the (so called) fingerboard, which in this case is used merely to indicate the positions for the steel, and a table of measurements is given that anyone can follow. And as this, the usual stumbling block, has been eliminated, the rest is plain sailing. It may be of interest to know that a guitar like this has been used in band work for years, bringing not only pleasure but profit. A general description is given in some parts in order that an original touch might be introduced.

The Guitar Unit

The complete assembly of this unit is divided into six sub-assemblies for ease of construction, as follows:—1. The Body; 2. The Machine Heads; 3. The Tail Piece and Cover; 4. The Bridge Pick-up; 5. The Nut and Fingerboard; and finally 6. The Socket and Plug.

The Body

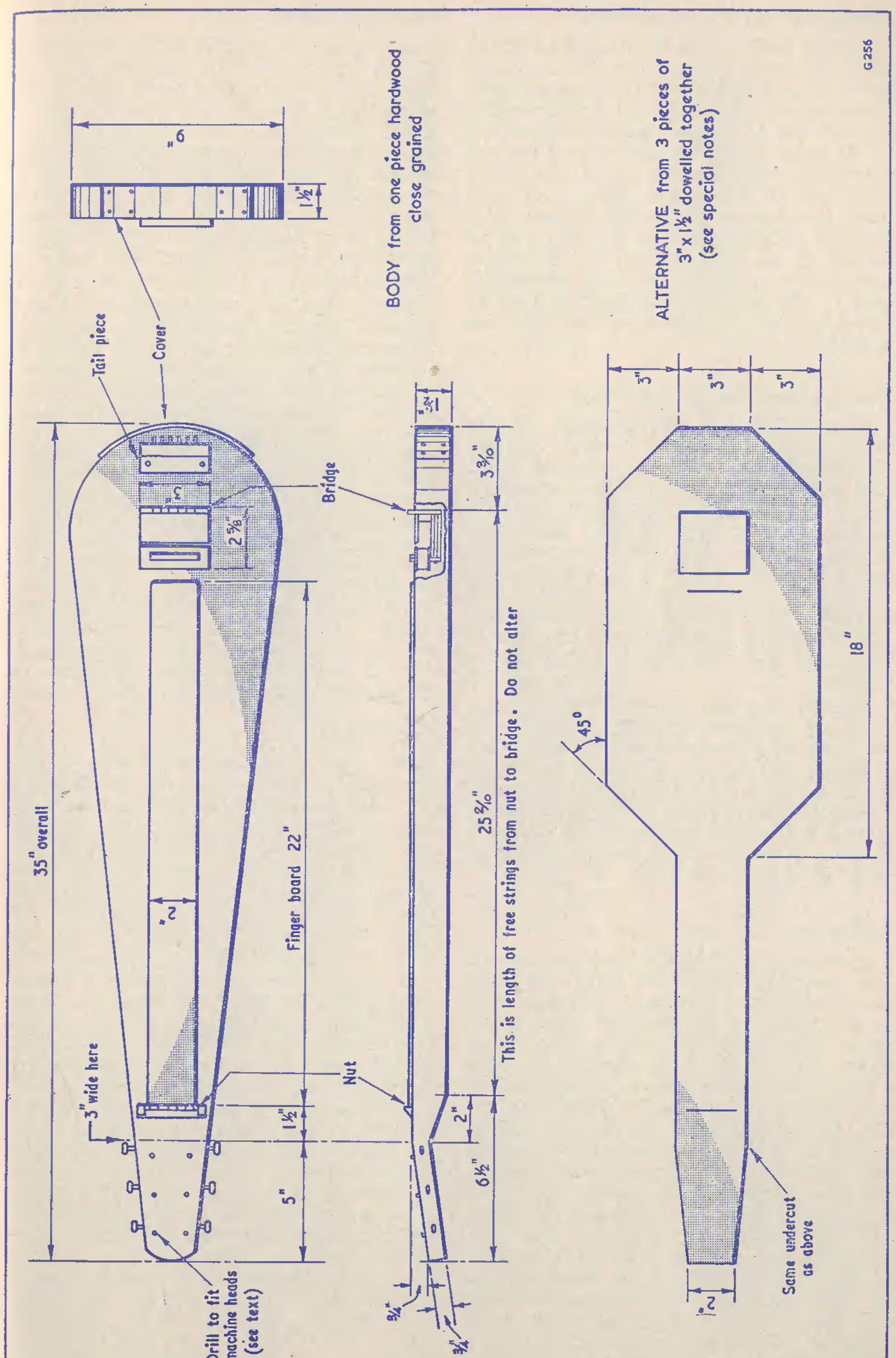
The wood for the body must be seasoned hardwood of close grain, free from knots and any liability to bend or warp. Oak is not suitable. If in doubt, a good timber merchant will advise if shown the plans, and will perhaps cut out the shape for a small charge. The drilling and fitting required for the units is then quite simple, and is fully explained later. Final drilling and fitting on the body can only be done when all the other units are completed, then the body is polished before the final assembly.

When the body shape has been chosen and cut out, work can be started by fitting the machine heads. The pair of machine heads, also the socket and plug, are bought complete; and the other sub-assemblies are made as in the text. Machine heads can be obtained from any good music shop for about 16s. to 25s. per pair, with brass or plated pegs and a choice of colour for the taps, or they can be ordered from firms such as Messrs. Boosey and Hawkes Ltd. Measurements are not given on the plan as there is some variation, and drilling is better done from the pair supplied.

Work out the colour scheme to be made before ordering. For instance, if the fingerboard is to be white the taps would look better white; alternatively, the body sprayed with metallic gold cellulose would give a professional appearance if combined with a cream coloured plastic fingerboard and taps. If a body of dyed and polished wood finish is preferred, the fingerboard and taps could be brown. Attention given to these points will make a vast difference to the finished product and be well worth the extra time and thought.

Fitting the Machine Heads

The fitting is made so that the wire-threading hole in each peg projects above the wood. Place the machine heads in position with the worm shafts on the side of the pegs away from the nut, and the pegs nearest to the nut. Any strain on the pegs will tend to close the peg gears to the worm of each. Measure for clearance of taps, and drill holes at right angles to the surface of the wood to give a close fit on the pegs without binding. If the holes are too large they will not support the pegs when the strings are tuned. Screw into position and check the fitting by turning each tap, then remove both machine heads until the final assembly.



Fitting the Tail Piece and Cover

The tail piece is sunk ¼-in into the wood to allow the cover to clear the base studs. If saw cuts are first made at right angles to the body, and the piece removed, it will be easier to mark the 45 degree position for removal of the other piece. See that the tail piece is firmly screwed below the studs to take the total pull of the strings. The cover will bend round as shown when screwed into position, leaving clearance for strings to be looped on the studs. When the alternative body shape is made, the cover should be bent to the angles of the base. Check by screwing in position, then remove until final assembly.

The Combined Bridge and Pickup

This method has the advantage of easy construction and gives a good output. The magnets are available from any good tool store, or can be obtained from Messrs. James Neill and Co. (Sheffield) Ltd. for 8s. 6d. per pair, delivery seven days. The bridge pole piece with extension piece and clamping piece of iron or mild steel, must carry the magnetic flux to the gap, so clean flat contact with the magnets is essential. The coil pole piece of soft iron or transformer iron must also make the same clean flat contact.

Assemble the two pole pieces by screwing the bolts in, then place the magnets with same poles at one end (north and north together), and tighten the bolts as shown on the drawing. Now check that the magnetic flux is all concentrated in the gap between the coil pole and the extension piece. Leave the unit in this condition until painting or spraying as explained later.

Fitting the Unit

A recess is made in the body to take this unit, and it should be 3in across the body by 2¾in long and ⅞-in deep. The underside of the body can be kept free from fixing holes, if required, by running two wood screws through the fixing plate to the base between the magnets, but adjustment of the unit will require the removal of the extension piece or the drilling of two adjusting holes in position above the screws. If bolts are used as shown, by drilling and countersinking and a tapped plate used for fixing, adjustment can be made from the underside of the body. The plate should be of brass. The pole extension piece will have to be unscrewed when setting the unit into the recess. Check the adjusting action on the steel balancing pin shown, measure for the nut position as explained later, then remove the unit until final assembly.

The Coil Bobbin

Two pieces of paxolin are cut to size as shown for the bobbin end plates, and two small holes are drilled for the ends of the wire to pass through. The centre portion is made from thin insulating material, cut wide enough to allow for flaps which pass through the end plates and are glued flat to the outside to prevent the wire from forcing the plates off. The top end plate should have a cover plate made to match the colour scheme and hide the flaps. The materials are available from electrical stores.

To make winding easy, fix the bobbin on a piece of hardwood arranged on a shaft with a handle for turning, and mount the spool of wire on another shaft to allow any uninterrupted feed. The coil can be wound for low or high impedance as required. The low impedance is easier to wind and not easy to damage, but a small step-up transformer must be used as in microphone practice. The high impedance coil can be run to the amplifier without a transformer.

