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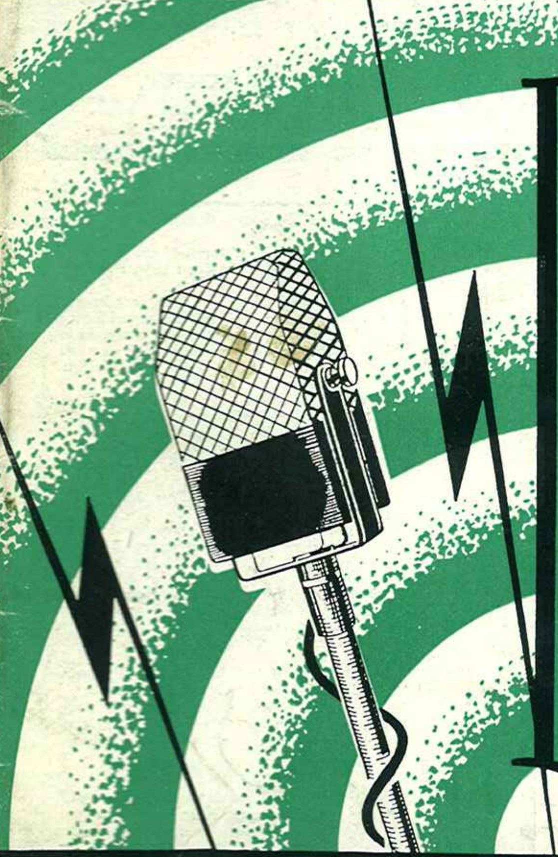
Vol. 3 No. 5
DECEMBER
1949

RADIO CONSTRUCTOR

For Every Radio Enthusiast



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Contents

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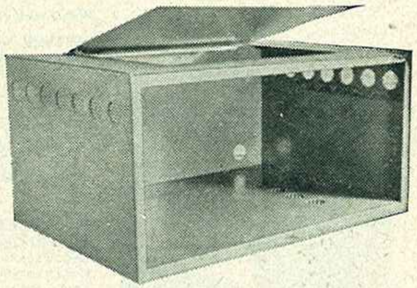

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Radio Constructor

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Edited by: C. W. C. OVERLAND, G2ATV LIONEL E. HOWES, G3AYA

EDITORIAL

ONCE again Christmas is upon us, though why the spirit of goodwill achieves prominence only at this time of the year beats us. Why not be logical and practise it the whole year round?

That is the idea behind the International Short Wave League, sponsored by our companion journal "Short Wave News," and we have often wondered whether this could be extended to include the "Radio Constructor."

A visit to the local radio component dealer will demonstrate, as mentioned recently by our contributor "Centre Tap," that the helpful spirit exists amongst the followers of our hobby. Why should this spirit of co-operation be hampered by being restricted to these chance meetings?

The ISWL has a considerable number of local chapters organised around the country, and these clubs hold regular meetings. If any of our readers are interested in contacting others with similar interests, we should be pleased to put them in touch with their local ISWL representative on receipt of a note to that effect.

The ISWL is a short wave organisation, and it may be that this specialisation in one particular branch of radio may not appeal to some readers. We suggest, in this event, that there exists an opening for local constructional groups, and we would be glad to receive any comments, suggestions and offers of help regarding the formation of such groups.

We think the idea is a good one, but we are also not unmindful of the fact that it may not be easy to achieve, and whether it goes any further depends on your. We are prepared to help as much as we can if sufficient interest is shown, but without your aid we can do little. So get out that pen and paper and shoot along your reactions. For now, we'll sign off in the usual manner by wishing you, one and all, A Merry Christmas and A Happy New Year.

G2ATV

NOTICES

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

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

ALL CORRESPONDENCE should be addressed to *Radio Constructor*, 57, Maida Vale, Paddington, London, W.9. Telephone: CUN. 6518.

BUILDING YOUR OWN
SIGNAL GENERATOR

By **W. G. MORLEY**

PART ONE

ONE of the most useful items for the home-constructor and experimenter is the signal generator. Its uses are many: the easy servicing of recalcitrant receivers and the trouble-free construction of newly-designed equipment being only two of its many uses. Unfortunately, the average commercial signal generator has one disadvantage—a fairly high price.

Is it possible to construct a reliable signal generator cheaply? I think it is, and with relatively little trouble, provided we take a certain amount of care in its original design. Let us therefore analyse the various facilities that are needed and see if they may be met in a home-constructed job.

Range and Calibration

First of all, the most obvious thing needed in a signal generator is a wide frequency range accurately calibrated. A range of some 100 Kcs to 15 Mcs should cover all the normal frequencies required by the constructor and falls in line with that offered by most commercial generators. (This can be extended up to 30 Mcs by using the second harmonic of the "top" range; or, with careful design, we could tune up to this frequency on the fundamental, if we thought its inclusion of sufficient importance.) This range is not too extensive or too difficult to provide, especially when we consider that the oscillator of a simple all-wave superhet very often works at frequencies of up to 18 Mcs and higher, and that the construction of an all-wave receiver is by no means beyond the ability of the average home-constructor.

The question of accuracy of calibration presents a somewhat different problem. We must first of all provide a dial or scale (directly calibrated, if possible) in which the pointer is so made that errors due to parallax, etc., are reduced to a minimum. After making certain that our scale, like Caesar's wife, is beyond reproach, we then have to make an accurate *original* calibration and see that the frequency given by the signal generator remains always constant *after* that calibration.

Output Attenuation

If a signal generator for normal bench work is to be at all useful, its output must be capable of attenuation. This is best done by means of extracting the RF output of the oscillator at a

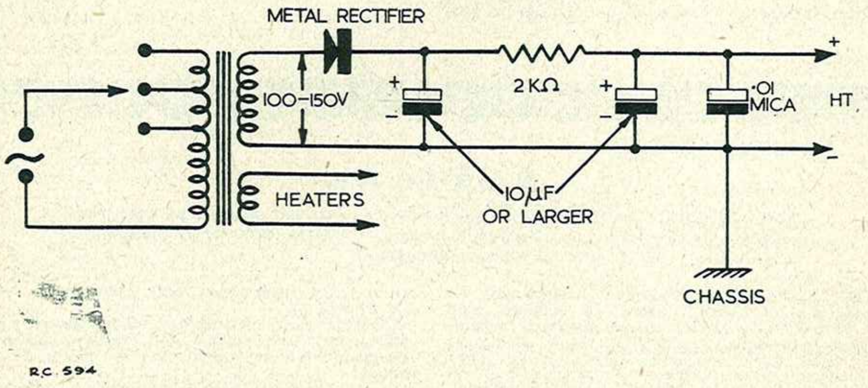
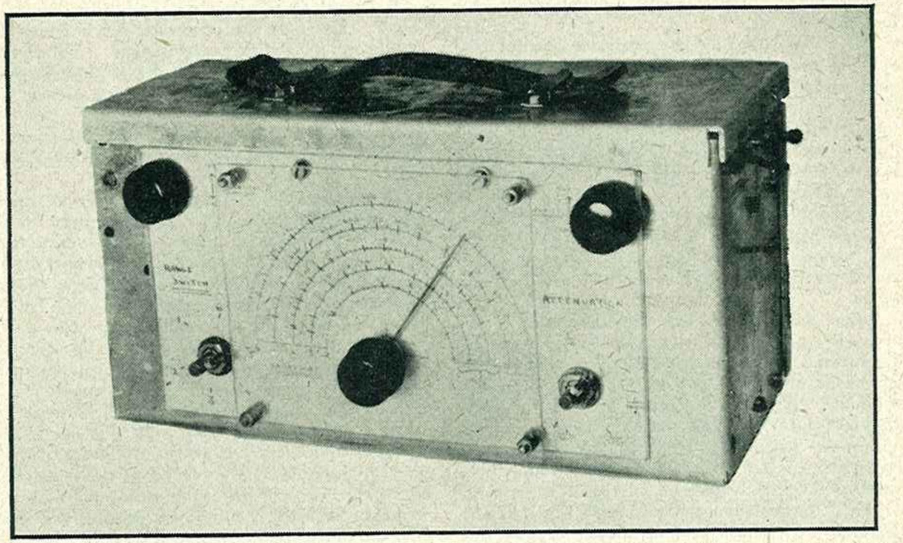


Fig. 1. A typical power supply circuit for a Signal Generator.



fairly low impedance, say 100 ohms or less, so that, in addition to easy attenuation, we can feed the signal to wherever we may need it by means of an ordinary flexible screened lead. Attenuation is usually carried out by means of coarse and fine controls: the coarse attenuation being provided by a switch which, say, offers the full output of the oscillator, one tenth of its output, one hundredth, one thousandth, and so on. The fine attenuator could be described roughly as a low-impedance, non-inductive volume control which covers the range of zero output to the full output which is offered by the coarse attenuator.*

Now, in some commercial signal generators we find that the attenuator is directly calibrated in volts or microvolts. This means that the output taken from the oscillator and fed to the attenuation network has a substantially constant voltage irrespective of whichever range is being used and whichever part of the chosen range has been actually tuned.

In a home-built signal generator this degree of accuracy can hardly be produced. We may find, if we are using a variable capacitor, that our output falls somewhat at the low-frequency end of the range, and that different coils offer somewhat different voltages. However, unless we are going in for lab. work (in which case we would probably measure our RF input externally, anyway) this needn't worry us at all. All we need is an output which may be varied from a really strong signal to one of a few micro-volts or less. This is easily arranged and, after having used the home-built signal generator on a few items of equipment, we will soon have the "feel" of it and know what results to expect when using it on an unfamiliar receiver, even if we do not know its actual output to the nearest micro-volt.

Modulation

AF modulation at 400 cps is almost always offered by the commercial generator. This may be switched in or out as desired and the AF oscillator may also be used to give an audio signal in the output leads. In addition, a pair of terminals to allow the use of an external source of modulation presents a refinement often met.

The home-constructor will have little difficulty in providing these facilities. Making an AF oscillator is simplicity itself, and the various forms of modulation, etc., are "frills" which take hardly any trouble at all.

Other points which increase the usefulness of the signal generator are such things as complete screening, filtering of the mains input leads and so on. These can be very simply incorporated in one's own generator and will be dealt with later.

The Construction of the Signal Generator

It may be seen from the briefly capitulated points dealt with above that the construction of a really useful signal generator is quite practicable. The main advantage of doing this, apart from the pleasure of construction, is the fact that we may use materials which will be already on hand in the average experimenter's spares box or which may be obtained from the "surplus" dealers and which will greatly cut the cost of construction.

Let us now proceed to the practical problems which may be encountered in the design of our own instrument.

The Power Pack

The power pack of our signal generator differs from that of, say, a receiver, because the power

*This form of attenuation is fitted in a different form in some generators, but the effect—that of a controlled, continuously-variable output—remains nevertheless the same.

requirements of the oscillator are relatively very low indeed.

The HT required by the oscillator circuits need only be some 50 to 120 volts. The HT current, very probably, will lie well under 20 milliamps. Heater supplies will also be quite small. To take an example, if we were using, say, two 6J5's (one as RF and one as AF oscillator) then the heater consumption would be 0.6 amps at 6.3 volts. If the HT voltage and current were 100 volts and 20 milliamps respectively then the total wattage supplied by a power pack feeding the two valves would be only 3.78 watts (heaters) and 2 watts (HT), giving a grand total of 5.78 watts.

When small powers like this are required, the necessary mains transformer need have very small dimensions. (It is not, of course, possible to use one of the popular heater transformers at present available, as the HT supply must be entirely disconnected from the mains.) Only a single untapped secondary winding on the mains transformer is necessary for HT since a half-wave rectifier is quite sufficient at this low current. An ideal component may be obtained by utilising the mains transformer from an old HT battery eliminator. The original secondary winding supplies HT at a convenient voltage and an auxiliary LT winding can easily be added by winding a few turns on top of the windings already present on the transformer bobbin. A small metal rectifier provides a cheap means of rectification, and, although a valve rectifier may be used, there is hardly any point in supplying the extra heater current.

A practical power pack circuit is shown in Fig.1. There is no necessity for a smoothing choke and a resistor is used instead. The electrolytic capacitors are a little larger than is really needed but it is worth while making certain that all ripple is removed. The 0.01μF capacitor needs to be a mica component and is best mounted directly at the HT positive end of the oscillator coils.

In practice it is hardly worth while incorporating HT regulation in a signal generator of this type. Differences in mains voltage may cause slight differences in oscillator frequencies at the higher frequency ranges. However these changes in frequency will very probably be much smaller than will be noticeable on the scale and as the mains voltage should be sufficiently constant whilst lining up is in progress, no harm can result.

The transformer itself, as stated above, can be quite small in physical dimensions. However, we must not have it too small, in case it should heat up and cause drifting of the oscillator circuits. The only requirements needed in the power unit are those of supplying the small voltages and currents required without dissipating too much heat in the signal generator case.

The transformer shown in Fig. 1 represents a fairly ideal case. If other transformers giving different HT secondary voltages are available, then it may represent a saving to use them instead. Incidentally, the mains input tappings are not entirely necessary. With a transformer input set for correct working at 230 volts the signal generator should function quite well on most voltages.

