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The RADIO CONSTRUCTOR

for the Radio and Television Enthusiast

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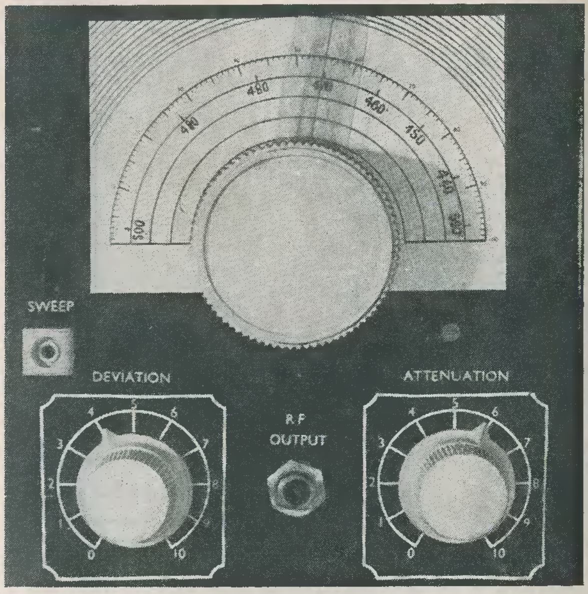

A SIMPLE WOBBULATOR

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MODERN LINE TIMEBASE CIRCUITS, Part 2
A PROGRESSIVE RECEIVER
MIXING CIRCUITS · RADIO CONTROL NOTES
THE "CLIPPER" COMMUNICATIONS RECEIVER
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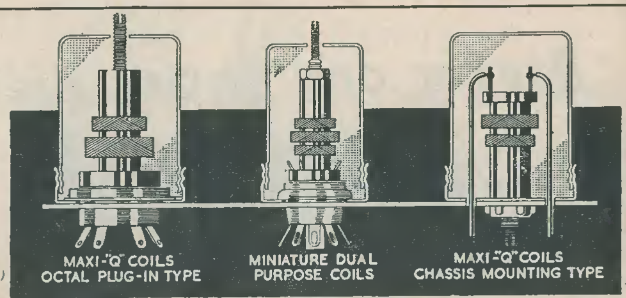

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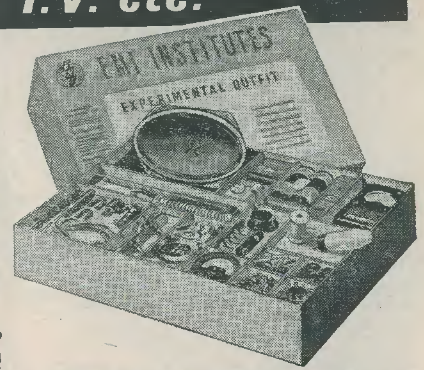

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incorporating THE RADIO AMATEUR

CONTENTS FOR APRIL

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Editor
C. W. C. OVERLAND, G2ATV

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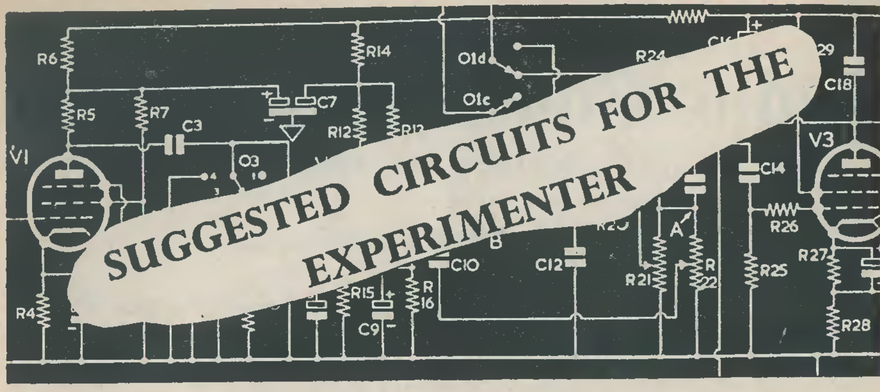
NOTICES

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

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

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

ALL CORRESPONDENCE should be addressed to THE RADIO CONSTRUCTOR, 57 Maida Vale, London, W.9 *Telephone* CUN. 6518



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

No. 53 A "VOLUME-COMPENSATOR" CIRCUIT FOR SOUND RECEIVERS

A SOMEWHAT IRRITATING ATTRIBUTE OF sound reception is the fact that, for similar gain control settings, the volume of broadcast orchestral music is often apparently greater than that of broadcast speech. This effect is particularly noticeable in programmes which alternate speech and music, such as are given by light music and variety shows. What usually occurs is that it is frequently necessary to advance the volume control of the receiver in order to hear the speech of a particular performer clearly: when the performer is followed by an orchestral item, volume then becomes objectionably loud. The effect can be especially embarrassing for those who live in flats and apartments, in which it is advisable to keep one's radio at reasonably low level in order to prevent upsetting closely neighbouring occupants.