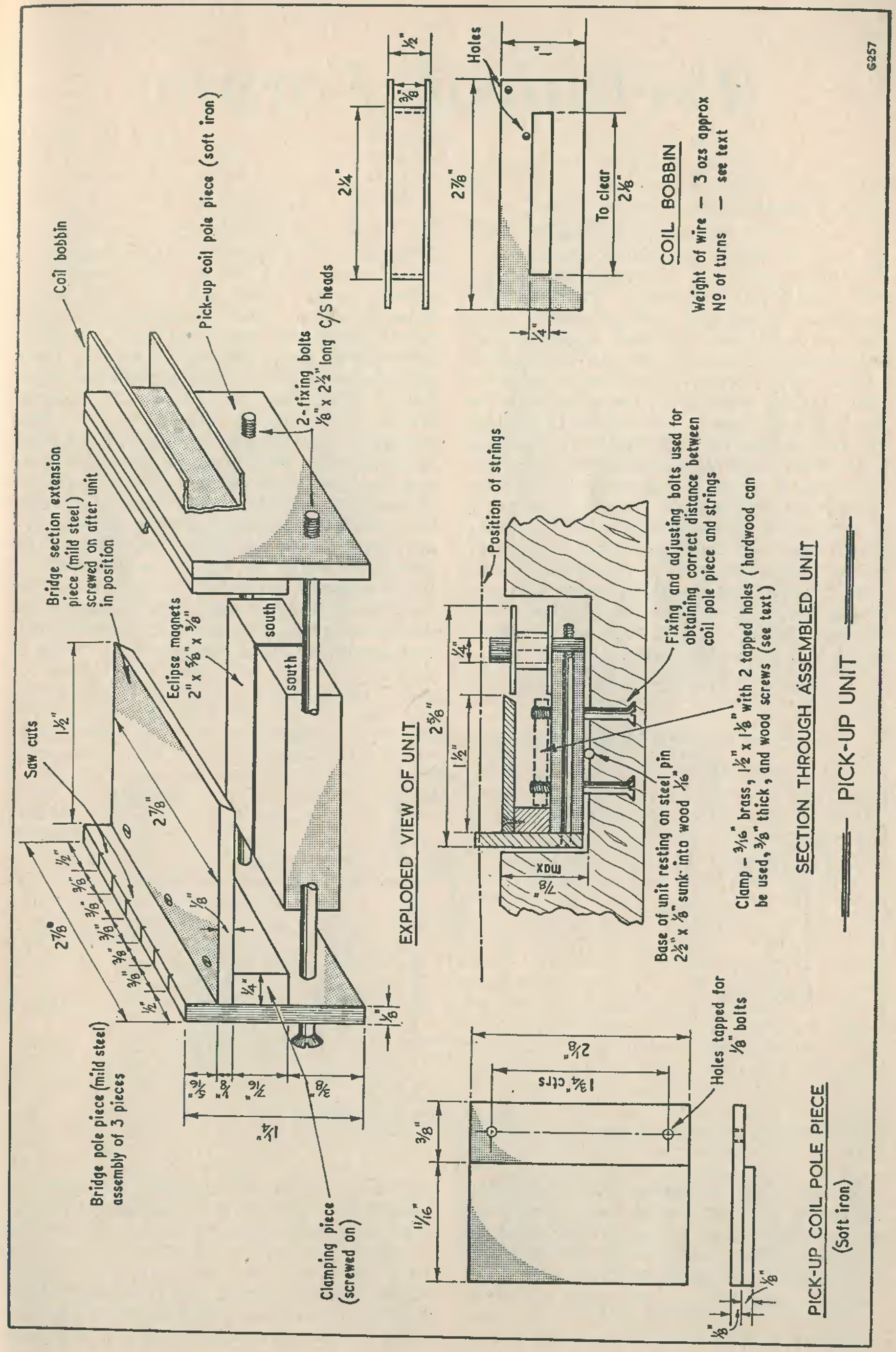
About three yards of flexible screened lead should be used with a plug at each end for respective sockets in guitar and amplifier, so the units are not altered if a different length is ever required, and tripping over the lead will not cause serious breakages. The volume control can be on the body or the amplifier, and circuits are given for both.

Coil Details

For high impedance, wind about sixty-six layers of sixty-seven turns per layer of 36 s.w.g. enamelled copper wire to total approximately 4,400 turns. The starting and finishing ends should have a thicker wire soldered on and wound a few turns to prevent breakage, and the finished coil should be taped for protection, with the loose ends sheathed in sleeving and left about ten inches long.

If a coil of low impedance is required, wind eleven layers of ten turns per layer of 20 s.w.g. enamelled copper wire to give 110 turns, which should fill the bobbin; thicker ends are not required, but sleeving should be used from coil to socket. A hole is drilled from the position chosen for the socket to the unit recess to take the leads. The transformer will be built into the input of the amplifier, and should have a ratio of about thirty seven to one. If the guitar is to be used with an existing microphone amplifier the transformer given here may not be required. There are many types of plugs and sockets available, and a small one suitable for sinking into the side of the body can soon be found at a good radio shop.

(to be continued)



Technical Forum

Noise Measurement

LAST MONTH WE DISCUSSED THE FACTORS which mainly contribute towards producing noise in electronic equipment, with particular reference to television receivers. It was seen that, in general, these factors could be gathered together and expressed as resistances connected in the input circuit of an otherwise noiseless receiver. This lumping together of the effective noise generating elements is both helpful in explaining their individual contribution to the total noise, and also of assistance in calculating the noise level in the set. However, such a calculation is not easy to make accurately, as many of the factors which govern it are not easily determined, and the more usual method of finding the noise level is by measurement. This measurement is usually made by comparing the noise level in the receiver under test with that of a known source in a manner which will be described later.

Readers may remember that in the last issue the noise generated by a thermionic valve was discussed, and a formula given for the calculation of this noise. For reference this formula is repeated below.

Noise current $i = \sqrt{2e \, Ia \, B \, K^2}$

where $e = 1.59 \times 10^{-19}$

B = bandwidth in c/s

K = a constant depending upon the proportion of the electrons leaving the cathode which arrive at the anode. This property of a valve for producing noise is utilised in the noise generator which incorporates a thermionic diode. In order that there should be no doubt as to the value of "K" in the noise diode it is operated in saturation, a condition where every electron leaving the cathode arrives at the anode, thus K = 1. These special diodes usually have a fine tungsten filament which is fed from an adjustable voltage source so that the electron emission may be varied to vary the noise output. The valve is maintained in saturation by an anode voltage which is in the region of 200V. The complete circuit of the noise generator is simple and is shown in Fig. 1. Figure 2 shows the manner in which the anode current of the diode varies in accordance with filament voltage, assuming an anode potential which is sufficiently high to maintain the valve in saturation. The noise is distributed over a wide bandwidth, which is usually limited first by the capacity shunting effect of the diode itself. A noise range which conforms exactly to the formula quoted can, however, usually be relied upon up to 100 Mc/s. Whilst special noise diodes are available from valve manufacturers, experimenters may like to use the ex-Government type CV172 which is available on the surplus market.

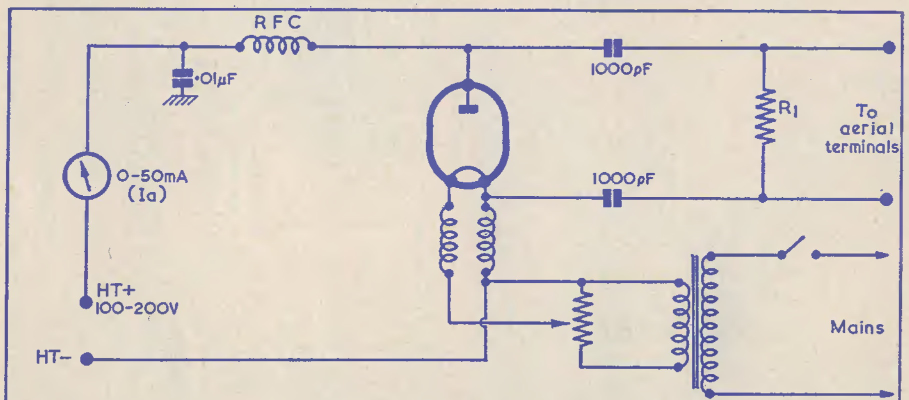


Fig.1
Circuit of noise generator

To use the noise generator, the output resistance R_1 is made equal to the input matching resistance of the t.v. receiver, usually 80 ohms, and the unit connected across the aerial terminals. A device is required to indicate the relative noise levels in the set, and for this purpose an a.c. voltmeter capable of recording millivolts is required; a normal low reading voltmeter with an amplifier is quite suitable.