"RADIO CONSTRUCTOR" QUIZ

Conducted by W. Groome

(1) Having got a "universal" set going nicely, our Mr. Brain left it available for family use. When his wife touched the tuning knob she received a shock. What had he done wrong, apart from half killing his old woman?

(2) Frame scanning-coils are often of the high-resistance type. Why are transformer-fed low-resistance coils usually found in the line scan circuit?

(3) In many television sets (the RC "Inexpensive" is one) a cathode-follower is used after the video stage. What does it do?

(4) Can a moving-coil loudspeaker be used as a microphone?

(5) When listening to a distant station with a superhet, the background noise may be heard to rise and fall in intensity. What causes this fluctuation?

(6) It is usual to bias push-pull valves by a resistor common to both cathodes. Why is the by-pass capacitor often omitted in such circuits?

Answers on page 129

CAN ANYONE HELP?

Dear Sir,

I am anxious to learn if, through your readers or excellent book, I can obtain information of the circuit of an ex-RAF battery receiver R1120, and how to convert it to an ordinary short wave receiver. I am imbued with much enthusiasm but very little knowledge of short wave sets, and although the set in its present form receives several stations it is difficult to tune and operate, and the chassis is alive.

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LOGICAL FAULT FINDING

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

By J. R. DAVIES

6: DISTORTION (Contd.)

5—Distortion Which Requires an Alteration in Receiver Design to Clear

WHEN a receiver which has seen better days is encountered on the test bench, it usually happens that its quality of reproduction is intolerable compared with present day standards. The serviceman is then faced with the alternative of leaving it as it is (although he would dearly love to deposit it in the dustbin!) or bringing it up to modern standards. If he decides on the latter course the job is not necessarily difficult. Most of the older receivers that one meets have pretty simple AF circuits using triode valves which cannot help but give reasonable reproduction when used correctly. The fitting of a modern loudspeaker often makes an amazing improvement in reproduction. Unfortunately these very old receivers are usually found to be bristling with AF transformers, these components introducing a large amount of the distortion. As these transformers were originally used to bolster up the rather poor gain given by the valves, it is often worthwhile to fit a modern pentode output valve and replace the transformer by resistance-capacitance coupling. Fig. 37 (*a*) and (*b*) respectively show typical "Before" and "After" diagrams of a receiver which has been rejuvenated in this fashion. The transformer has been taken out of circuit, the loss in gain being replaced by using an output pentode in place of the second triode. The capacitor across the speaker transformer primary will probably be necessary to by-pass the third harmonic content introduced by the pentode. In addition, it may also be necessary to increase the "HT+1" tapping on the HT battery to allow for the greater voltage drop given by the resistor in the anode circuit of the first valve. Also, of course, the GB tapping should be adjusted to suit the new valve.

Passing from these early receivers, we might now spend some time considering those home-constructed receivers which have always given a distorted output. Assuming that no mistake has been made in wiring, and that they have not been built from a tested circuit diagram, then the trouble must obviously lie in their design.

Usually the fault is due to bad matching somewhere. Some constructors who have just entered the hobby of radio-construction may find the theory of matching a little difficult to assimilate. They might find it clearer if they were to compare a matching transformer with the gearbox of a car. In just the same manner as the engine of a car is designed to give its maximum efficiency at a certain number of revs., so is the output valve of Fig. 38 (to take an example) designed to work best when its anode is connected to an impedance (loosely, the resistance offered to AC measured in ohms) of such and such a number of ohms. Now, when we want the car to climb a gradient we change into, say, second gear to enable the engine to run at its most efficient number of revs. That is, we alter the ratio between the number of revs. at the engine and those at the driving wheels. In the same manner, when we want our output anode to drive the voice coil of a loudspeaker, we use a transformer to enable the different impedance at

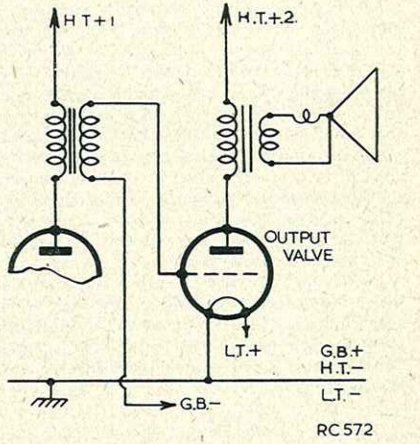


Fig. 37(a). An old-fashioned AF circuit in which an inter-valve transformer is used.

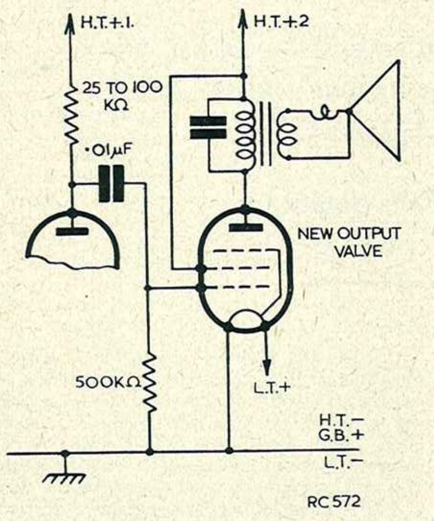


Fig. 37(b). How the circuit of Fig. 37(a) may be improved. The transformer is replaced by resistance-capacitance coupling, the loss of gain being made good by using an output pentode in place of the original triode. Note that the grid leak should go to GB —, and not HT — as shown.

the coil to be converted to the optimum impedance required in the valve's anode circuit. If we select the wrong gear in the car we do not get the best results; our progress is slow or jerky, intermingled with coughs and grunts from the engine. Exactly the same holds true when a speaker is badly matched to the output valve!

Anode resistors are components that also need some care in selection when designing the AF section of a receiver. It is usually safe to use an anode resistor whose value is equal to twice the Ra of the valve.* Also the capacitor coupling an AF anode to the next grid is best kept reasonably small despite the fact that a large capacitor gives an apparent increase in bass reproduction. 0.01μF is a good value for an AF intervalve coupling capacitor, the grid leak of the following valve have a maximum value of some 500K Ω. If these values are increased it is possible to introduce "grid-blocking."

Finally, let us raise a rather important point which is often overlooked by some home-constructors. This refers to the volume control used in a superhet and which we mentioned earlier when we discussed the effects of near-instability.

*" Twice the Ra of the valve." This does not always hold true, however, particularly if the value of the HT voltage is low. A smaller resistor may then be necessary to ensure that too much voltage is not dropped across it.

Fig. 39 shows the basic diagram of a modern diode detector as is used in the majority of commercial receivers. By reason of the rectifying action of the diode, we get the AF signal developed between the bottom connection of the IF transformer secondary and earth. In addition to the AF we also have the IF signal between these two points. This is filtered away by R1, C1 and C2 and doesn't concern us here. The AF signal remaining is built up across R2. It is then fed via C3 to the volume control R3 (C3 is used to isolate the volume control from the direct voltage which also appears on R2 as a result of rectification). Now, owing to the nature of the circuit, whereas R2 forms the DC load for the diode, the AC load is represented by R2 and R3 in parallel. (Capacitor C3 is assumed to have negligible reactance to AF.) For best results, the resistance values of the DC and AC loads should be as close as possible. R3 must therefore have a considerably higher resistance than R2. In practise a ratio of 4 : 1 between the values of R3 to R2 is quite sufficient for good reproduction. (One may encounter a receiver in which R2 is the potentiometer giving volume control and R3 the fixed grid leak. The ratio of resistance values remains the same, however.) The writer has come across quite a few unsuccessful home-constructed receivers in which the constructors, not aware of this fact, have used " any old pot'meter " as a volume control. He has also encountered several commercial receivers in which the volume control, having become faulty, has been replaced by one of incorrect value, with indifferent results. This is one reason why a " crackly " volume control should never be repaired by running a soft pencil around the track (p. 555, April '49 issue). Apart from the impermanence of the remedy, the resistance of the potentiometer is altered.

6—Distortion Caused by Overloading

Distortion caused by overloading is, of course, very easy to diagnose should it occur in the AF section of a receiver. Unless a component (usually the output valve or loudspeaker) is easily

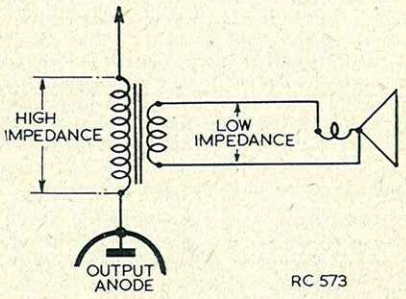


Fig. 38. Illustrating the use of a matching transformer (see text).

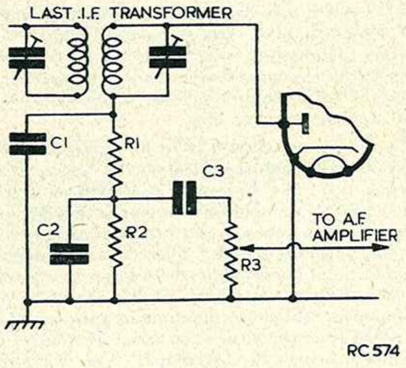


Fig. 39. Illustrating the necessity of a correctly-valued potentiometer when used as a volume control after a diode detector.

overloaded, whereupon replacement is the obvious cure, little can be done to clear this fault as it is inherent with the design. All-dry battery portables are typically prone to this trouble, the output valve being capable of handling a certain power output only.

Overloading at the detector is the fault with which the writer is more concerned here. This will be caused when the receiver is situated close to a powerful transmitter, and, when tuned to it, gives a distorted output.

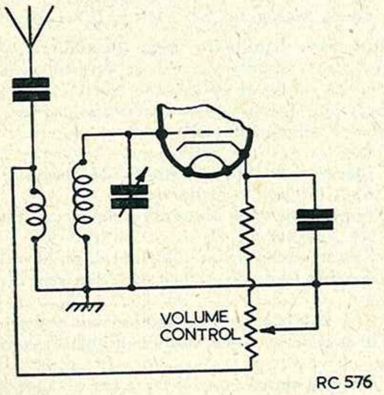


Fig. 41. How the volume control of Fig. 40 may be reconnected to enable it to be effective on a strong signal.

To illustrate the clearing of this fault, let us first of all take the case of an AC/DC straight receiver of the " midget " class. This is being used in proximity to a strong local station and, even with the volume control fully retarded, the strength of the signal is sufficient to overload the detector. Fig. 40 shows the pre-detector circuit, volume control being effected by the variable resistor in the cathode circuit of the RF pentode. This variable resistor does not offer sufficient control, so it is therefore necessary to alter the circuit in some manner. Fig. 41 illustrates a very effective way of doing this, the aerial now being connected to the end of the volume control remote from the cathode. As the slider travels upwards, more and more bias is put in the cathode circuit of the valve, thereby decreasing its gain. At the same time, the resistance between aerial and earth becomes progressively lower until, at the bottom position, there is a " dead short "

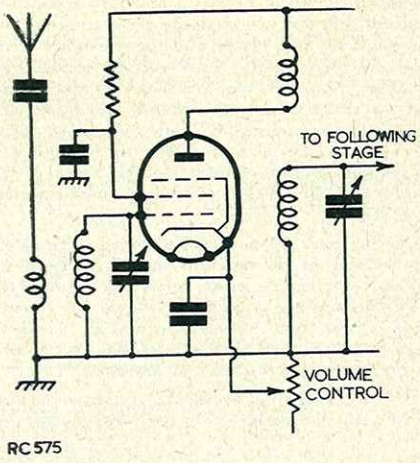


Fig. 40. A commonly-met volume control circuit as used in a straight mains receiver.

between the two. The decreasing resistance in the aerial circuit gives a somewhat drastic form of attenuation which will be effective on the strongest of signals.*

When a battery straight set is used, volume control is often applied by varying the voltage applied to the screen-grid of the RF valve, using the circuit of Fig. 42. (The method of volume control shown in Fig. 40 is obviously unworkable with battery valves.) The aerial circuit may

*This method of volume control connection is by no means original and will be found fitted to quite a few commercial receivers.

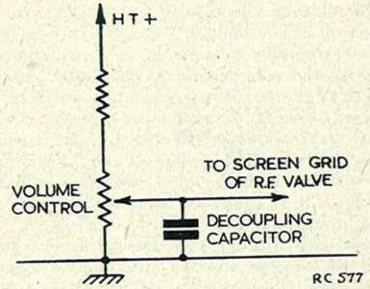


Fig. 42. A method of volume control used in battery receivers.

again be attenuated as before if the circuit is changed to that of Fig. 43. It will be seen that a current now flows through the aerial coupling coil, but, as both the current and the resistance of the coil are very small, there will be a negligible change in the DC characteristics of the circuit. As the slider travels downwards, the screen-grid decoupling capacitor " C " now comes into circuit between the aerial and earth; at the point of minimum volume, insofar as RF voltages are concerned, the aerial is effectively short-circuited to earth.

In the case of a superhet fitted with AVC, overloading at the detector should rarely occur. Should overloading occur on strong signals, the AVC decoupling capacitors should be tested. This is best done by substitution, as a leak as high as 10M Ω between the AVC line and chassis is often sufficient to cause the trouble.