The reason for the apparent change in volume is, of course, the fact that, whilst the peak voltages of both the broadcast speech and music remain the same, the number of different audio frequencies making up the music is considerably higher than that in speech.

This Month's Circuit

The circuit described this month is intended to go some way towards reducing the apparent volume of music in programmes of this nature. It is not designed to function purely as a volume-compression device. Instead, it operates by applying an additional AVC bias to the receiver when the AF appearing at the output anode contains a large proportion of frequencies outside those normally given by speech. Such frequencies would occur in most orchestral music. The circuit is not intended to work during programmes which are devoted entirely to music. If used during a symphony concert, for instance, the effects given might not be aesthetically pleasant, since the arrangement is frequency-selective. The circuit should be employed only when the receiver is tuned to a local station. The associated receiver may be any conventional superhet.

Operation

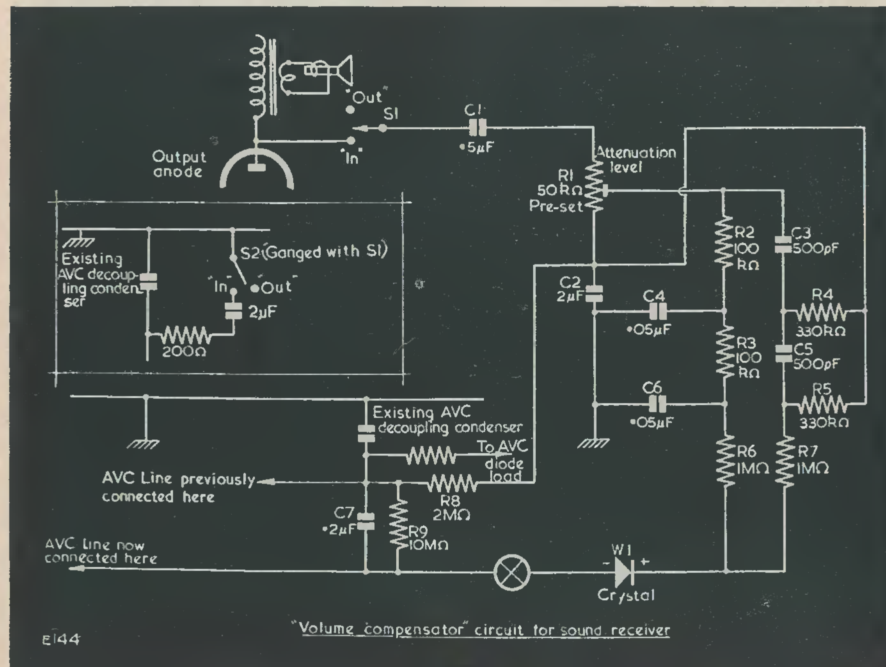
The operation of the circuit is quite simple. AF appearing at the output anode of a receiver is applied, via C1, to the pre-set potentiometer R1. The AF tapped off this potentiometer is then passed to two filters. One of these, R2–C4, R3–C6, is a two-section low-pass filter which affords a high attenuation of frequencies above 200c/s. The second filter, C3–R4, C5–R5, is a high-pass filter, providing attenuation of frequencies below 1,000c/s.

The outputs of the two filters are passed, via R6 and R7, to the crystal diode, W1. This diode rectifies and charges C7 to a negative voltage which is dependent upon the amplitude of the AF provided by the two filters. The voltage across C7 is applied to the AVC line in series with that given by the existing AVC decoupling condenser and resistor.

The largest proportion of speech power is contained within the frequency range 200 to 1,000c/s. Thus, during speech, the rectified voltage developed across C7 will be low, and the set will work at nearly normal gain. When the speech is replaced by orchestral music, however, the AF voltages passed by the filters will be considerably greater, and a higher AVC voltage will be developed. The effective volume of the receiver will, in consequence, be attenuated during the transmission of musical items. The amount of attenuation is controllable by the pre-set potentiometer R1.

especially when lower audio frequencies are being rectified. Also, a DC return circuit has to be provided for the rectifier. Both these requirements are met by applying the existing AVC voltage, via R8, to the 2μF condenser C2. So long as the existing AVC voltage is reasonably steady (as is given by local-station listening) the voltage across C2 will then be equal to that on the AVC line. (C2 must not, of course, be an electrolytic component). All the filter resistive returns are then made to C2 and not to chassis.