Making a Measurement

Before attempting to make a measurement, the set under test must be installed under normal working conditions and the channel selector set to the position at which the measurement is to be taken. It is important that the r.f. and i.f. stages are correctly aligned as it has already been shown that the overall bandwidth has a considerable effect upon the noise level. The output level indicator is connected to the output of the last i.f. stage, and the noise generator across the aerial terminals. The receiver and indicator are then switched on and allowed to warm up, and at this stage the filament voltage of the noise diode is set to zero. When the receiver reaches working temperature there will be a reading on the indicator which is proportional to the total noise generated by the r.f. and i.f. stages. The gain of the amplifier in the indicator should be adjusted until the meter reads about a quarter of full scale. A quick check is desirable at this stage to ensure that the meter is in fact reading noise and not being disturbed by a t.v. signal picked upon the wiring. Examination of the raster on the c.r. tube will soon reveal whether or not any signal is present.

The filament voltage of the diode is now gradually increased until the noise power shown by the meter is doubled. As the meter is recording voltage an increase in power of 2:1 is shown by an increase in voltage of $\sqrt{2}$ or 1.4 times. Thus the filament voltage of the diode is adjusted until the meter reads 1.4 times its original value. Under this condition the noise fed into the receiver from the generator is exactly equal to the noise occurring within the set itself. At this stage the anode current of the noise diode is noted, and its value may be used to calculate the noise current which is flowing in the matching resistor R_1.

Noise Factor

It is, however, better practice to quote the noise performance of a receiver by stating its "Noise Factor." This term has been given to the ratio of the noise power applied to the receiver from the generator to the noise power available from the aerial resistance. Using the formulae already given it may be shown that the noise factor may be calculated by:

$$NF = 20 \, Ia \, R_1$$

where Ia is the anode current of the noise diode in amperes and R_1 is the aerial resistance, which in the example under consideration is 80 ohms.

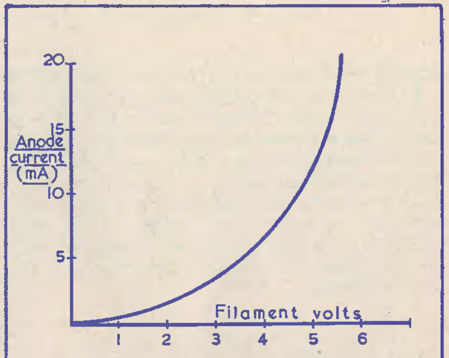


Fig.2
Graph showing how anode current increases with filament voltage in a noise diode

Construction of Generator

For readers who are interested in the actual measurement of noise, a few comments regarding the construction of the generator may be helpful. The noise generator should be housed in a small metal container and the output leads kept as short as possible. The choke in the anode circuit is a good all-wave component, whilst the heater chokes may consist of 30 turns of P.V.C. covered wire wound into a self-supporting coil with the aid of a pencil used as a mandrel. The filament voltage is adjustable from zero to the maximum permitted for the diode employed, 7V in the case of the CV172. This control is obtained by means of a wire-wound potentiometer connected across a 7V filament winding on a mains transformer. The h.t. supply voltage is not critical and may be between 100 and 200V, and this can be obtained from a simple half-wave rectifier circuit with an R-C smoothing filter. It is seen that the noise generated is dependent upon the diode anode current and the resistor R_1 which is made to equal the aerial input resistance of the set being tested. Thus for a given value of R_1 the anode current meter may be calibrated directly to read noise factor.

Field Report on

The "TRANSISTORETTE"

by G. A. FRENCH

THE TRANSISTORETTE (whose construction was described in the issues of February to May inclusive) has caused much interest amongst constructors, and the writer has received a number of letters from readers in consequence.

One or two "standard" queries have been apparent in quite a few letters. The most frequently raised question concerns the practicability of using headphones with the Transistorette.

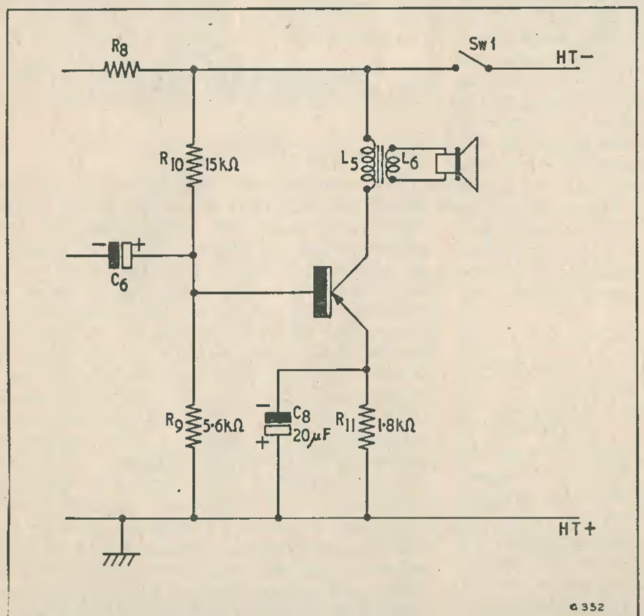


Fig. 1. The modified output circuit

In answer to this query it should be stated that the Transistorette was not originally designed for headphones, and that the results obtained may not be as good overall as when a louspeaker is employed. The main reason for this is that quite a high level of amplification is given by the a.f. stages of the receiver and that there is, in consequence, a similarly high level of background hiss at the output transformer. This hiss is hardly noticeable when a loudspeaker is connected to the set, but could be annoying if headphones (with their closer coupling to the ear) were employed. Should readers wish to experiment with high-impedance (2,000Ω) headphones these should be connected across the primary of the loudspeaker transformer, or could be connected in place of that primary. Low-impedance phones, of the type available on the surplus market, would give a fairly reasonable match if connected to the secondary of the loudspeaker transformer. In all cases where headphones are employed the h.t. battery voltage should be reduced to 9 volts or so, or to whatever voltage provides the best compromise between reasonable background hiss and adequate a.f. gain. However, as was stated above, the loudspeaker gives the better overall results.

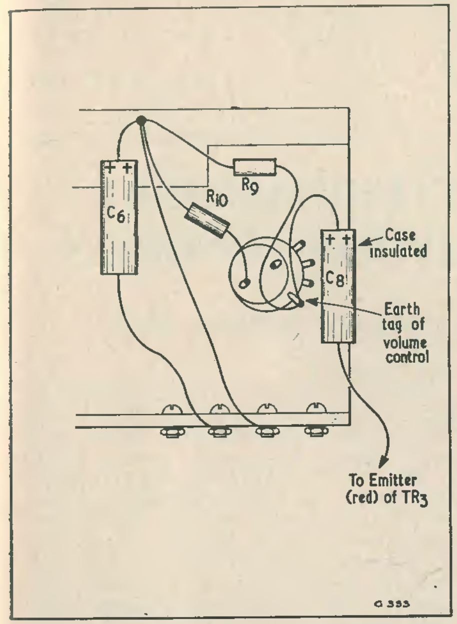


Fig. 2. The new layout employed at the rear of the chassis

Most other queries have been answered individually by the writer. Two letters, worthy of comment, asked if a suitable transistor receiver would be designed for use in a car. At the present state of transistor design such a possibility is remote, owing mainly to the low audio power available from transistor output stages.

A Modification

In some instances constructors have found that the output transistor, TR3, has caused distortion, or has consumed too high an h.t. current. To overcome this difficulty it has been decided to issue a modification to the output circuit. The new output circuit is illustrated in Fig. 1, and the purpose of the additional components shown in this diagram is that of stabilising the operating conditions of the transistor. This stabilisation ensures that variations from transistor to transistor, or with alterations in operating temperature, are reduced. The new output stage is fully approved by Standard Telephones and Cables, and readers may be interested in comparing it with the original circuit in the February issue. New component references (starting from R_9 in the case of resistors and consisting of C_8 in the case of the condenser) are given in Fig. 1, this being done to prevent confusion with the original circuit. The parts list accompanying this article details the new components necessitated by the modification.

In the original circuit R_6 was 5 kΩ, and this resistor is now discarded. If, however, its value happens to lie close to that of R_9 of Fig. 1 (5.6 kΩ) it could be re-employed in the modified arrangement. Otherwise, it would be better to use a new component.

Layout

The modifications required to the layout originally described are not excessive. C_7 and R_6, whose positions were shown in Fig. 16 of the April issue, are not now required. C_7 may, in consequence, be removed altogether. If, as was mentioned above, R_6 is sufficiently close in value to R_9, it may be retained in position. Otherwise it should be replaced. An additional resistor, R_{10}, connects the positive end of C_6 to the h.t. negative line at the on-off switch contacts. An additional condenser, C_8, is connected between the volume control earth tag and the

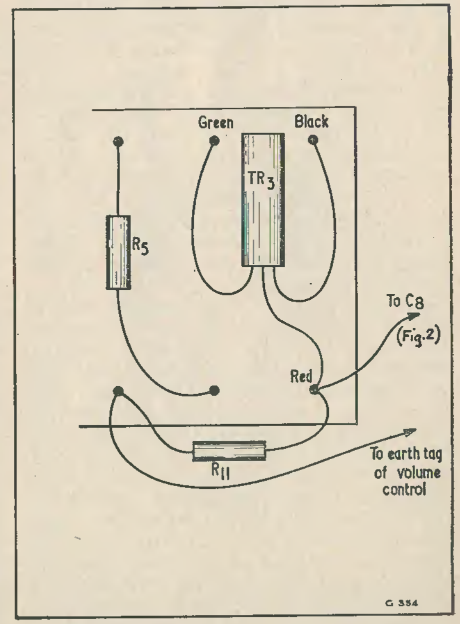


Fig. 3. The modified tag-panel connections

emitter of TR3. Fig. 2 shows the layout of these new components.