Should the station causing distortion be located so near to the receiver that it is obvious that no

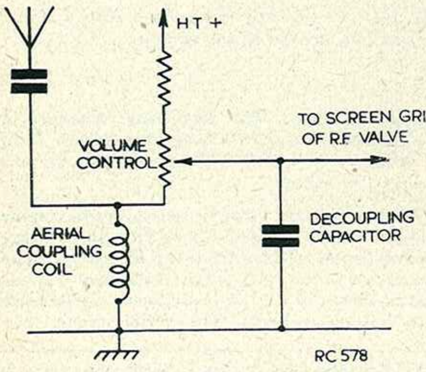


Fig. 43. A more effective version of Fig. 42 for use when very strong signals are being received.

AVC system can cope with the signal strength, a " local-distance " switch may be fitted. This simply switches the aerial to earth via a resistor of low value, the value being found by experiment, and the whole addition being made external to the receiver (see Fig. 44).

A far better solution is to fit a rejector wave-trap in series with the aerial and the set as shown in Fig. 45. The wave-trap is located as near to the aerial terminal of the receiver as possible and, when fitted, is tuned to give maximum attenuation of the powerful signal. The coil and condenser should be of good quality as a large Q is needed in this circuit. For best results, the wave-trap components should be mounted in a screened box, the lead from the box to the aerial terminal of the receiver being also screened. The wave-trap " rejects " the strong signal sufficiently to prevent it overloading the receiver, and at the same time gives the additional advantage of reducing the interference experienced on adjacent frequencies.

SUMMARY

DISTORTION

1. Distortion Caused by the Loudspeaker.

Usually occurs above a certain volume level or at a certain note and is sometimes recognisable by the " mechanical " nature of the noise.

Loudspeaker checked by substitution with one known to be good. Repairs carried out as mentioned in detail above.

2—Distortion Caused by a Valve Operating Under Incorrect Conditions.

Usually all frequencies are distorted, and at all levels of volume.

(*a*) Check AF coupling capacitors.
(*b*) Check all anode, screen-grid and cathode voltages.
(*c*) Check cathode by-pass capacitor.
(*d*) Check valves.
(*e*) Check filament or heater voltages.
(*f*) Check voltage of GB battery (if applicable).

3—Distortion Caused by Near-Instability.

Distortion usually occurs at certain volume level or on reception of a certain note.

Ascertain whether or not distortion occurs at middle of volume control travel.

If not :—

(*a*) Check main HT capacitor (or HT battery for high internal resistance).
(*b*) Check any other decoupling capacitors in the AF circuit.
(*c*) Check screening at all points and see that speaker leads are kept away from grid leads, etc.
(*d*) Check GB battery for high internal resistance.

If distortion occurs at middle of volume control travel :—

(*a*) Check volume control for correct value and operation.
(*b*) Check screening of lead to grid of controlled valve.
(*c*) Add a grid stopper to the appropriate grid or fit an RF by-pass circuit in the anode.

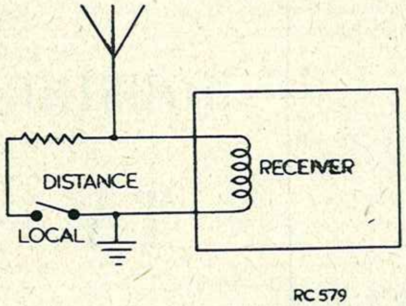


Fig. 44. A simple " local-distance " switch circuit that may be used if a very strong signal is being received.

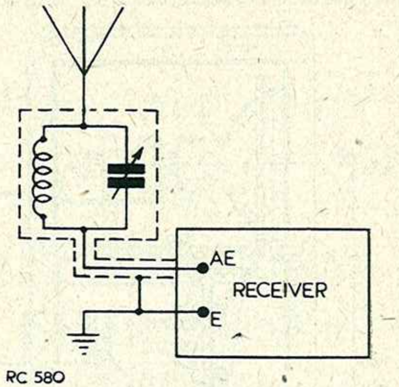


Fig. 45. A far better alternative to Fig. 44, in which a rejector wave-trap is connected in the aerial circuit of the receiver.

4—Distortion Caused by Breakdown of Components Not Directly Connected with Valve Supplies.

(*a*) Ascertain that no poor connection exists between the output transformer secondary and the voice coil of the speaker.
(*b*) Check the speaker transformer and its tone correction capacitor.
(*c*) Check the negative feedback circuit, if fitted.

5—Distortion Which Requires an Alteration in Receiver Design to Clear.

No set sequence of checking may be made under this heading.

6—Distortion Caused by Overloading.

If distortion is caused by overloaded components in the AF section of the receiver, the replacement of the appropriate components may effect a remedy, although the trouble is usually inherent in the design.

If distortion is caused by overloading at the detector.

(*a*) Increase the efficiency of the volume control circuit, if this is fitted in the RF section of the receiver.
(*b*) Check the AVC line, if fitted, for leaks to chassis.
(*c*) Fit a " local-distance " switch, or a rejector wave-trap in the aerial circuit.

(To be continued)

ANSWERS TO THE QUIZ

(1) It is possible for the chassis of an AC/DC set to be " live " without detriment to its performance, a danger which is not easy to eliminate where a two-pin mains connection is used. The point which Mr. Brain overlooked, and which cannot be too strongly emphasised, is that every metallic object connected to chassis is also " live." These include tuning capacitors, their shafts, and the grub-screws of the knobs. Mr. Brain's good lady made contact with a grub-screw which he should have made short enough to screw right in. As a further precaution, the sunken screw should be covered by putting wax or other suitable insulation into the hole.

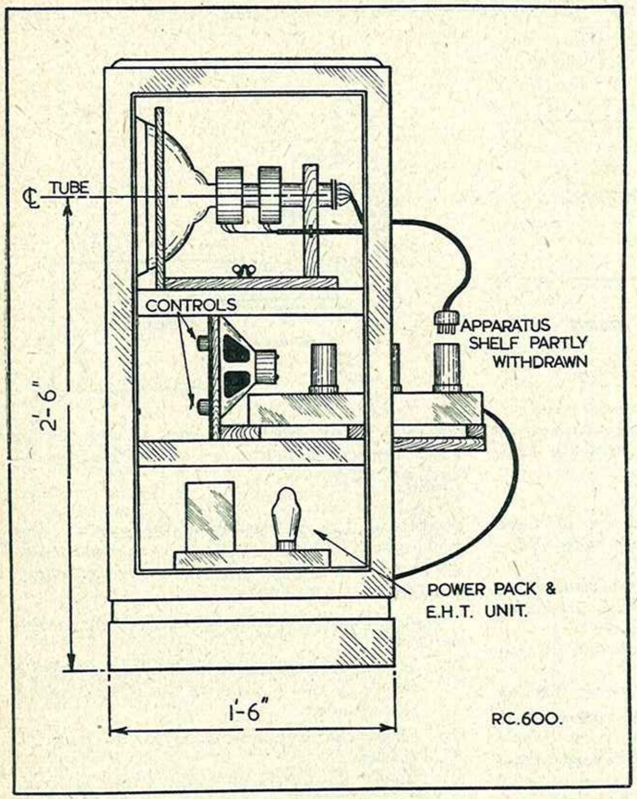
(2) High insulation is essential, because of the very high voltage set up by line fly-back. Due to their form, this high insulation is less easily arranged in the coils than in a transformer. The step-down ratio ensures that no high voltage appears in the scan-coil.

(3) Many sync-separators require a signal of opposite phase to that applied to the CRT, and in any case, some way of splitting a single video signal two ways must be provided. The " concertina " or cathode-follower phase-splitter, already well-known to push-pull enthusiasts, provides on its cathode a suitable signal for the CRT, and on its anode a signal of opposite phase for the sync circuit.

(4) Yes. The loudspeaking " inter-com " sets frequently use the loudspeaker by switching it from output stage to input grid. It may be matched to grid by using its output transformer, the high impedance winding being hooked into the grid circuit. Tone may be rather muffled with some speakers.

(5) This is due to the action of AVC on a fading signal. Volume is kept fairly level, but as the signal fades the sensitivity of the set increases automatically, and it is able to receive static and other interference. When the signal strength increases again the sensitivity is decreased and less " slush " received.

(6) Audio frequencies at the cathodes are of opposite phase, and cancel each other in the common bias resistor (assuming the stage is balanced). There is therefore no current feedback (degeneration). Hum may also cancel in the same way, but there are exceptions in that case.



HOUSING TV EQUIPMENT

By R.M.S.

THE construction of a television receiver presents a fairly difficult task and it is quite usual for the home constructor to concentrate on the electrical requirements and "build a cabinet round the finished job." If, however, the general method of accommodating the equipment is considered as soon as the circuit requirements are fixed, the shape of chassis, etc., can be arranged to advantage.

Consider a conventional magnetic deflection Televisor. The gear may be classified into three groups :—

(*i*) The CRT with focus and deflecting coils.
(*ii*) Sound and vision receivers and time bases.
(*iii*) Power Pack and EHT supply unit.

Clearly the tube dominates the layout as it must be positioned to facilitate viewing. Its shape and the necessity of avoiding magnetic fields in its proximity compel the builder to allow reasonable clearances in the compartment behind the screen. Commercial receivers are compact, making table models of rational dimensions. For the home constructor the congestion of components does not assist construction and definitely impedes alteration and adjustment. Furthermore, a receiver of this type monopolises a table or other article of furniture to obtain the necessary viewing height. For these reasons only the console cabinet will be considered.

The height of the tube above the floor should be related to the chairs viewers are likely to occupy. As one likes to relax when looking in, the horizontal centre of the screen should be level with the viewer's eyes when the latter is occupying a medium easy chair. In practice this dimension is about 2' 6" to 2' 9" and with a 9" diam. tube leaves some 24" of height available for the receivers. Heavy components like the power pack can be placed to advantage at the bottom level of the cabinet, next above coming the receivers and time bases and finally the tube (see Fig. 1). The minimum width of the case is fixed by the size of the tube mask, and for a 9" diam. tube approximates to 15" outside dimension, allowing for the thickness of the wooden frame.

Materials

Timber for the cabinet frame is fairly easy to obtain but plywood is expensive and in short supply. To get a fine finish, good wood and considerable skill are required unless the completed cabinet is covered with some other convenient material. The author used navy blue rexine of the stick-on variety to cover the set shown. A covering material permits the use of millboard and strong cardboard for side and rear panels, the front of the case being the only large area utilising plywood.

The application of rexine is not difficult but a few simple hints are worth remembering. The adhesive should be carpenter's glue applied hot and very thin; the slightest lump will show through so the surface before covering should be smooth enough to receive paint. Apply to an area, lay on the rexine and, with a cloth, smooth it down, working always from the centre towards the edges. Avoid sharp edges and three-dimensional curves. The former look better if the wood or underlying material is radiused, and the latter are difficult to cover. Do not lap the joins. Overlap them in the first instance and then, whilst the glue is still wet using a steel straight edge and a razor blade, cut down the centre of the lap and remove the two superfluous strips. The glued sections will then butt exactly.

Electrical Considerations

As the power pack and EHT unit are situated at floor level, multicore leads are necessary to convey the various supplies to the receivers; these leads emanate from a terminal strip running along the rear edge of the power pack. Connection strips enable current and voltage readings to be taken far easier than do multi-pin plugs. The shape of the power pack chassis has little bearing on its performance, so it can be constructed to use the bottom space to advantage; similarly the EHT unit, if this is to be on the same level. The depth of the cabinet is governed by the length of the receivers and time base chassis, and these will be considered.

Systematic construction entails building a vision amplifier, a sound receiver and a chassis containing the line and frame time bases. The modern method of strip construction is convenient and desirable, allowing self-contained units to be assembled side by side, interchassis connections being made by plugs where no electrical measurements are likely to be taken. A chassis size of 15" x 3" for the sound and vision and 15" x 6" for the time base will accommodate the average equipment. These placed abreast occupy 13" with $\frac{1}{2}$" space between chassis. If the cabinet is made about 18" deep, space is left for connections, controls and the loud speaker. It is essential that no leads or apparatus should be trapped in the woodwork because the inevitable small alterations made after the set has been on the air would otherwise be major operations.

A convenient scheme is to make the receiver shelf a sliding "L" shaped frame, the vertical panel forming the baffle for the loudspeaker with the front controls disposed either side of it. This layout enables the receivers and time bases with controls to be withdrawn backwards at will. All sensitive leads are short, those to the CRT deflection coils being terminated in a multi-pin plug. The cables from the power pack must, of course, be long enough for the rack to come clear of the cabinet. The loudspeaker baffle is covered with metallic gauze which is earthed. Potentiometers operated from the front panel must have insulated shafts as these pass through the earthed metal gauze. The front of the cabinet is cut away below the screen giving a recess about 10" x 5$\frac{1}{2}$" which is filled by the 6" diam. loudspeaker and the controls when the apparatus shelf is in place. The shelf is scotched by two wooden chocks which can be removed from the back of the cabinet.