Another point of importance is given by the presence of the two resistors R6 and R7. These resistors prevent either filter from



"Volume compensator" circuit for sound receiver

The Crystal Diode Circuit

It will have been noted that the above remarks have not entirely covered some points of the circuit. These points are slight complications which are necessitated by the provision of a return path for the crystal diode, and for preventing the formation of low frequency AF voltages in the AVC line.

To commence with, since the voltage rectified by the crystal diode is to be added in series to that given by the existing AVC circuit, the latter has to be kept stable, upsetting the characteristics of the other, and also provide a useful time delay for the charging of C7. The discharge time for C7 (C7 and R9) is higher than the charging time, but this should approximate to what is required in practice.

Practical Points

To put the circuit into operation, most of the components required could be fitted to a small chassis separate from the main receiver chassis. C7, R8 and R9, however, must be mounted close to the existing AVC decoupling condenser. If a long lead is used to connect C7 to the crystal diode, it is possible that it may cause RF instability. In such a case, a 20kΩ resistor should be inserted, in series, at the point marked with a cross. This resistor must be mounted close to C7.

AF Instability

It is possible that, with some receivers, the circuit may introduce instability at very low audio frequencies. Should this occur, the best solution would consist of increasing the values of C7 and the existing AVC decoupling condenser to 2μF (non-electrolytic). To prevent this high value from upsetting the AVC characteristics of the receiver when the circuit is not in use, a second switch could be added, ganged to S1, to switch in additional capacity across the existing AVC decoupling condenser. The arrangement needed is shown in the "insert" in the diagram. The series 200Ω resistor is intended merely to limit charging currents at the moment of switching in the extra condenser.

This extra condenser will, of course, considerably increase the time constant of the AVC system. However, this effect should not be of great consequence for local station reception, which is all the circuit is intended for.

RADIO AND TV INTERFERENCE

Wireless Telegraphy (Control of Interference from Electric Motors) Regulations 1955

Wireless Telegraphy (Control of Interference from Refrigerators) Regulations 1955

These two sets of regulations have been laid before Parliament. They give the Postmaster-General power to control interference with radio (including television) from refrigerators and from domestic and industrial appliances which are driven by small electric motors, e.g. vacuum cleaners, hair driers and drills. These are the commoner sources of interference with sound broadcasting and television reception.

Both sets of regulations come into force on 1st September, 1955, and lay down the requirements which must be complied with (*a*) by manufacturers, assemblers and importers of all electrical refrigerators, and (*b*) by users of new and old electric motors. These arrangements were recommended by the Advisory Committees appointed under Section 9 of the Wireless Telegraphy Act, 1949, and the regulations have been drawn up with the agreement of these Committees.

The introduction of the electric motors regulations does not mean that everyone using a vacuum cleaner, hair dryer, or other domestic electric article will have to fit a suppressor at once. Only a proportion of these appliances cause interference, and the Postmaster-General hopes that in such cases the owners of the appliances will co-operate by having the trouble put right when it is pointed out to them by the Post Office. The new powers will be used only where it is necessary for the Post Office to insist on an appliance being put right because it causes interference and the owner will not voluntarily have a suppressor fitted.

The Postmaster-General hopes that there will be a progressive extension of the current practice of certain manufacturers who produce appliances incorporating suppressors or who provide for the easy addition of a suppressor if it proves necessary. The question of making the regulations for small motors apply to manufacturers is to be reviewed during the next two years.

The standards laid down in the regulations, i.e. the limits of interference and the frequency ranges over which they are to apply, have necessarily been based on data derived from existing sound and television broadcasting services, for which they are designed to give adequate protection in areas of moderate field-strength, provided the receiving installation, which includes the aerial system, is satisfactory. The standards are also expected to give adequate protection to the proposed frequency-modulated VHF sound broadcasting service in Band II (87.5 to 100Mc/s) and to go some way towards eliminating interference in the higher range of frequencies (Band III) to be used for the new ITA television service.

The Advisory Committees, when submitting to the Postmaster-General their reports

(*continued on page* 527)

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

There are many irritating little problems which, from time to time, harrow the home-constructor and radio serviceman. Some of these occur almost periodically, usually making their appearance when one's attention is already fully occupied elsewhere. Of these annoyances, perhaps the most exasperating are those concerned with soldering.

Organising Genius

In the January issue of *The Radio Constructor* Centre-Tap had a few words to say on this subject; and he rightly pointed out how lucky we were these days in being provided with rosin-cored solder, tinned wire and tinned tags. Compared with the old days, things couldn't be easier.