On the transistor tag-panel a few minor alterations are made, these being illustrated in Fig. 3. The most important change is that the chassis lead is now disconnected from the emitter of TR3. However, this chassis lead still ensures that the remaining tags at chassis potential on the tag-panel continue to be connected to the earth tag of the volume control.

R_7 is removed by the modification; and a new resistor, R_{11}, is added, this being fitted between the tags shown in the diagram. Fig. 3 should be compared with Figs. 17 and 18 of the April issue.

Additional Components required for the Output Stage Modification

R_9	5.6kΩ (see text)
R_{10}	15 kΩ
R_{11}	1.8 kΩ
C_8	20 μF, 12V Pk wkg. T.C.C. type CE30B (case insulated).

REPORT ON THE INTERNATIONAL AMATEUR RADIO UNION CONGRESS

Second Triennial Conference, Stresa, Italy

It is a pity that more is not heard of the activities of I.A.R.U., particularly the work carried out in Region I, for as Arthur Milne, G2MI, Region I Hon. Secretary, remarked at the opening session of the Second Triennial Conference held at Stresa, Northern Italy, in June, one of the most important aspects of its work is to defend Amateur Radio frequency allocations at I.T.U. Radio Conferences. Lack of adequate representation at these conferences would mean, without doubt, a steady further whittling down of our already meagre amateur frequencies.

A perusal, however, of the agenda submitted for the consideration of the fifty or so delegates from twelve Region I National Amateur Radio Societies soon showed that the activities of I.A.R.U. cover a much wider field of interest than solely licence matters, as the following résumé of the Conference's deliberations will reveal. Readers will recall that we reported the first of these triennial Conferences which was held at Lausanne in 1953, and your reporter, who was again present at Stresa this time, trusts that the following very brief account will give some idea, at least, of the amount of work put in by the delegates to the 1956 Conference.

Much time was spent on the problem of QRM from non-amateur transmitters in our various bands. The general opinion expressed was that the only way to deal with this was for each country to continue to press its Government to make representations to the Governments of those stations causing the interference. This may be a slow, long drawn-out method, but it is the only way the matter can be dealt with officially, and it has in a number of instances proved successful.

Top band enthusiasts will be gratified to hear that an appeal was made to those delegates from countries whose Governments could allocate frequencies between 1.8 to 2 Mc/s to press hard for these facilities. OE, EI, PA and HB9 are amongst countries who could have top band, if their Governments would make the necessary regulations. At the moment Great Britain is the only country whose amateurs demanded—and obtained—the right to use top band; and it was felt that if more countries did not use this band, amateurs may well lose it at the next I.T.U. conference. An interesting point brought out in the discussion on licence matters was that all countries in Region I now require a technical examination for the amateur radio licence.

Your reporter had the honour of being asked to open the discussion on Amateur Radio Emergency Networks, during which it transpired that numerous such organisations were in existence. Norway, for instance, provides one during their ski-ing season; Germany has one working with the Red Cross, and France has a most extensive organisation, including a listening watch during the night for stations in the trouble zones of N. Africa. The feeling of the Conference was that this aspect of amateur radio should be greatly encouraged.

The editor of Q.S.T., Mr. Budlong, W1BUD, who was present at the Congress, announced that during the forthcoming Geophysical Year radio amateurs would be asked to co-operate in two projects. One was to help track the earth satellite, the other was to help in V.H.F. tests. Details of these projects will appear in the July issue of Q.S.T.

In view of the fact that some countries have frequencies in the 72–72.8 Mc/s region, which is scheduled for amateur transmission, it was felt that all Region I societies should press their Governments for these frequencies to be made available.

The technical committee produced little of interest. A suggested procedure for reporting on "intruders" was outlined; a hope was expressed that more encouragement might be given to S.S.B. and rules formulated for V.H.F. contests. One interesting suggestion was that more attention should be paid to transistor gear for R.A.E.N. purposes. Another interesting decision taken by the Congress was to designate the frequency 14195 kc/s as an emergency calling frequency. It was not suggested that this frequency be kept clear, but that those wishing to should monitor it, so that anyone making an emergency call could do so with some hope of being heard without too much delay.

Surprises came at the final session when the new I.A.R.U. Bureau I Committee was elected for the coming three years. Mr. J. Clarricoats, G6CL, had to surrender the Hon. Treasurership to M. Jacques Simonnet, F9DW. Mr. Arthur Milne, G2MI, was unanimously re-elected Hon. Secretary, and M. Harry Laett, HB9GA, was deservedly elected Chairman.

Finally, your reporter must record his thanks to the Italian Amateur Radio Society for their hospitality and good taste in choosing such a beautiful venue as Stresa for the Congress. A. C. Gee, G2UK

TRADE REVIEW

Messrs. K. W. Electronics' Mobile V.H.F. Equipment

Since the introduction of the "mobile licence" for radio amateurs in this country, interest in mobile operation has increased rapidly. From the constructor's point of view, many new problems present themselves, particularly in the field of miniaturisation and the designing and building of equipment compact enough to be fitted in the modern car. For those with the requisite workshop facilities and skill, these features add greatly to the interest of their hobby, but for others they are a handicap to possessing efficient and unobtrusive gear. For many, the family car must not be made to resemble a "ham shack." If mobile equipment is to be fitted, it must be as neat as the BC receiver.

It is not surprising, therefore, that radio manufacturing firms have come to the amateur's aid. One of the first in this field is K. W. Electronics Ltd., of 136 Birchwood Road, Wilmington, Dartford, Kent. The most noteworthy of the equipment they are now producing, from the amateurs' point of view, is their "Hamobile" transmitter-receiver, the first commercial 2 metre equipment specially designed for the radio amateur to be manufactured in this country. Two models are available, one of 12 watts input and the other of 25 watts input, both phone and c.w. operation being provided for. The receiver is a double conversion superhet. The overall measurements of the units have been kept remarkably compact. The transmitter/receiver unit measures 12in by 8in by 5in and is designed specifically to go under the dashboard. A separate speaker unit measuring 6in by 6in by 2¼in is provided and the power supply, 10in by 4½in by 4½in can be located elsewhere in the car. A total of 19 valves are used, 8 during transmission and 14 during reception. Various aerial arrangements are available and an a.c. mains supply unit can be had by those wishing to use the equipment as a fixed 2 metre station.

Full particulars can be had from the address given. It is worthy of note that this gear can be obtained in kit form, thus enabling those who like to build as much of their gear as possible to do so, even though they may not have the facilities to build up from scratch.

Another item of equipment of interest to the amateur "mobiler" is the KW105 Mobile Radio Telephone manufactured by this firm. Primarily intended for the commercial user, one model covers the range 100-156 Mc/s and could therefore be used for 2 metre communication. This is one of the most powerful v.h.f. mobile units being made in this country to-day. Both transmitter and receiver, together with the rotary power supply, are housed in one cabinet for installation in the car boot. A neat control unit comprising loudspeaker, volume control and microphone is provided for fixing near the driver's seat. The transmitter has an r.f. output of 15 watts.

We foresee a considerable increase in mobile operation in the near future, and we recommend readers to keep Messrs. K. W. Electronics' products in mind when planning their mobile installations.

DESIGN CHARTS FOR CONSTRUCTORS

No. 8. INDUCTANCE-CAPACITY-WAVELENGTH CHART LONG WAVES

by HUGH GUY

THIS IS THE FOURTH AND FINAL CHART OF the series covering inductance and capacitance values for the Short, Medium, Intermediate and Long wavelengths, and their determination. In this month's issue the procedure that has been given in the previous issues in detail is outlined for the benefit of new readers.

The chart assists the determination of suitable values of inductance and capacitance for tuned circuits to resonate at a specified wavelength. The chart therefore has three scales, marked accordingly in the units of inductance, capacitance and wavelength.

Inductance values range from 100μH to 10mH, whilst the capacitance values vary from 50pF to 0.015μF (i.e. 15,000pF). The Long Wave band covers 450 to 6,000 metres.

Two reference lines will be seen marked on the chart. These are the "λ Line" and the "Key Line" respectively. They are used to transfer one set of data from one line to the other to relate the inductance, capacitance and wavelength information.