The cathode ray tube is held in a self-supporting wooden frame and secured to its shelf by two bolts fitted with wing nuts and passing through oversize holes. The tolerance on these holes enables the mask to be lined up with the $\frac{1}{4}$" plate glass window. The tube and its associated coils can be removed from the case as a homogeneous unit. The outside rim of the window is edged with stone coloured draught excluder, sandwiched between

(*Continued at foot of next page*)

from our mailbag

TV IN HEREFORD

I do hope you will excuse me writing to you, as I thought you might be interested in my results with television.

Hereford is 111 miles from AP and 50 from Sutton Coldfield. The equipment in use here is a 1355 with suitable RF unit, and your time base with a 5CP1 tube.

Using a 26 unit for Birmingham, the pilot tests of 1kW were well received, good enough for consistent watching, a length of hook-up wire being used as aerial.

Reception from pilot tests at Wolverhampton required a dipole aerial, as the signal was not too strong.

Transmissions from Coventry, which began last week, are weaker still, but an improved aerial increased the strength so that it was similar to transmissions coming from Birmingham.

These pilot tests appear to have been fairly well received by dealers on sets with less RF gain. Great results are expected when Sutton Coldfield comes on the air with 35kW.

With the delay in opening Sutton Coldfield, I had another attempt at AP, using a 24 unit converted to a 25. This conversion was simple as only the mixer and aerial windings were shortened, the oscillator being left so that it was lower in frequency. This unit works better than either a 25 or a 26 with band-sets altered, as with these two latter units quite a bit of 7 Mcs break-through occurs, which does not happen with a converted 24 unit.

Signals from AP are found to fade a lot, and so results are variable, but a picture can be obtained. A picture was seen this morning for the first time in a week, but this was no doubt due to the bad weather last week and to the display of Northern Lights a week ago.

The sound transmission is received poorly, if at all. Using the 1355, the valve noise nearly masks it. Better reception is hoped for with a new, higher aerial. The present height is 20ft., or 200ft. above sea level.

I have only one 1355 set, and I intend to draw off from the RF unit IF signals of 7 Mcs for vision and 10.5 Mcs for sound. To this end I have built a three-stage 10.5 Mcs IF and audio strip, and the arrangement seems to work with a signal generator used as a " sound " or " vision " signal. It is out of the question to use this for AP sound, because every trimmer and IF core must be " peaked " to find the signal, let alone to understand it !

The time base is exactly to your circuit, except that the line control is a 1M Ω preset with a 100k Ω variable on the panel. The valves used are 6H6, 6SN7 (half) 6SH7, EF50 (2) and 6SN7 (2). Everything seems to work OK except that the following cannot be eased in any way.

With a picture of the test card, say, 2in. across, both edges of the frame at the sides are visible. As the amplitude control is altered and the picture made bigger, the left-hand side " piles up " forming a white line at the edge. (*The brilliant vertical line at the edge is due to a portion of the picture being cramped into this edge. The cause is probably non-linearity in the line amplifier.—Ed.*)

For my EHT supply I use two transformers. Each has a 115V primary and has 0-1500-2000V, 6.3V and 2.5V secondaries. Using a 2X2 rectifier, I can arrange the windings to give me what I like. The time base and 1355 are supplied from one large power pack giving 300V at 250mA.

By the way I found that the network for the 5CP1 was not quite right, for it was found impossible to focus until a 1M Ω resistor was placed from the junction of VR2 and R3 to earth.

Thank you for all the fun and interest I have had from this television construction.

J. W. Tebbutt
(Hereford)

May I take this opportunity to congratulate you on your fine magazine. I have only one grouse, and that is that I think too much space is devoted to TV.

The recent correspondence about circuit diagrams and wiring diagrams interested me. I started radio at the age of 14, and I have worked from circuit diagrams only. To be quite honest, a wiring diagram confuses me. It seems to me that those who demand point-to-point diagrams want to build a set with a minimum of thought and time. That is not the function of our hobby. It is a means of developing the intelligence and ingenuity.

Each set should be a personal one ; one which is like no other and which has some claim to originality, even if only originality of layout !

R. L. Kenyon
(Liverpool, 8).

(*Continued from overleaf*)

the plate glass and the woodwork, the tubular part of the rubber containing a 3/036 VIR cable to prevent it crushing at the corners and to make a clean join.

The side and rear panels of the cabinet are of paper board covered with rexine and are readily removable. A small plinth was included at the bottom to set off the height and the top was recessed to relieve the general squareness that such structures tend to assume. The apparatus at present contained in the cabinet is conventional, the front controls being sound volume, contrast, focus and brilliance. The EHT is obtained from either a pulse multiplier or line flyback. Numerous modifications have been made to the equipment during the last 18 months, and the author has found the layout practical and presentable and trusts that others may do likewise.

A 4-VALVE SUPERHET MIDGET

PERSONAL PORTABLE

by VINCENT HILL

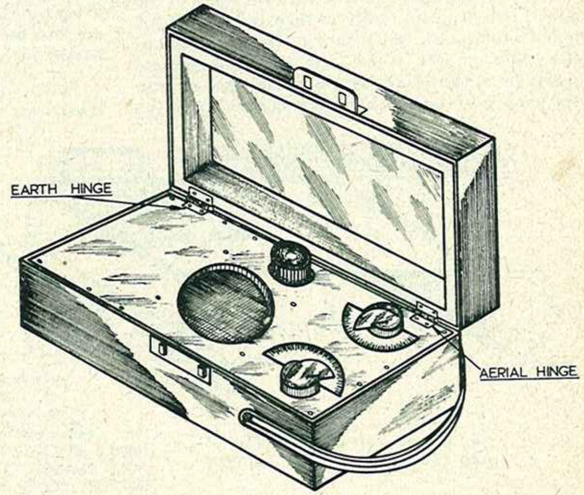
UTILISING BUTTON BASE VALVES

(concluded from November issue)

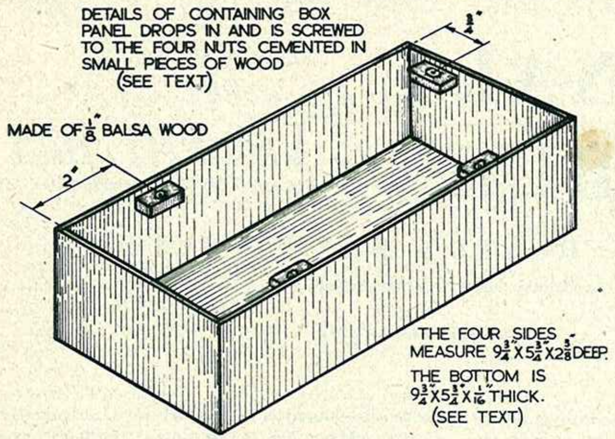
Before continuing this description, we must apologise for an error which occurred in the circuit diagram given last month. In this, the HT+ line was shown as going to the secondary of the first IF transformer. It should, of course, have been connected to the primary winding and through this to the anode of V1 (1R5)—Ed.

The number of turns required is around 20, using 24/DCC. More can be put on if the higher end of the medium waveband is desired. When finished give the outside of the frame and the winding a good coat of shellac.

The box to hold the set is made of ⅛-in. Balsa wood for the sides and 1/16-in. Balsa wood for the bottom. This wood is supplied by Model Aeroplane shops in widths up to 4-in.; a 3-in. width is needed. It can be cut with scissors, but a better job is made of the jointing if a fret saw with a very fine blade is used. The sides are made first and glued with Balsa cement, true-ing up square whilst the cement is drying, which is a matter of minutes only. The longer side at the back—the one on to which the frame aerial will fall—is bevelled with sandpaper to a 45 degree angle. The bottom—of 1/16-in. material—is best cut with scissors, and has to be glued down the middle, as it is not wide enough, otherwise. Of course, this bottom could be of thicker material, all in one piece, but the idea is to reduce the very important depth size of the set as much as possible. When planning the dimensions of the sides do not forget to include the panel thickness in the width; this will make it 2⅜-in. The lid is measured up, jointed and fitted with a top in a similar way—not forgetting to bevel the side which meets the containing box to an angle of 45 degrees. This lid is eventually glued on top of the frame, but this should not be done until the electrical construction is finished and tested. Both the containing box and the lid will prove to be very



SKETCH SHOWING THREE-QUARTER VIEW OF COMPLETE RECEIVER



R.C.590

light in weight, and the Balsa cement ensures a very strong jointing.

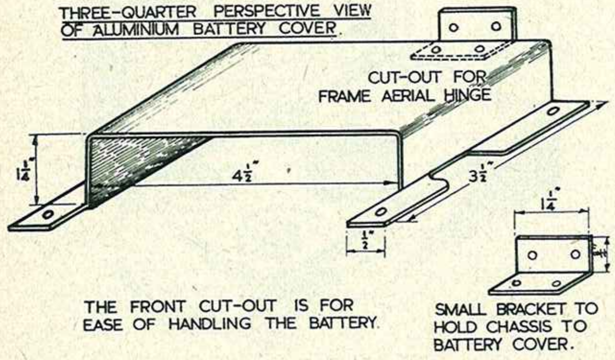
The panel and chassis, with frame attached, simply drop into the box, but means must be taken to fix it there in such a manner that it can be lifted out-and-in easily. This is most simply accomplished by means of four small pieces of wood, each fitted with a 6BA nut, these pieces of wood being cemented in strategical positions to the inside of the box; four holes in the panel correspond and a 6BA bolt is screwed into each nut. The wood can be $\frac{3}{8}$-in. stuff about $\frac{3}{4}$-in. long; a hole is drilled centrally to take the shaft of the bolt; a larger hole cut with a penknife for the nut, and the nut cemented by means of Durofix to the wood. The best way to fit the peices of wood in the box so that they are true with the holes in the panel, is first of all to screw them with the 6BA bolt to the panel, put plenty of Balsa cement to the sides of the wood and the approximate positions on the inside of the box, and then to drop the panel into the box, holding it in a level position for the few minutes necessary for the cement to dry; they are thus automatically in the right position.

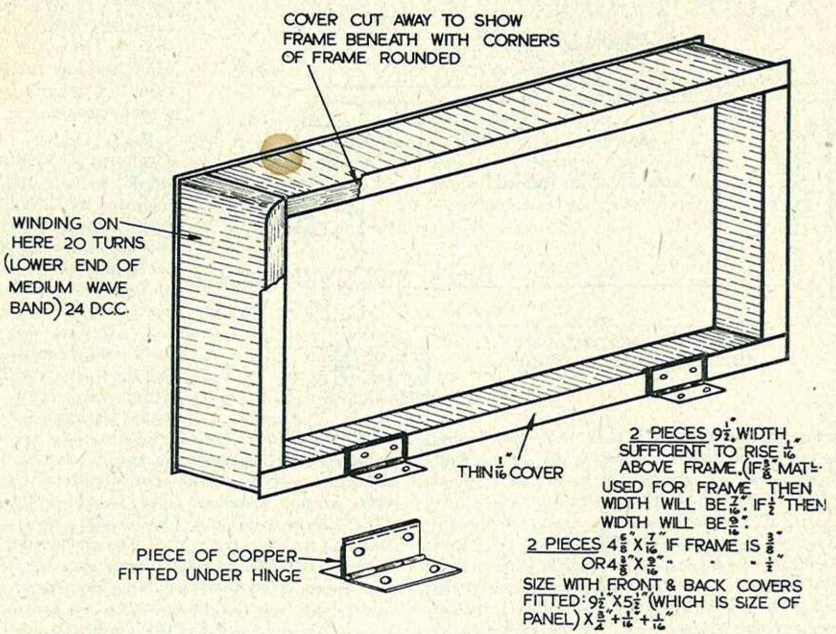
The box can be painted or covered with leather. The leather can be obtained from a motor car upholstery shop, and costs from 15/- to 20/- for a yard of 56-in. width. A quarter of a yard is sufficient. Cording material of the same colour can be obtained also for use as a handle. The leather is best glued with a strong solution of gelatine, and some care is necessary to make a successful job. The handle is made from the cording material and simply glued to the leather covered sides of the box; it will be quite safe.

Small knobs are used for the tuning controls, of about an inch diameter; pointer knobs are perhaps more useful. The tuning dials are about $2\frac{1}{2}$-in. in diameter, semi-circular in shape, and they lie with the curved sides facing each other. They are marked in degrees only. If suitable dials cannot be obtained from the radio dealer, they can be bought as protractors and adapted. If the protractors are transparent they can be backed with a suitable white card and glued on to the panel. Durofix is the best kind of cement for this purpose.

The B-114 Battery combines both high tension and low tension supplies, and it is essential to buy a 4-pin plug for this; the connections to this plug are best made of ordinary connecting wire, neatly bound with cotton.