The working out of an example is shown in dotted lines on the chart and best illustrates the use of it.

Example

Determine suitable component values to tune to the Light programme on 1,500 metres.

A horizontal line is scanned across to the "λ Line" from the wavelength scale through the point "1,500 metres."

This intersection is now dropped vertically to intersect the "Key Line." This move relates what are, in fact, two distinct sets of data.

Through this intersection a diagonal line is traced, either visually or by means of a straight edge, parallel to the other diagonal lines already marked on the chart.

Now any two component values intersecting on this diagonal will tune to the required wavelength of 1,500 metres. Thus at one extreme 10mH will resonate with 63pF, whilst at the other an inductance of 100μH requires 6,300pF.

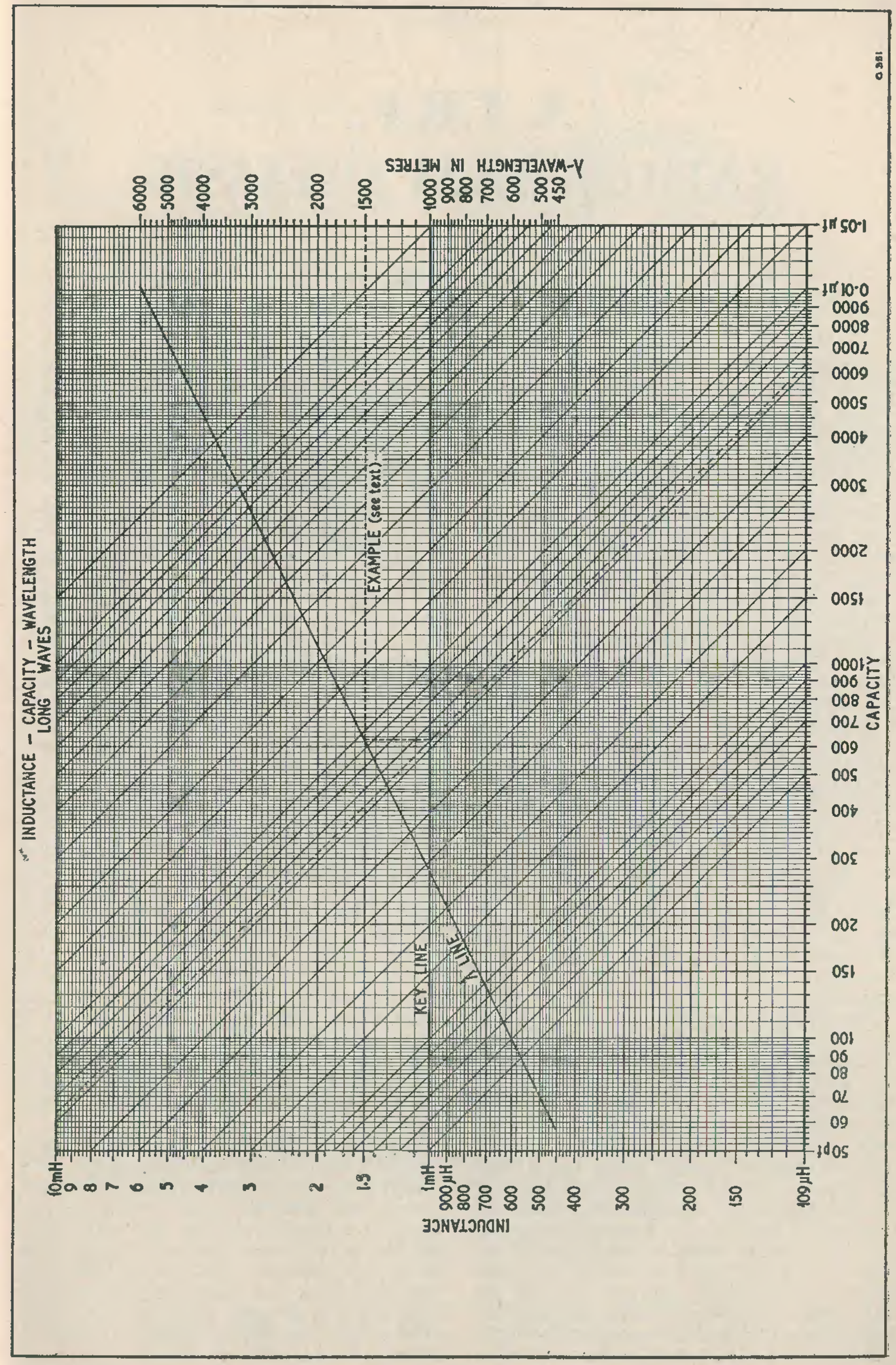
Of course, the changes may be rung on this use of the chart: for example, the above procedure is merely reversed if it is required to know at what wavelength two given components will resonate.

Consider, for example, a tuned circuit comprising an inductance of 2.5mH and a capacitance of 1,000pF. The point of intersection is first located, in the steps to determine the resonant wavelength. It will be noted that here, as is invariably the case, the point of intersection does not occur on one of the existing diagonal lines. A diagonal line is, therefore, either sketched lightly in pencil through the point, or alternatively interpolated, that is, mentally drawn in, to cut the "Key Line." This point is then referred vertically to the "λ Line," when the appropriate wavelength is read on the "Wavelength" scale. In the case considered, the wavelength is found to be 3,000 metres. The calculated answer yields a result of 2,980 metres. Hence the chart gives an accuracy of better than 1%.

Next month a design chart of a similar nature will be given, this time relating inductance and capacitance values with their *frequencies* of resonance for the audio-frequency spectrum. This will assist constructors in the choice of appropriate components for tone control circuits, for example, and for low frequency amplifier filters in general.

NEXT MONTH . . . **General Purpose Transistor Equipment**

Owing to circumstances beyond our control, Part 8 of RIGHT—*From the Start* has had to be held over to the next issue.



A T.R.F. RADIOGRAM CHASSIS

by C. NOALL

It is not easy to design a circuit for that important and greatly-to-be- encouraged person, the "beginner," which will satisfy his desire to build something in the "quality" class without overtaxing his, as yet, rather limited constructional ability. In this radiogram chassis, however, the writer believes he has succeeded in reconciling these two somewhat opposite requirements in a satisfactory manner; whilst a further recommendation is that the overall cost has been kept low by using inexpensive "surplus" type valves.

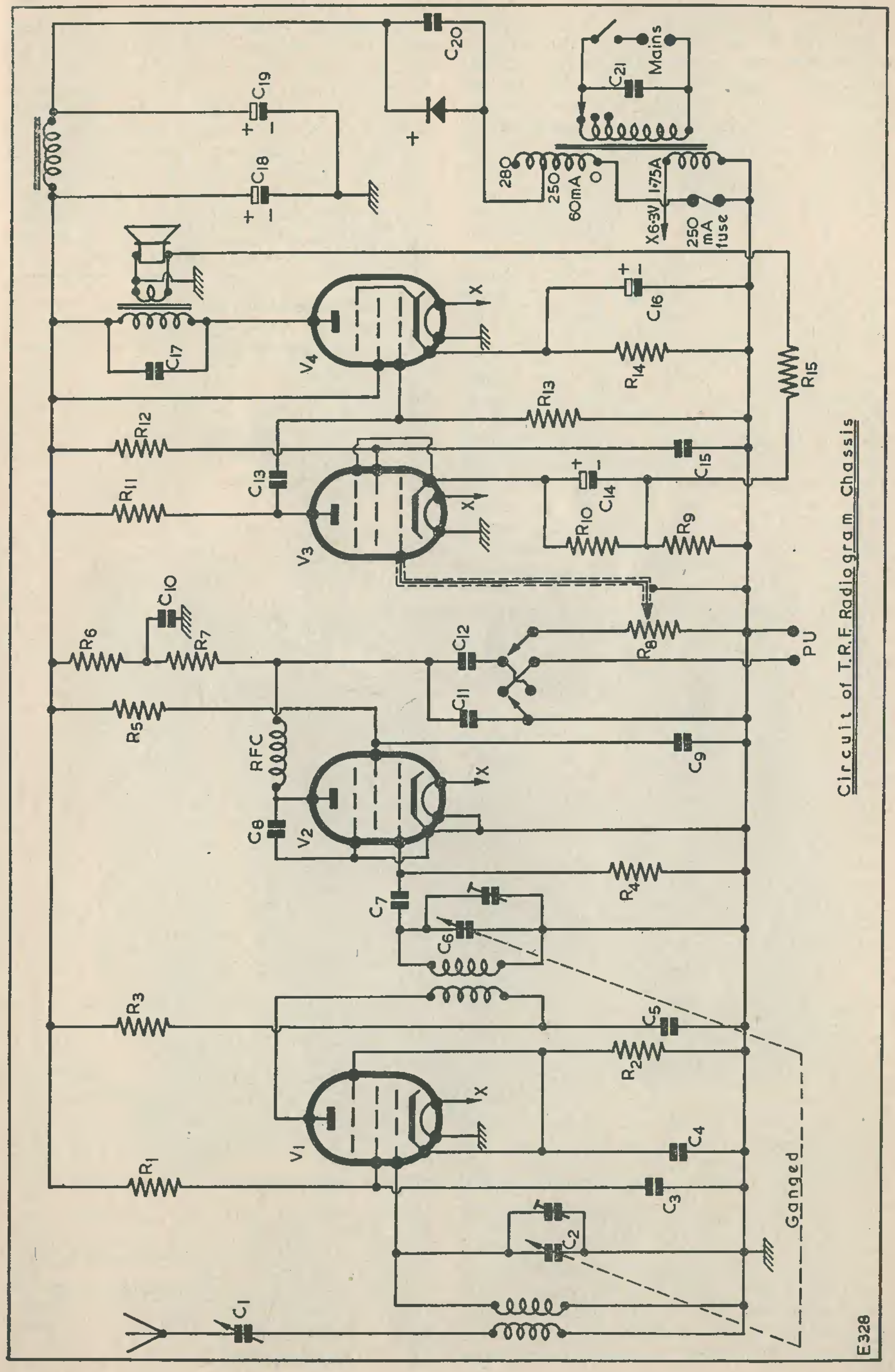
This circuit aims at providing high quality reproduction of both radio and records, and incorporates negative feedback. On the radio side, a simple "straight" design is employed; this has been preferred to a superhet circuit on account of the ease with which it may be lined-up—no signal generator being required—as well as for the high-fidelity reception which it ensures. The set will, of course, only supply such entertainment from the local B.B.C. transmitters; but this limitation will hardly be considered a drawback by the majority of listeners, I think. Distant stations could be brought in by the addition of a reaction circuit; but this automatically introduces quality degeneration, and has, for this reason, been omitted.