When the radio part is completed and being tried out, an ordinary aerial is hitched to the aerial hinge to enable some sort of signal to be received. The trimmers of the IFT's are adjusted for loudest reception. Do not discard the outside aerial until a second station is tuned in successfully and the IFT adjustment checked. When the outside aerial is slipped off, a diminution of volume is to be expected, and the aerial capacitor is carefully rotated for loudest volume. The IFT trimmers should be again checked on a





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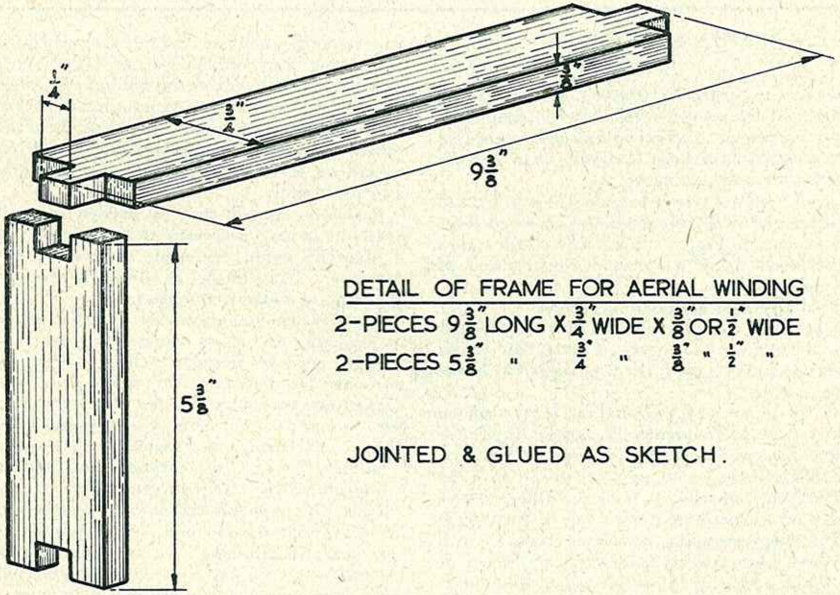
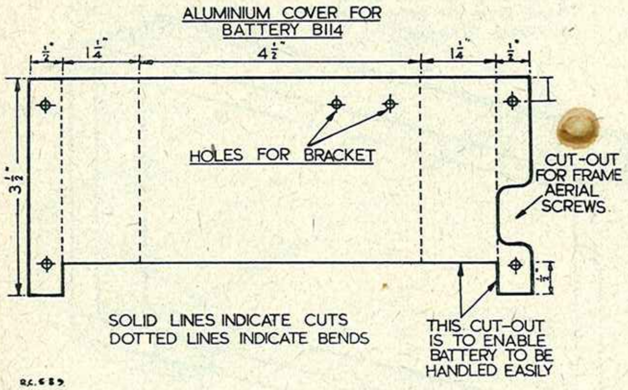


DETAIL OF FRAME FOR AERIAL WINDING
2-PIECES $9\frac{3}{8}$" LONG X $\frac{3}{4}$" WIDE X $\frac{3}{8}$" OR $\frac{1}{2}$" WIDE
2-PIECES $5\frac{3}{8}$" " $\frac{3}{4}$" " $\frac{3}{8}$" " $\frac{1}{2}$" "

JOINTED & GLUED AS SKETCH.

R.C.592.



weak foreign station. It is best to do this during the hours of darkness, since it is only then that the long distance stations will be heard. Spend some time on this IFT adjustment, since the efficiency of the set depends upon successful setting. Using the specified oscillator coil and the .0003 μF tuning capacitor with a frame of 20 turns, the capacitors tune to approximately the same dial reading round about 380 metres, but at 203 metres the discrepancy will be as much as some 25 degrees. This gives some indication of the difficulties which would be experienced were it attempted to gang a two section capacitor with the frame and oscillator coil. The oscillator coil capacitor tunes very sharply, but the aerial capacitor has more latitude, particularly on strong signals.

With regard to the results to be expected, I think the set should be regarded as essentially a local station set, though this does not preclude the receiving of a number of long distance signals, particularly after nightfall. The set was made for a poor reception area, the nearest transmitter being some eighty miles away; though the signals travel chiefly over the sea, which really halves the distance. The signal from this particular transmitter is easily received at any time of the day, with ample volume. The Third programme, which comes from a local transmitter, is so strong that the volume control has to be turned right down. It should be remembered that this matter of volume is comparitive, and that neither the loudspeaker nor the power valve can handle more than 1/5th of a watt; but this amount is more than sufficient for a personal set of this nature. Also, the purpose of the set is purely for those occasions when it is impossible to use the more conventional set.

DESIGN OF THE SUPERHET

(*Continued from page 143*)

frequencies in order to produce the difference frequency at the anode. This type of frequency changer is claimed to offer less unwanted coupling between oscillator and signal circuits than appears in the octode and pentagrid.

In some types of triode-hexode, the positions of the signal and oscillator grids are reversed from those shown in Fig. 3. Fig. 5(d) illustrates a triode-hexode using a internal construction of this type.

The Two Types of Frequency-Changer

Up to now, we have spoken of two different types of frequency-changer. Firstly, the single triode type and secondly, the type using electronic mixing.

Now we do not wish to spend too much time on the first type of frequency-changer as it is now obsolete for normal broadcast work. However, if the reader intends delving more deeply into the theory of the superhet than is possible in these articles, he will find that this type of frequency-changer keeps cropping up quite often, so it is well worth while sparing it a paragraph here.

Now the action of the single triode frequency-changer depends upon the fact that it detects the two signals applied to its grid.* If it did not detect or distort these two signals they would both appear on its anode as separate frequencies without having been combined at all. (Lack of space prevents the writer from explaining *why* detection is necessary, and the constructor must accept this statement for the present. Perhaps, if there were sufficient interest, the Editor might approve an article on multiplicative frequency-changing at a future date).

However, as all that is needed is really a detector, it isn't necessary to use a triode at all. A pentode could be used, or even a crystal detector! This latter is done in frequency-changing at radar frequencies.

The frequency-changers we are most interested in, though, are those using electronic mixing. In this type of frequency-changer there is no necessity for detection, the whole process being carried out by controlling the electron stream by the two grids. For this reason (mainly), these types of frequency-changer are known as "additive." The first types are known as "multiplicative" frequency-changers.

Now, this month's article has covered quite a lot of ground, and has laid a good foundation for the future instalments. In next month's article we shall carry on and deal with the external circuits appropriate to the frequency-changer.

* The frequency-changer is still often referred to as the "first detector."

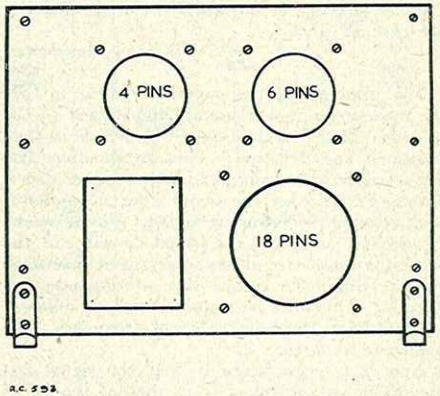
SURPLUS RADIO EQUIPMENT

described by B. Carter

In this series of articles it is intended to describe units that have (a) immediate application, after some modification perhaps, in the amateur world, and (b) to list the contents of those units that can best become sources of valuable components. This month's unit with very little modification may be of use to many amateurs as it is purchased.

AMPLIFIER TYPE A1271 (IOU/549)

This unit was used in the services as a microphone preamplifier. The case is made in several pieces and enamelled black, the sides and back are in one piece, the top is separate and so is the front panel all of which is made of heavy gauge tinplate but the bottom is made of thin paxolin. The unit the writer purchased was slightly difficult to pull apart, the nuts were sealed with glue or varnish which, however, yielded after contact with a hot soldering iron. The chassis is mounted to the case by means of four rubber to metal bonded studs which engage a lip inside the walls of the case. Careful scratching of the sealing compound from the threads of the studs and gripping of the rubber side of the stud is needed for a successful extraction.

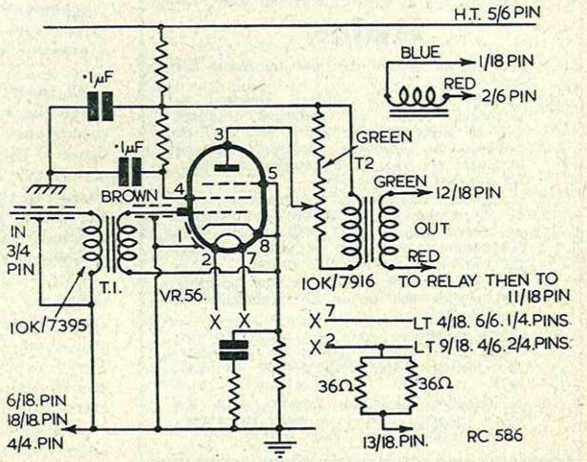


COMPONENTS:

1 Amplifier Valve VR56 (EF36), 10E/11402.
1 18-pin Socket (large Shell-Breeze), 10H/396.
1 6-pin Socket (small Shell-Breeze), 10H/392.
1 4-pin Socket (small Shell-Breeze), 10H/391.
1 Paxolin Arm to hold valve and grid cap, 10A/14385.
1 Potentiometer, 4 rubber mounting studs.
1 Transformer, Input, 10K/7396.
1 Transformer, Output, 10K/7916.
1 Relay, 400 Ω (H. 15132, SS), 10F/753A. With switches 4 off, 2 on when inoperative.
1 Capacitor, 2.0μF, 250VDC wkg.
4 Capacitors, 0.1μF, 350VDC.
2 Resistors, carbon 2w. 36 Ω.

(Above) FRONT PANEL OF AMPLIFIER

(On Right) THE THEORETICAL CIRCUIT DIAGRAM



Query Corner

A "Radio Constructor" service for readers

Change in IF

"My receiver is a superheterodyne employing a high intermediate frequency. I am thinking of changing the IF transformers for those having a lower frequency, but before making the modification I would lke to know what effect it will have on the performance of the receiver. My reason for proposing the modification is to obtain a higher IF gain."

J. D. Winter, Manchester.

The principle of the superheterodyne is that the incoming signal frequency is changed to the so-called intermediate frequency, which is then amplified and detected. This intermediate frequency is fixed for any particular receiver and is obtained by mixing the signal from an oscillator with that of the incoming signal. The resonant frequencies of the signal tuned circuit and the oscillator tuned circuit are so arranged that their sum or difference equals the intermediate frequency. This may be simply stated as follows: Intermediate frequency=Signal frequency (±) oscillator frequency.

Now it is very desirable that the signal frequency is well removed from that of the IF in order that whistles shall be avoided, and there are in use to-day three main intermediate frequencies, namely 110 kcs, 465 kcs and 1.6 Mcs.

The former is located just above the long waveband on 2,727 metres. This IF will no longer be found on modern receivers as its use gives rise to the effect known as second channel interference. This effect is characterised by the reception of the same signal at two different points on the tuning scale; one point occurs when the local oscillator frequency is above the signal frequency and the other when it is below. Interference of this form is particularly troublesome with short wave superhets and as a result this class of receiver frequently employs an intermediate frequency of 1.6 Mcs. This frequency is just below the medium waveband. The 465 kcs range of IF's fall between the long and medium wavebands and are the most popular choice of commercial receiver designers.

From the foregoing it will be apparent that if the IF of a receiver is decreased the local oscillator section will require redesigning, and also the possibility of second channel interference will be increased. It is recommended that if the receiver is required for medium and long wave reception a minimum IF of 465 kcs be employed, but if efficient short wave reception is expected then an IF of 1.6 Mcs should be used for the reasons stated above.

"Query Corner" Rules

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

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

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

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

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

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

Vitreous Enamel Resistors

"I recently constructed a TRF type of television receiver and experienced a great deal of trouble when attempting to align the vision RF channel as it appeared that an adjustment of the contrast control upsets the frequency response and reduced the definition. Being unable to trace the fault to any particular component I tried replacing each component in turn and found that the fault disappeared when the low value vitreous enamel bias resistors were replaced by those of the standard carbon type. These resistors are included in the cathode circuit of each of the RF valves and are not capacitatively shunted. Can you offer an explanation of this effect?"

D. Vinter, Slough.

As the bias is increased on an RF amplifying valve the anode current decreases and the input capacitance decreases. Now the input capacitance of the valve is normally connected directly across the input tuned circuit, and hence any change in this capacitance results in a shifting of the tuning point. The effect of such a detuning in a television RF stage is to distort the overall frequency response of the complete vision RF amplifier with a consequent loss of picture definition. Because of the detuning effect a small amount of negative feed back is frequently employed in the gain-controlled RF stages. This feedback is obtained by the use of a unbypassed cathode resistor R in Fig. 1. This has the effect of greatly reducing the changes of input capacitance and input conductance of the valve when its bias is adjusted by means of the contrast

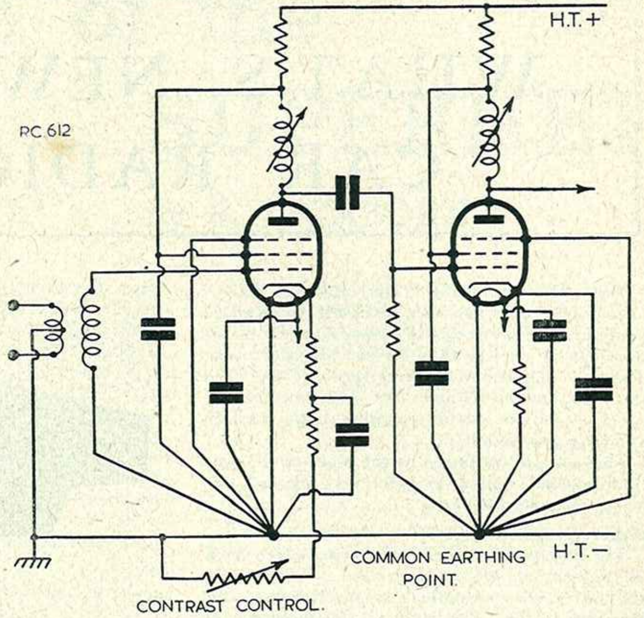


Fig. 1. Showing the first two stages of a vision RF amplifier in which the connections to the single point earthing tags are clearly indicated.

control. The optimum value for the cathode resistor for a given set of operating conditions is normally published by the valve manufacturers.

Now vitreous enamel resistors are usually of the wire wound type and therefore possess a certain amount of inductance. Consequently this type of resistor is not generally suitable for inclusion in circuits carrying very-high-frequency currents, as their impedance at RF may be considerably greater than their resistance. This would seem to be the cause of the trouble in the receiver mentioned in the query, as upon changing the vitreous enamel cathode resistors for those of the standard non-inductance carbon type the correct amount of negative feed back was obtained; consequently the frequency response of the receiver was no longer upset by alterations in the setting of the contrast control.

Instability at VHF

"I recently built a TRF type of television receiver but find great difficulty in obtaining stable operation when the RF gain (contrast) control is set near its maximum position. The instability occurs in one of the RF stages and no improvement has been obtained by very careful screening."

F. Hansworth, Slough.

The technique employed in designing amplifiers for very-high-frequencies is somewhat different to that used at the lower frequencies. For example more careful screening between the anode and the grid circuit of valves is essential as the reactances of the stray capacitances at VHF may be quite low. In order to reduce stray capacitances to a minimum all signal carrying leads must be of the shortest possible length and connections must be of the lowest resistance. Dry solder joints are a very prolific cause of instability. It is useful to remember that the plates of screen and cathode decoupling capacitors are at earth potential as far as RF is concerned and may therefore be situated with advantage between the input and output leads of an amplifier stage to improve the screening.

Possibly one of the most outstanding features of VHF wiring technique is the use of the single point earthing system. With this system, the passage of RF currents in the chassis is reduced to a minimum, a factor which goes a long way to ensuring RF circuit stability. Fig. 1 shows a two-stage amplifier in which the single point earthing technique is employed. Each earthing point may consist of a soldering tag securely bolted to the chassis, care being taken that both the chassis and tag are perfectly free from dirt. It has been our experience that tinplate or cadmium plated steel chassis are superior to those made of aluminium when it is required to make very low resistance contacts to the chassis itself.

Finally it must not be forgotten that unwanted interstage coupling may occur via the valve heater wiring, and decoupling capacitors are included in the circuit as a precautionary measure to prevent this happening.

WHAT'S NEW IN CAR RADIO?

For some time now "His Master's Voice" automobile radio has been available as standard equipment or an exclusive optional extra on the products of no less than 20 car manufacturers. The most popular of the receivers sold has been the push-button Model 100 with its 6-valve superheterodyne circuit covering both medium and long wavebands.

This set still continues as the main model, but Radiomobile Limited, have recently released two pieces of news about it.

Bigger Output Brings Price Reduction

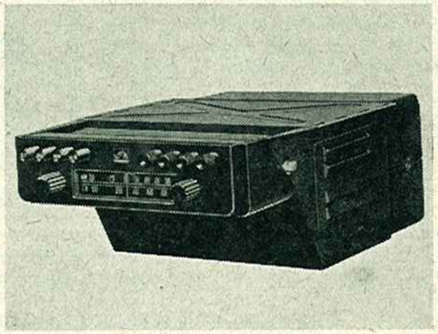
The first point concerns the price which from 1st September, 1949, £24, instead of £27 6s. 0d., and which with reductions in purchase tax and the price of the aerial gives a total reduction of about £4 10s. 0d., for the complete installation.

"De-Luxe" Listening

There is also new Radiomobile equipment available which enables the existing Model 100 to be converted into a de-luxe installation complete with an additional loudspeaker. This extra "speaker" is fitted at the top of the rear seat squab, or some other suitable place and in combination with the one in the receiver gives really outstanding reproduction.

Short Wave for Export

To cope with reception in certain countries abroad, Radiomobile have now introduced a short wave receiver—Model 4050—which covers the medium waveband as well. The size, shape and fittings of the set make it interchangeable with the other "His Master's Voice" automobile radios and it can be fitted as an optional extra on cars destined for abroad; it is not yet available for the home market. Another set for export only is Model 4014, which has medium waveband coverage only, is particularly suitable for such overseas countries as Australia, New Zealand, and South America. A similar set to this—Model 4012—covers the broadcast band wavelength for U.S.A. and Canada.



Model 100/4010 12V/6V Push-button Car Radio suitable for reception of the Medium and Long wavebands.

Model 4050/4051 Push-button Car Radio for reception of Medium and certain Short wavebands.

Coach Radio

The provision of Radio together with Speech Amplification Equipment in coaches is fast becoming popular. Radiomobile Limited, have always paid particular attention to this branch of automobile radio and they will have two complete sets of such equipment on show at Radiolympia. Model 4030 available for either 12 or 24 volts is specially designed for incorporation in passenger vehicles and is capable of providing an output up to four extension speakers. There are also facilities for the inclusion of microphones to enable a driver or courier to speak through the system to the passengers.

Model 4032 is a similar set for passenger vehicles but with a special "isolated" circuit for two-wire electrical systems.

Design of the SUPERHET

PART 2

By R. J. CABORN

In our article last month we reviewed briefly the general theory of the superhet. It was intended then only to give a sufficient idea of the working of this type of receiver to enable the reader to appreciate the fact that amplifying the signal at one frequency (the intermediate frequency) allows us to obtain considerably greater selectivity and sensitivity than would be offered by the TRF straight receiver. It was explained that the frequency of the signal received on the aerial was converted by the frequency-changer to that of the IF amplifier. This month we intend to explain how the frequency-changer works.

Frequency-changing

Now, to fully appreciate the working of the frequency-changer it is first of all necessary to understand what happens when two different frequencies are combined together.

We may do this graphically by examining the curves of two typical signals, such as those shown in Fig. 1. Referring to this diagram we see that the top curve (a), has five separate cycles within the length of the graph. Now, if we were to assume that this length represented 1μ second of time (*i.e.*, 1 millionth of a second), then the frequency of the signal would obviously be 5,000,000 cycles per second, or 5 Mcs. The second signal shown has 4 complete cycles to the same length of time and may therefore be considered as having a frequency of 4 Mcs. Now, if these two frequencies are combined together we would find that the resultant of the combination is the curve of Fig. 1(c), a signal of frequency 1 Mcs, *i.e.*, one complete cycle to the μ second. This statement may be proved by accurately drawing the first two waves on graph paper, regarding those parts of the curves above the central line as positive and those below as negative; and then, by plotting a series of points on a third time axis corresponding to the sum of the positive or negative values of the first two curves, obtaining our third wave-form.

The result, therefore, of combining two frequencies, one 5 Mcs and the other 4 Mcs, is to produce a third frequency of 1 Mcs. Using the same method it can also be proved that the combination of a frequency of, say, 7 Mcs, with another of 5 Mcs would result in the formation of a third frequency of 2 Mcs. Taking these conclusions a stage further we can state that, however many examples we may choose, we will always find that the resultant frequency is equal to the *difference* of the first two frequencies.

This is a very important conclusion and we may express it generally by stating that, if two frequencies, F^1 and F^2, are combined together in a frequency-changer, then the resulting frequency will be equal to $F^1—F^2$ (or $F^2—F^1$ if F^2 is greater than F^1).

The Frequency-Changer.

We said just now that the two frequencies F^1 and F^2 have to be combined together *in a frequency-changer*. The frequency-changer itself is therefore a necessary part of the equipment.

Now this frequency-changer may be one of two types. A simple example of the first type is shown in Fig. 2(a). In this figure we find two RF oscillators, both feeding their outputs to the grid of a triode. "RF Oscillator 1" gives an output at frequency F^1. The second RF oscillator supplies a frequency of value F^2. These two

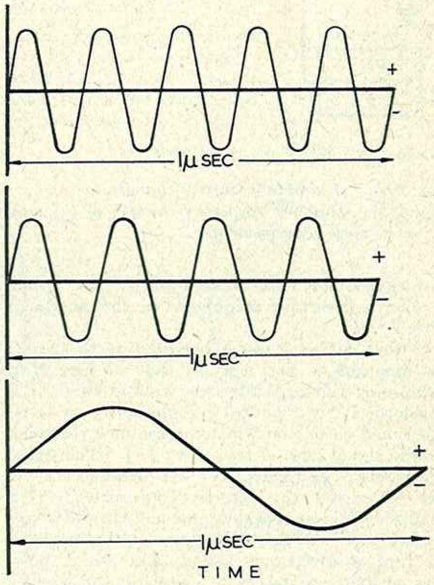


Fig. 1. Illustrating how the combination of two frequencies may produce a third having a frequency equal to the difference between the first two.

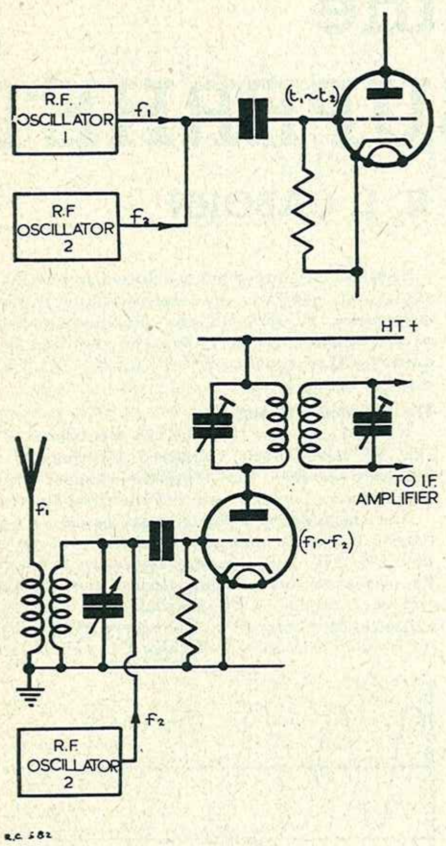


Fig. 2(a). A simple frequency-changer.
Fig. 2(b). How the frequency-changer of (a) may be put to more practicable use.

frequencies are then converted by the triode to give a resultant frequency in the anode of $F^1 \sim F^2$.*

It does not need much imagination to change the diagram of Fig. 2(a) to that of Fig. 2(b). Examining the two diagrams we find that " RF Oscillator 1 " of Fig. 2(a) is replaced by an aerial and tuned circuit on which we are now receiving a radio signal (also of frequency F^1). The signal F^1, previously supplied by " RF Oscillator 1," is now given by the remote transmitter. " RF Oscillator 2 " remains the same and the difference frequency, $F^1 \sim F^2$, still appears at the anode of the frequency-changer valve. This time, however, we have a tuned circuit—actually the primary of the first IF transformer—connected to the anode, this circuit being tuned to $F^1 \sim F^2$. Our frequency-changer is now therefore carrying out the duties it would do in a superhet. That is to say, a required signal is picked up on the aerial, F^1, and combined with that from a local oscillator, F^2, the intermediate frequency $F^1 \sim F^2$ being then accepted and amplified by the IF amplifier to be detected and subsequently fed to the loudspeaker.

* The expression $F^1 \sim F^2$ means the difference between F^1 and F^2 irrespective of which has the larger value.

Electronic Mixing.

The type of frequency-changer shown in Figs. 2(a) and (b) is known as a " single-triode " frequency-changer. It is not used nowadays for broadcast or short wave reception although it has useful applications on higher frequencies. This is because it has been superceded by a frequency-changer which relies for its action upon what is known as " electronic mixing." We shall return to the triode later, but for the present it has served its purpose.

An easily understood example of a frequency-changer using electronic mixing is given by the triode-hexode. Fig. 3 shows a diagram of this valve. It consists really of two valves, the triode and the hexode. The triode part forms the local oscillator and takes the place of " RF Oscillator 2 " of Fig. 2(b). It may, for instance, be connected as a tuned grid oscillator (Fig. 4). Now, owing to the internal link inside the valve the oscillation voltages found on the oscillator grid are transferred to the third grid of the hexode section. At the same time the signal frequency is applied to the first grid of the hexode, the " signal grid." The second and fourth grids of the valve then act as ordinary screen-grids, the second screening the oscillator and signal grids from each other, the fourth screening the anode from the oscillator grid.

Now, it may easily be seen that, in its movement from cathode to anode in the hexode section of the valve, the electron stream is controlled by two grids: firstly the signal grid and secondly the oscillator grid. The electron stream will therefore

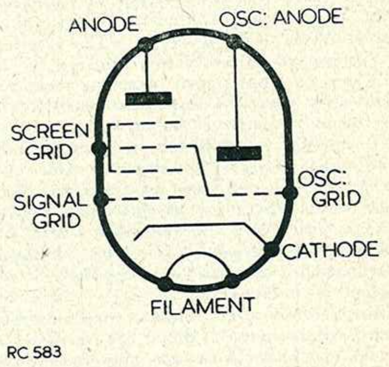


Fig. 3. The construction of the triode-hexode frequency-changer.

be varied in strength both at the signal and at the oscillator frequency. The resultant frequency appearing at the anode can hardly help then but contain the difference frequency ($F^1 \sim F^2$). We may therefore connect the primary of our first IF transformer in the anode circuit of the hexode portion, and tune it to the difference frequency.