Examining the circuit, V_1, an EF50, is an r.f. amplifier and V_2, also an EF50, the detector. The l.f. portion of the set consists of V_3, an EF36, the l.f. amplifier, and V_4, a 6V6, which is the output stage. The degree of amplification obtained from the last two stages should be quite sufficient to cope with all modern "gram" units, but it may be as well to point out that a further preliminary stage of amplification would be required to operate, say, a sensitive moving-coil microphone. Nothing elaborate in the way of tone-correction networks has been included. The circuit does not aspire to the hi-fi class, and complicated designs for balancing out different recording frequency characteristics would only bother the novice without adding significantly to the amplifier's overall performance. A manual tone control is also lacking, it being regarded as quite inessential in the present design. R_{15} could be replaced by a variable potentiometer, if desired, this component then being used to vary the output quality.

The receiver is not a kit-of-parts model, and the constructor will therefore have to do a little "chassis-bashing" before he can begin its assembly. This is, of course, no bad thing, since he will learn much in the process about such matters as metal working and the correct layout of components. Much of the drudgery of this work may be eliminated if a chassis is purchased in which the valveholder cut-outs have already been punched; but it is not always easy to obtain a pre-punched chassis to suit one's exact requirements.

It is important to ensure that the output transformer is kept well away from the power pack components to avoid all possibility of induced hum pick-up. V_3 should, ideally, be enclosed in a metal cover for the same reason. Keep all wiring as short and rigid as possible, and use screened lead for all grid connections in the l.f. section. Due to the rather "flat" tuning characteristics of the receiver, no reduction drive is necessary on the tuning condenser; a pointer-type knob fitted directly to the spindle will answer perfectly well. The simplest form of dial can be used, also—a fact which may be considered a boon when the chassis has to be packed away in an awkwardly-shaped cabinet.

Inspired by the example of some commercially-made table radiograms, the constructor may be tempted to cram the chassis into a very shallow "shelf" where there is hardly clearance room for the valve cans; but this is not a wise practice. A minimum air gap of one and a half inches should be allowed above the main components; and it would also be good policy to mount the 6V6 at the rear of the chassis, as near to the ventilation grille as possible.



Circuit of T.R.F. Radiogram Chassis

It may be necessary to accommodate certain of the smaller components—such as condensers and resistors—upon tag boards; but many could be wired directly to the valveholders or clamped to the chassis. A set in which most of the components are mounted in the latter fashion is, in the writer's view, definitely easier to service; but the constructor should use his own judgment regarding such details of layout. Do be sure to keep all condensers—particularly electrolytics—as far from all sources of heat as possible. Earth the metal braiding of screened leads at one end only, and keep all grid connections as far removed as you can from the heater and mains wiring.

Before switching on, check all your wiring very carefully. Then, with the valves removed, plug in to the mains, and check for h.t. at all appropriate places with a meter. If no meter is available, double-check the wiring, paying particular attention to undesirable solder bridges between the valve tags, etc., and test for any short between h.t.+ and chassis. Then switch on; *do not on any account omit the fuse.*

Some slight adjustments will be necessary to get the best results from the receiver section of the unit. Connect up an aerial—preferably a long outdoor wire—and, with the volume control well advanced, rotate the tuning condenser. You will almost certainly hear signals at some setting of the dial. Select a station at the l.f. end—the Northern Home Service, say—and adjust the aerial coil trimmer (on the ganged condenser) for maximum volume. Then peak the detector coil trimmer for the same frequency. Next tune in a station near the h.f. end of the dial—the Light or Third would do very well—and repeat the same procedure, then choose a compromise setting which will give optimum performance at both ends of the dial. Finally, adjust C_1 for maximum volume. The alignment of the set is now completed.

Negative Feedback

When first testing out the radiogram, it is desirable to put the negative feedback circuit out of action by disconnecting R_{15} from the output transformer secondary. The set should then give a perfectly satisfactory account of itself on both radio and gramophone, except that reproduction may sound rather shrill, with accentuated surface noise on records. Having assured yourself that all is well, reconnect R_{15}, and observe the result. If reproduction now seems worse than before, with a hollow "woolly" effect, or if there is a continuous oscillation, leave R_{15} connected but reverse the two other connections to the transformer secondary. A great improvement in quality should now be observed, with hum and background noise much reduced. The gain also will be less, however, and it will be found necessary to advance the volume control in order to achieve the same output volume as before. If desired, a switch could be fitted to R_{15}, so that n.f.b. could be switched in and out, as required. When using n.f.b. with an output pentode, it may be found that a crisper reproduction on speech can be obtained with the feedback circuit removed; but it always gives improved results with music.

List of Components

C_1	50pF, Variable
C_2	500pF, Variable
C_3	0.1µF
C_4	0.1µF
C_5	0.1µF
C_6	500pF, Variable
C_7	300pF, Mica
C_8	300pF, Mica
C_9	0.1µF
C_{10}	1µF
C_{11}	100pF
C_{12}	0.01µF
C_{13}	0.02µF
C_{14}	50µF, 25VW
C_{15}	0.2µF
C_{16}	50µF, 25VW
C_{17}	0.002µF
C_{18}, C_{19}	16µF, 450VW
C_{20}	0.01µF, 500VW
C_{21}	0.1µF, 500VW
R_1	1MΩ
R_2	50Ω
R_3	50kΩ
R_4	250kΩ
R_5	1MΩ
R_6	50kΩ
R_7	100kΩ
R_8	250kΩ, Pot.
R_9	100Ω
R_{10}	1,200Ω
R_{11}	250kΩ
R_{12}	750kΩ
R_{13}	500kΩ
R_{14}	270Ω
R_{15}	1,800Ω

Valves

V_1, V_2	EF50
V_3	EF36
V_4	6V6

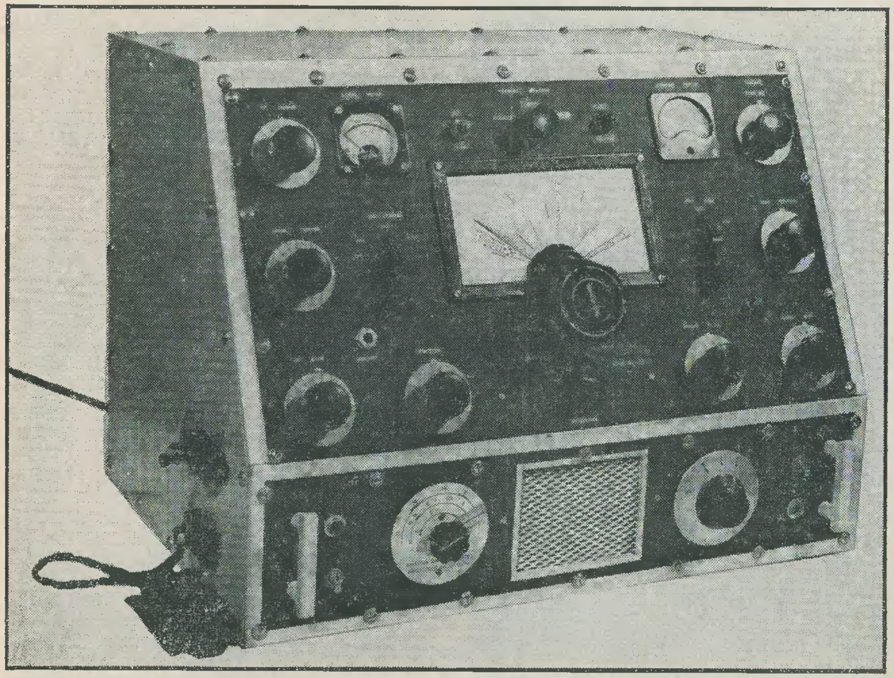
M.R. 250V, 80mA
Choke 80mA
H.T. Fuse 250mA
Output Transformer, Pentode type, secondary to match L.S.
Mains Transformer, Electrovoice 106 (H. L. Smith & Co. Ltd)
L_1 Repanco RA2
L_2 Repanco RHF2

"Straight" receivers are sometimes prone to a trouble known as "modulation hum," the tracing and cure of which can provide quite a headache for the constructor. I have found that one of the surest ways of preventing this annoying fault is to connect a low value condenser across the terminals of the metal rectifier—C_{20} in the diagram. It must, however, be of a high voltage rating, to guard against breakdowns.