This had been done in Fig. 4 which shows the circuit of a conventional frequency-changer. The required signal is picked up on the aerial and is transferred, via the tuned circuit L^1, C^1 to the signal grid of the triode-hexode. L^2, C^2 forms the oscillator tuned circuit and is tuned to a frequency removed from the aerial frequency by a value equal to the intermediate frequency.

Other Types of Mixer.

There are, of course, other types of frequency-changer whose action is similar to that of the triode-hexode.

The pentagrid (or heptode) is a commonly-used type. A diagram of this valve is shown in Fig. 5(a). In this valve the necessary local oscillations are obtained by treating the second grid as though it were an anode. A virtual triode is then formed by the cathode and the first two grids, these being connected to an oscillatory circuit which could be similar to that used by the triode-hexode in Fig. 4. As the first two grids are varying their potential at the oscillator frequency they will control the electron stream in much the same manner as was done by the third grid in the hexode section of the triode-hexode (Fig. 3). The signal grid (Fig. 5(a) again), also takes a hand in controlling the electron stream and again we find the difference frequency at the anode.

In the octode (Fig. 5(b)), a further electrode is added. This consists of a suppressor grid fitted between the anode and the second screen-grid. The octode acts in much the same manner as the pentagrid but the suppressor grid gives it more the characteristic of an RF pentode than that of a screen-grid valve, and it is therefore capable, under certain conditions, of greater amplification than the pentagrid.

Fig. 5(c) shows a hexode. In this valve the oscillator grids are placed further away from the cathode than is the signal grid. Their action is nevertheless the same, both signal and oscillator grids varying the electron stream at their different

(*Continued on page 136*)

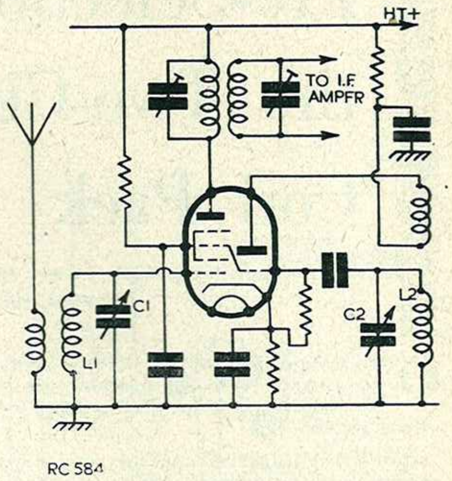
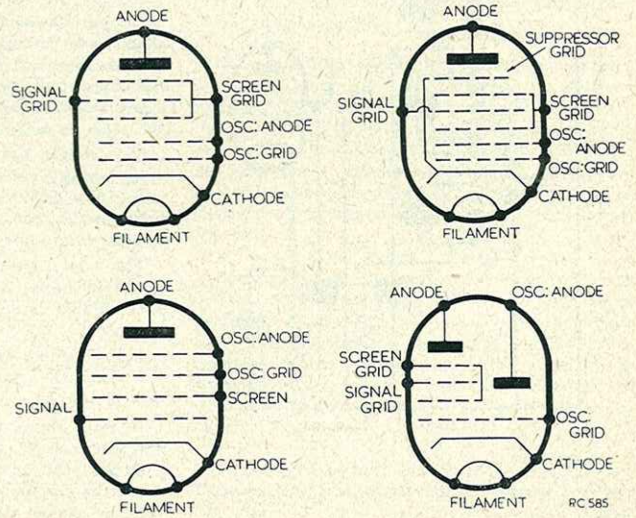


Fig. 4. A practical frequency-changer circuit using the triode-hexode.



Top left.
Fig. 5(a). The pentagrid.
Top right.
Fig. 5(b). The octode.
Bottom left.
Fig. 5(c) The hexode.
Bottom right.
Fig. 5(d). A form of triode-hexode alternative to that shown in Fig. 3.

Pre-Selection and the Two-Circuit Coil Pack

By LEN MILLER

Describing a simple yet very effective means of adding one or more RF stages with minimum expense.

ONE of the major problems which confronts the potential set-builder undoubtly lies in the choice and design of the signal frequency section.

If cost, time and patience, the necessary ability and accessability of suitable aligning apparatus is of no object, then he, the set builder will almost certainly build a three-circuit coil pack made up from one or other of the several sets of coils which are now readily available.

Alternatively he may save himself a lot of alignment bother by purchasing a ready made three-circuit coil pack. Unfortunately, excellent as many of these packs are, they are expensive, and if cost *is* of some avail (and it is to this section of the radio constructing public that this article is dedicated), he will, on digesting the advertisement colums, sadly come to the conclusion that

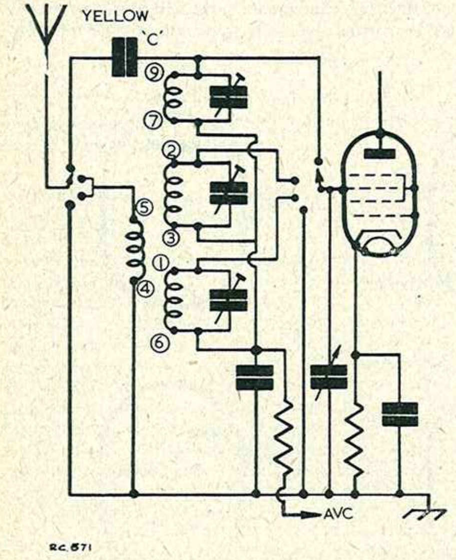


Fig. 1. Normal input circuit of " Weymouth " pack.

the RF stage will have to be sacrificed, as a two-circuit pack can be purchased for a little over 30/-, whilst the pack complete with RF section is in the region of a few pounds.

The difference in price charged is of course quite justified, as while the two-circuit pack can be constructed with the coils bunched round a single wafer switch quite effectively, it is essential in a three-circuit job to employ thorough screening between the RF and mixer input coils. This means separate compartments for each set of coils and separate wafers ganged on a spindle which runs through each compartment. The cost for the extra set of coils (for the RF section) is bound to appear at first sight, out of proportion to the cost of a simple two-circuit pack.

However, there *is* a money-saving way out of the problem. Naturally it is a compromise, but to say the least it is a compromise in the right direction, namely, for the extra expense of a very few shillings above the cost of a two-circuit pack, *short-wave* performance can be equal to the expensive three-circuit job.

By purchasing (or even making) an additional short-wave coil and incorporating it as about to be described will result in a receiver utilising an RF stage on the short-wave band only, and surely many readers will admit that this is where the RF stage is most needed.

The writer has not had the opportunity of studying the circuit arrangements of all of the many two-circuit packs now on the market, but believes that most of them will lend themselves to this simple modification.

The constructional details of this article are therefore based on the original " Weymouth " pack, which is really admirably suited for this purpose.

Fig. 1 shows the mixer input circuit of the " Weymouth " pack, and the modified version is shown complete in Fig. 2.

It will be noticed that the only alteration necessary is to disconnect the capacitor " C " from its tag on the wave-change switch. This capacitor now becomes the coupling between the RF and mixer valves, and is connected to the

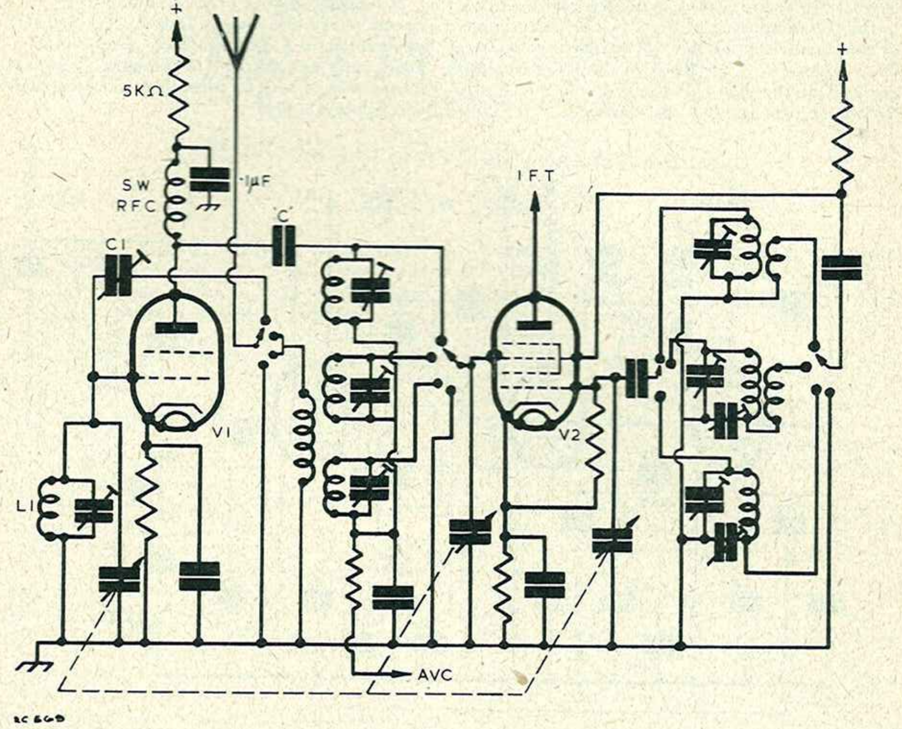


Fig. 2. " Weymouth " pack with SW RF stage. (Note; No extra switching required), AVC may be applied to V1 if desired.

anode of V1. Thus when the wave-change switch is in the short-wave position, the aerial is connected, *via* the 30 pF capacitor C1 to the grid of V1, whilst the output of this stage is choke-capacitance fed (*via* " C ") to the short-wave coil in the pack and the grid of the mixer V2.

On the medium and long wave positions the aerial is switched direct to the mixer primary and the coil pack functions normally, the RF stage now being inoperative and completely isolated from the set.

Provided that the RF short-wave coil is adequately screened, no interaction is experienced due to the self-capacity of the wave-change switch, as it will be apparent that the short-wave coil in the pack is not connected in any way to this switch.

From the purely constructional side, a three-gang capacitor can be used, alignment being effected by means of the parallel trimmers and the short-wave series aerial capacitor C1, the RF coil L1 preferably being mounted in a can which should be located close to the appropriate section of the gang capacitor.

This method of adding an RF stage even offers advantages over the more orthodox tuner, inasmuch as a high-slope RF valve (such as a 6AC7, 6SG7 or EF50) can safely be used. Normally, a high-slope valve would " spill over " on medium and long waves, but as it is now only being used on the short-wave band the possibility of instability on the other wave bands obviously does not exist.

Signal-to-noise ratio is greatly improved upon by employing a high-gain RF stage. The more ambitious set builder may even wish to employ two RF stages ahead of the mixer, which is quite practical in this case, provided that screening is thorough. Capacitor " C " is then connected to the anode of the second RF valve, as shown in Fig. 3.

Regarding the additional coil (or coils, if two RF stages are contemplated), in the case of the " Weymouth " pack, additional coils of identical characteristics are readily available, and, referring to the coil numbering in Fig 1 (which corresponds to the numbering on the " Weymouth coils), tag No. 7 goes to earth (or the AVC line), tag No. 9 to the grid of the RF valve concerned, whilst the remaining tags are left disconnected.

It is believed that other manufacturers of two-circuit packs also supply individual coils, but in any case it is a comparatively simple matter to make one's own, as the " Weymouth " uses a ¾-in. former wound with 6½ turns of 24 guage enamelled wire, closewound.

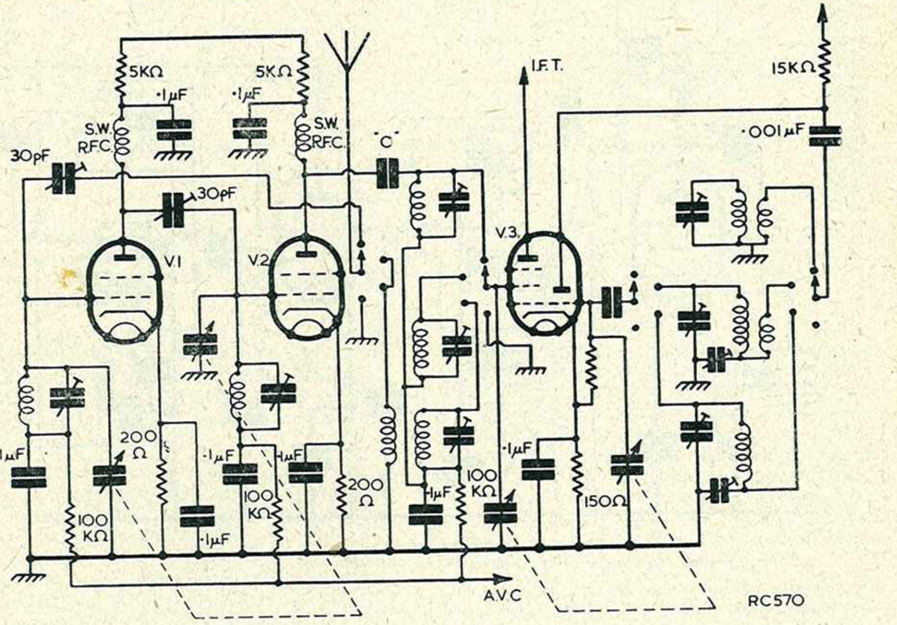


Fig. 3. Two SW RF stages ahead of pack. V1, V2 should be low-slope types such as 6K7, V3—6K8. Two separate 2-gang capacitors are recommended for best results, but a single 4-gang can be used.

RECEIVER CONTEST RULES

(1) The Contest is open to any reader.

(2) Any number of articles may be submitted by any one contestant.

(3) The articles will be judged on their merits, taking into account ingenuity, practicability, and technical soundness.

(4) Receivers described may be either battery or mains types, and there is no limit to the number of valves or wavebands employed.

(5) Articles need *not* be typewritten, though this is preferable. This point will *not* be taken into account when judging. Articles should be written or typed on one side only of the paper, and all drawings must be on separate sheets apart from the text. Drawings may be rough but should be clear and legible, and will not themselves have any bearing on the judging.

(6) All articles must be accompanied by a suitable S.A.E. for return or acceptance.

(7) The Radio Constructor does not accept any responsibility for MSS, which are submitted at owner's risk.

(8) The decisions of the judges—R.C. editorial staff—shall be binding.

(9) The latest date for entries is December 30th (last post).

The 58 Set VIBRATOR UNIT

By R. E. HARE, G1491

(ISWL Surplus Gear Query Service)

THIS power unit, if obtained complete, is housed in a strong metal case, the lower section of which contains the accumulator box with two 2-volt lead acid accumulators, and the upper section contains the vibrator unit.

Provision is made on the vibrator unit for selection of either or both accumulators for service by the selector switch S1 (see circuit diagram). There is also provision, via a four-pin socket, for charging the two accumulators from a 6-volt source. Since the author has received many queries regarding the unit, the following article was written to include all the salient features and the use to which this unit can be put.

The unit can be a very compact source of HT and LT supply where the reader has a portable receiver, or intends to build one on the popular " personal " receiver lines, and also, of course, for field day receivers. In all of these cases, HT batteries are a costly and inefficient means of obtaining power.

When used, as was intended with the 58 set (Walkie-Talkie) the rated HT outputs were as follows :—

On Receive 67 volts at 4.7 mA.

On Transmit 130 volts at 13 to 25 mA.

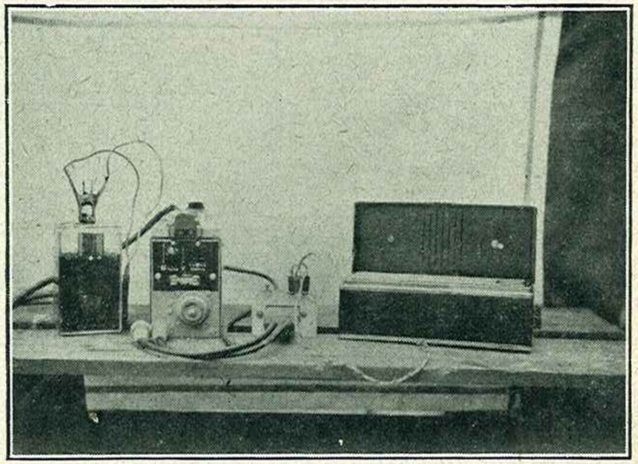
In the case of " personal " receiver constructors with the range of valves normally employed, *i.e.*, 1T4, 1R5, 1S5, 1S4, 67 volts is the normal HT voltage.

Since the author had already built a personal receiver he at once set out to use the vibrator for supply purposes. As no official circuits were available the circuit was traced out, and is that one shown.

Some readers may find that their own particular unit differs from the one here shown, due to the inevitable " mods." For instance, in some units there is another relay fitted to ensure that when charging is carried out the polarity will be correct, regardless of polarity relationships between charging plug and socket.

Having traced the circuit it was seen that only four leads and an earthed screen emerged from the unit, and attached themselves to the 10-way output socket PL1.

To start the vibrator working, it can be seen that RL1 must be energised. Since one end of the relay solenoid is ultimately connected to the positive of the accumulator, then the other end which appears at pin 2 on PL1 must be earthed. A link was placed between pins 2 and 3 on PL1, and the vibrator started buzzing. Investigations were then carried out with a test meter and 67 volts were measured between pins 1 or 9 (HT+) and pins 3 or 8 (HT—). No LT voltage was detected ; after another close look at the diagram it was realised that RL1 performed more than one duty. It was in fact an LT smoothing choke, with C4 (1,200μF) as the associated smoothing



The vibrator unit is shown here coupled to the junction box made by the writer. The type of accumulator obtained with the complete 58 set power unit is also shown. The writer's personal receiver can be seen on the extreme right.

capacitor. This explained the lack of LT voltage since pins 2 and 3 were shorted together. Pin 2 was in fact the LT+ pin and between this and pin 3 were the filaments of the 58 set.

On checking it was found that approx. 1.5 volts was obtained across pins 2 and 3 under the conditions mentioned at a current of approximately .5 amp. The reason for RL2 was fairly obvious—to increase the HT voltage for transmission. The operation of this relay increased the HT volts to 130 volts. RL2, it can be seen, is earthed at one end of its solenoid, and the other end is brought out to pin 10 on PL1. By shorting pin 10 to pin 2 when the point is at LT+ potential RL2 will close. If, therefore, the vibrator is used without utilising the LT output and an increase in HT is required, a small resistance resistor must be placed across pins 2 and 3 to allow a large enough positive potential to appear at pin 2 and operate RL2.

The bias for the transmitter was derived from a 21 volt "Mini-Max" Battery housed in a container on the unit, the negative terminal appearing at pin 6 on OS. This need not bother the reader, except that the housing may be utilised for a battery for bias purpose, should the particular receiver require bias supplies.

In harnessing the output from this unit, the author had three things in mind :—

(*a*) To operate a personal Rx.
(*b*) To operate a 38 set.
(*c*) To be available as portable power unit.

With these three facts in mind, a small junction box was fabricated from an American phone adaptor box. A slot was cut in the side of sufficient dimensions to allow PL1 to slide inside the box. Inside the box, opposite the slot, a plug was placed for PL1 to connect to. This plug was made from a thick piece of paxolin sheet, with 4BA screws suitably filed to act as plug points.

On the flat top of the box, a flush mounting four-pin British valve base was fixed with an ordinary spst toggle switch beside it. It was arranged that the LT and HT connections to the valve socket were in harmony with those of the similar four-pin power supply plug for the 38 set. That is grid pin HT—, Anode pin HT+, and the other two pins for filament supply. The switch enabled the HT+ to be stepped to 130V if required by shorting pins 2 and 10. The four valve base pins were clearly marked with their respective purposes (LT+, LT—, etc.) so that ordinary banana wander plugs could be quickly plugged in from any outside unit, such as the personal receiver. It was found that with some vibrator units the "hash" was more marked and an extra 1,000μF capacitor 3 volt wkg.) was placed in parallel with C4 to eliminate this.

Although the 38 set filament supply voltage is 2 volts, little detrimental effect was noticed either on transmit or receive, when the set was worked with the available 1.5V from the vibrator unit. If, however, 2V is required, then a separate 2 volt accumulator should be used. This is easily obtained if the complete power unit is in the reader's possession.

For those who do possess the whole unit, the official charging figures for the accumulators are 3 amps for a minimum period of 8-10 hours where the cells are known to be completely discharged. However, in the author's opinion, the charging rate is too high, since the accumulators appear to be only 20 AH capacity. It was found that a charge between 1 and 2 amps over 16 hours gives a much longer working life.

The floating bead indicators should indicate a third of condition of charge for each bead floating at the surface of the acid. That is three beads floating at the surface indicates full charge. The white bead, however, soon sinks after the accumulator is taken off charge, although the terminal voltage on load is still approximately 2.2 volts, and remains so for many hours continuous use.

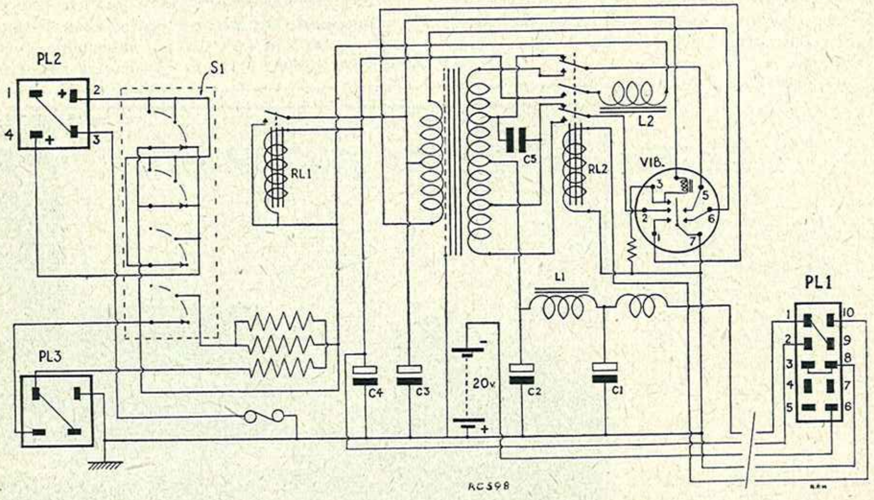


Fig. 1. Circuit. Component List: C1-20μF, C2-20μF, C3-5μF, C4-1,200μF, C5-0.03μF, PL1-Power output socket, PL2-Accumulator input plug, PL3-Charging socket, VIB-Vibrator socket. Pins shown are numbers marked on socket. S1-Battery Selector Switch (shown in "B" position).

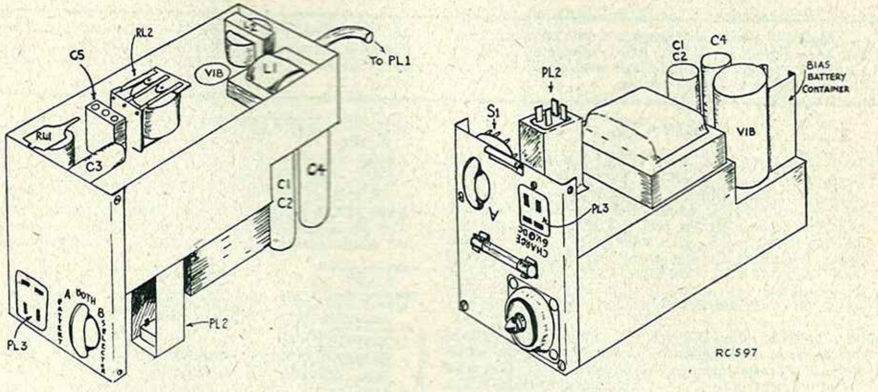


Fig. 2. Perspective views of the Vibrator Unit.

The Third Amateur Radio Exhibition

Organised by the **Radio Society of Great Britain**, this exhibition opened at the Royal Hotel, Woburn Place, W.C.1., on November 23rd, and judging by the attendance and interest shown on this date should prove as successful as in previous years. Rather than describe in detail each stand, we propose, in this limited space, to mention only those new items which were brought to our notice.

On the **Denco** stand, the television kit which can be used either for the Midlands or London service by changing the RF unit, was proving of particular interest. So, too, was the DCR19, a communications receiver. One particular item which should prove very useful was the IF Alignment Oscillator, suitable for either 465 or 1,600 kcs IF's. At 39/6, this struck us as a very nice instrument to have in the shack. A new series of stoutly made, aluminium 4-sided undrilled chassis varying in size from 7″ x 4″ x 2″ to 20″ x 9″ x 2½″ were on show, and an adjustable chassis hole-cutter at 7/6 should be a good seller.

E. J. Philpotts Metalworks Ltd. showed examples of their metal work by G4B1, which will need no introduction to our readers. Numerous standardised instrument and speaker cabinets were on exhibit, together with enamelled and crackle finish chassis and panels in different colours, and an extremely attractive de-luxe type rack assembly, totally enclosed, with hinged domed top and full-length door at the back. At £14/10/- for 5 tiers, this should be a very popular unit, as there is ample room to house even the most elaborate of 150W phone transmitters.

Some interesting new items were seen on the stand of **Southern Radio and Electrical Supplies.** In particular, their Sorad transmitter was attracting attention. Model 491 gives 30-40W input on CW and 25W on phone, and the 493 gives 60W CW and phone. A compact morse oscillator was on show on the stand, in a black crackle diecast case 8½″ x 5¾″ x 2¾″. The Sorad wavemeters and monitors were equally neat units.

E.M.I. Sales and Service Ltd. were also exhibiting a series of very attractively produced wavemeters, grid-dip oscillators, spot frequency markers and CRT modulation indicators.

On the **Radiocraft** stand, the transmitters type 44; 44P, 45, 45P and 46 are compact little units designed to appeal particularly to the 25W licensee, and they are also available as kits. TVI filters for use with various types of aerial feeders, and a standing wave indicator at 6/9, were also useful products of this firm.

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