Unless a separate playing desk is to be used, care should be taken to ensure that the gram unit you purchase makes a good fit with the cabinet. Regarding the choice of record player, it may be remarked that the modern long-playing disc has made the auto-changer rather less essential than it used to be, and a considerable saving in cost can be achieved if this feature is dispensed with. Whatever type of player is selected, make sure it is one of the latest, fitted with the new featherweight pick-ups. Older models, at reduced prices, are not good "buys," as their heavier pick-ups result in increased record wear.

The design of this radiogram unit is so simple and straightforward that no serious snags are likely to arise during its construction. Provided that good quality components only are used and that all reasonable care is taken during assembly, it should function perfectly as soon as the preliminary adjustments have been made.

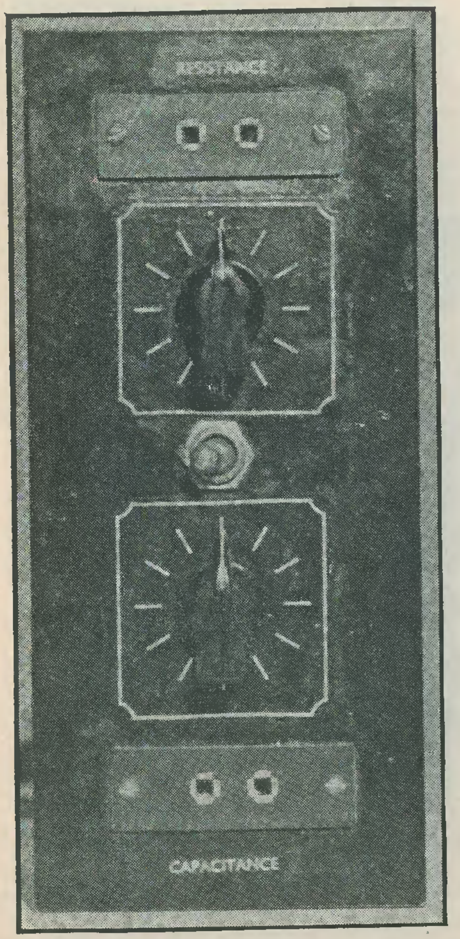
Note: The above circuit will be found very flexible so far as valves are concerned, a wide range of substitutions being possible for those shown here. Thus, V_1, V_2 and V_3 could all be 6J7's, and V_4 an EL32, without changing any circuit constants. Many other variations are possible, with only slight changes to the bias resistor values; and the design could easily be stretched to cover modern valve types.



The photograph above shows the receiving station of reader Eric Jackson, of March, Cambs., which was built around the "Invader" described in the October 1953 *issue of the* Radio Amateur. *Additional items which have been added to this are an S meter, upper left; a tuning meter, upper right; an FL8 filter, to the left of the tuning dial; aerial switch, above the dial; a morse practice oscillator; and, along the bottom on either side of the speaker, a Webb's Radio wavemeter. Congratulations to our reader on his impressive effort*

A Handy RESISTANCE-CONDENSER BOX

by E. GOVIER



Front Panel layout

Many readers of the magazine, like the writer, must spend a great deal of time in the workshop either on constructional work, or on experimental projects of one sort or another. In either type of work, but more so the latter, in the course of time many hours must be wasted trying this or that value of component in a circuit. This is especially true where both a resistance and condenser combination are required to be wired in a particular part of the circuit. In order to save endless time and trouble, the writer built the simple little resistance/condenser box about to be described.

Circuit and Construction Notes

As may be seen from Fig. 1, this is simplicity itself. It consists of eleven resistors and condensers, with two eleven-way, single-pole, Yaxley type switches. The values of the components will be found in the component list, and from this it will be seen that these values have been chosen to include standard preferred values, easily obtainable from advertisers where they are not already to hand. These values were chosen to cover as wide a range as the writer normally uses, but there is no reason why an intending constructor should not alter any, or all, of these to suit his individual requirements. The components themselves are not of the high precision type but the more usual $\pm$ 20% types, the unit only being required to operate to rough limits. A resistance/condenser box using the high precision type of component is, of course, more desirable but more expensive. For those desirous of working to extremely fine limits of accuracy, these more costly components should be used.

The resistors should first be wired to the switch contacts with the lowest value component in position 1 (R_1 of Fig. 1), and the highest value at the opposite end of the switch range. Once these are all soldered into position, the free ends should be bent so that they all join, cleaned and tinned, and then soldered together so that the whole assembly becomes self-supporting (see photographs). The selector tag of switch 1 should now be soldered direct to one side of the single-pole single-throw switch 2, and from this to one tag of a paxolin strip of the aerial/earth type mounted on the front panel of the box. The common termination of the resistors should now be joined to the other tag of the paxolin strip. Thus, these then become A and B.

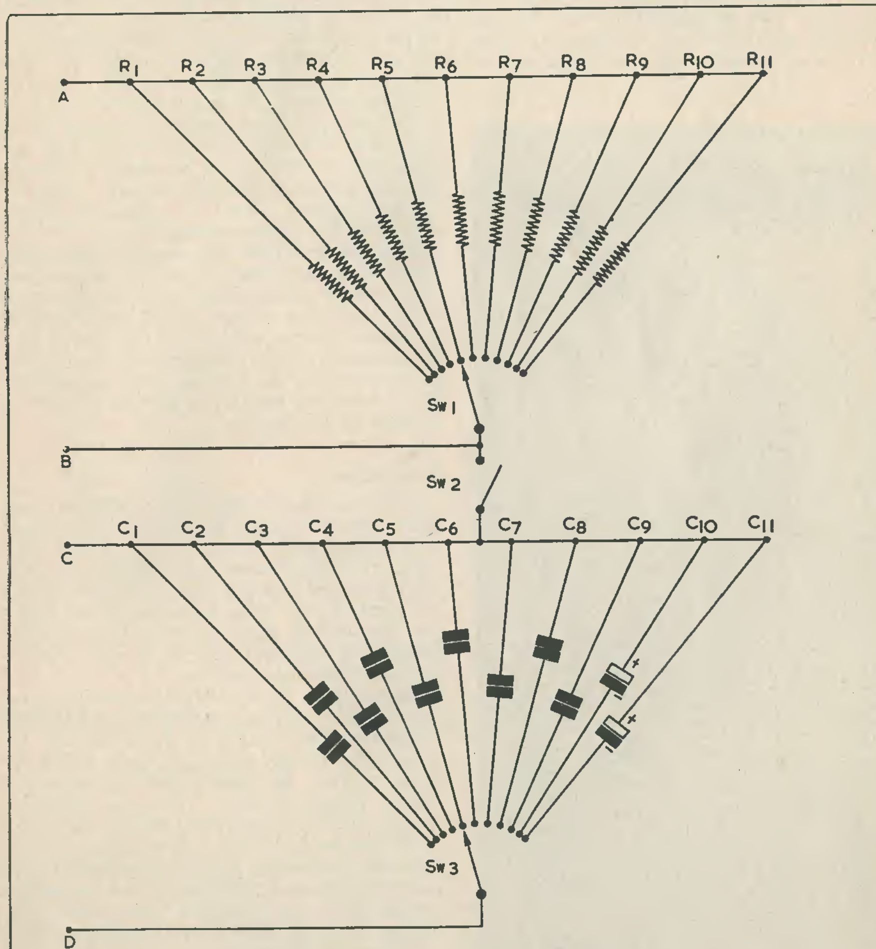


FIG.1. Circuit of the RESISTOR / CONDENSER BOX

Exactly similar treatment should be given to the condensers, but here more care will be needed owing to the greater physical size of the individual components—especially the 8μF electrolytic. However, a glance at the accompanying illustrations will greatly assist here.

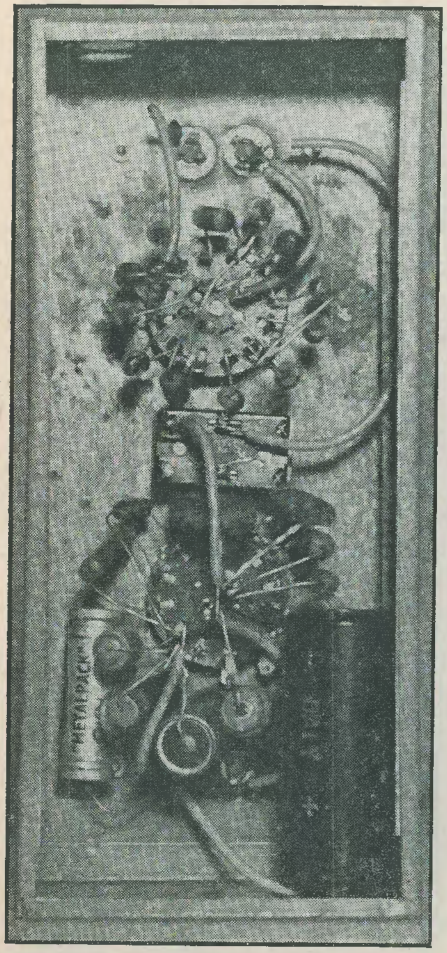
The metal case containing the unit was obtained, complete with a slide-in back panel, from R.C.S. Products (Radio) Ltd. On the inside of this rear panel has been affixed a small card showing the values of components at any particular switch position. However, this could equally well be carried out by using the Panel Signs set No. 3 and affixing the appropriate value transfers on the front panel. For those that prefer to construct their own metal case, the sizes are—length 7½in, width 3¼in, depth 2¼in.

Four "banana" plugs should now be fitted with short lengths of flex and terminated at the other end with crocodile clips. A tip here is to fit under the crocodile screws a solder tag and to solder the wire end to this tag.

Little else need be said about the actual construction of the resistance/capacitance box, but a few of its uses may not come amiss—especially for beginner readers.

Practical Uses

There are, of course, many of these and only a few will be described here. Broadly speaking, any resistor or condenser, within the range of the unit, may be switched into, or out of, circuit by operating the appropriate switch. Thus, in Fig. 2, the dropping resistor on the screen grid of the valve may be changed experimentally by connecting the common resistor line (A) to the h.t. rail, and the output from switch 1 (B) to the junction of the bypass condenser and the remaining resistor. Similarly, any of the resistors in the associated circuit could be so replaced if desired.



Back of Panel layout

For the replacing of decoupling condensers, exactly the same method applies, the common terminal (C) being connected to the junction of the anode line resistors and the output from switch 3 (D) being connected to chassis. The above remarks apply for a single component so long as switch 2 is in the off position.

Before proceeding further, it would be as well here to warn beginner readers that the component which is to be replaced should first be removed from the circuit. This, of course, applies where a suspected faulty component is to be replaced.

Fig. 3 shows how it is possible to experiment with the values of both a decoupling resistor and condenser at one and the same time. For this, switch 2 must be in the on position. A comparison with Fig. 1 will show how this works. (A) the common resistor line is connected to the h.t. rail; (B) is secured to the remaining anode resistor and (D) is clipped to the chassis.

Precautions

When using an instrument such as this, there are, of course, several common sense precautions to be taken. Firstly, when clipping crocodile fasteners to the h.t. + rail, always ensure that the mains switch is in the off position and never, never leave one hand on the chassis itself while making adjustments. It is always best in the long run to switch off and be doubly sure.

Secondly, it is of little use putting a low value such as, say, a 330Ω resistor into circuit whilst experimenting with anode loads. A rough idea of the normal values required in each portion of the circuit is necessary before experimenting. The same remarks would, of course, apply to condensers.

Thirdly, make sure that the crocodile clips are only connected to those points in the circuit which are appropriate to the test being carried out. An expensive "burn out" may follow where the h.t. + rail is accidentally connected to the chassis!

Conclusion

All in all, this inexpensive little resistance/condenser box will save much time and trouble where used with a little foresight with reference to the above remarks. The long, and often laborious, removal and replacement of several components in an experimental circuit, with the often consequential heat damage from the soldering iron to surrounding components, soon becomes a thing of the past.

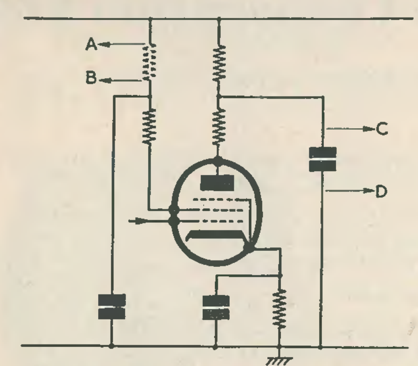


FIG.2. Substituting individual resistors & condensers

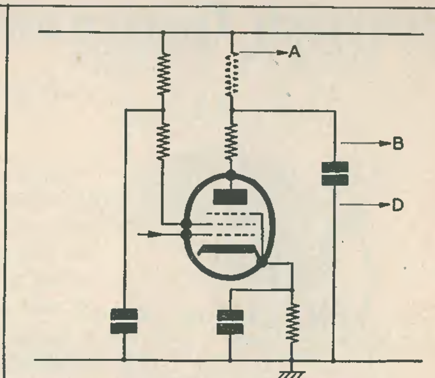


FIG.3. Substituting both a resistor & condenser

G 311

Component List

Resistors

- R_1 330Ω ½ watt
- R_2 1kΩ ½ watt
- R_3 3.3kΩ ½ watt
- R_4 4.7kΩ ½ watt
- R_5 10kΩ ½ watt
- R_6 27kΩ ½ watt
- R_7 47kΩ ½ watt
- R_8 100kΩ ½ watt
- R_9 220kΩ ½ watt
- R_{10} 470kΩ ½ watt
- R_{11} 1MΩ ½ watt

Cabinet

R.C.S. Products (Radio) Ltd.

Condensers

- C_1 220pF, Ceramic
- C_2 100pF, Ceramic
- C_3 220pF, Mica
- C_4 500pF, Mica
- C_5 0.001μF, Mica
- C_6 0.005μF, Tubular, 350V wkg
- C_7 0.01μF, Tubular, 350V wkg
- C_8 0.05μF, Tubular, 350V wkg
- C_9 0.1μF, Tubular, 350V wkg
- C_{10} 2μF, Electrolytic, 350V wkg
- C_{11} 8μF, Electrolytic, 350V wkg

Switches

(2) Single-pole, 11-way Yaxley type. Single-pole, single-throw on/off. (2) Paxolin aerial-earth strips. H. L. Smith & Co. Ltd.

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via fixed attenuator 1 Megohm and 15pF.
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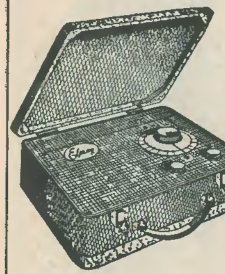

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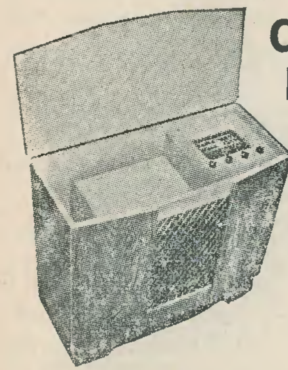

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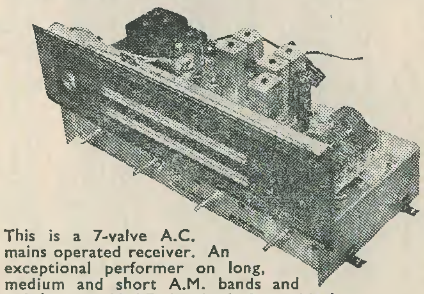

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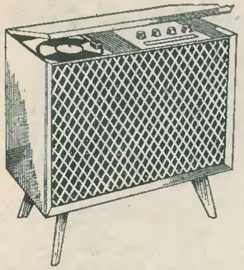

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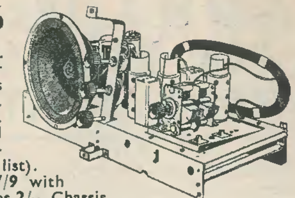

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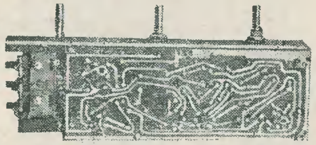

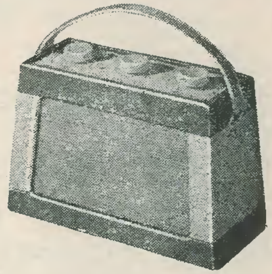

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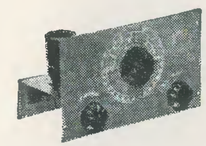

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