All this is very true. And yet it was only the other day that I picked up a brand-new component, straight from the very well-known manufacturer who made it, and which was fitted with the most unsolderable set of solder tags I have ever met! It was, in fact, quite impossible to tin the tags at all, although I tried the effect of several widely advertised cored solders. In each case all that happened was that the solder rolled off dismally leaving the tag completely untouched. In the optimistic days immediately after the war someone stated that it would take an organising genius to fail to produce coal from an island that was built upon it. I have an idea that this organising genius has now shifted his ground. He's producing solder tags that don't solder!

Anyway, I managed to solder the offending tags eventually; but only by the process of completely filing away all the plating until I had got down to the brass underneath.

Easy, When You Know How

Another problem which frequently crops up is given by the difficulty of soldering litz wire. This is quite definitely not a simple process; and it is especially difficult when the individual strands of the wire are very fine, as often occurs in such components as IF transformers and medium-wave coils. Peculiarly enough, very little has been written on this subject in the amateur press. Even in the august pages of *Wireless World*, a contributor who some time ago asked for suitable methods of soldering this type of wire has still, so far as I know, not yet been given any really satisfactory answer.

In practice, the process of soldering litz wire is quite simple, when you know how. There is one particular method which has been used by coil manufacturers for many years, and which, although a little old-fashioned nowadays so far as modern production technique is concerned, is still highly commendable for amateur use. Furthermore, it requires hardly any equipment which cannot be made or obtained quite easily at home.

The process (known usually as "burning" the wire) consists primarily of passing the end of the litz wire, complete with its covering, through a clean, low-temperature flame until it is just cherry-red. The end of the wire is next *immediately* doused in a cleansing fluid, held there for a few seconds, and then at once transferred to a "solder-pot" full of molten solder. The result is a beautifully tinned end to the wire, with every strand soldered.

As may be gathered, the procedure is quite simple, and the gear required is not at all complex. The low-temperature flame, for instance, can be provided by a lamp wick, (one to two inches wide) fitted in a jar which is half-filled with methylated spirits. If the jar has a lid made of tin-plate, a narrow slot cut in this will hold the wick quite comfortably. Another method of providing the flame would be given by using a Bunsen burner fitted with a "fish-tail" jet.

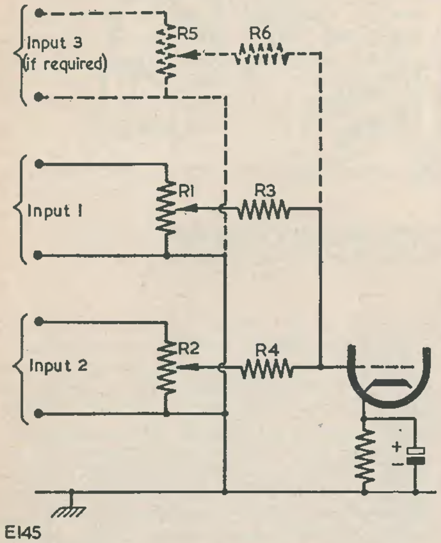


Fig. 1. *A simple, and very effective, mixing circuit*

The cleansing fluid most readily available to the amateur consists of methylated spirits also. Care should be taken, however, to ensure that this is not set alight when the wire is doused in it. The wire itself will not ignite the methylated spirits but any fabric covering which happens to have caught alight in the flame might do so. This risk is quite small but it has nevertheless to be guarded against. So please don't send me any letters containing scorched eyebrows!

The final requirement, that of a container holding molten solder, should not prove to be too difficult for the resourceful amateur. The best container would, of course, be an electrically-heated "solder-pot," but these are rather expensive. A simple solution might be found by heating the solder in a suitable vessel on a small electric-ring or similar appliance. (An empty food can is not suitable for holding the solder, as the latter would leak away through the seams.) Once again, care must be taken to ensure that the methylated spirit cleansing fluid used in the second part of the process is not liable to be set alight by whatever source of heat is employed.

It is advisable to stand all the equipment used for tinning the litz wire on a small tray. The reason for this is that any methylated spirit which happens to be spilt cannot then spread outside the tray.

It will be found, once everything has been prepared, that the process of tinning the wire is extremely easy. However, there is a certain degree of "knack" to be finally acquired for best results, and this is best given by having one or two trial runs with odd pieces of litz wire before starting on any more important items.

"Solder-Through" Wire

Although the procedure of "burning" litz wire using various slightly differing versions of that just described is now in use by manufacturers all over the country, it seems possible that in five to ten years time such methods will be largely out of date. The reason for this is that a new type of wire has been brought on the market in quantity production since the war, which obviates all this trouble completely. This wire is known as "solder-through" wire, and it is achieving increasing popularity continually.

"Solder-through" wire is coated with an enamel which undergoes a chemical change at soldering temperatures, whereupon it acts partly as a flux. Thus, if one removes the fabric covering and twists the inside *enamelled* wire around the appropriate tag it can be soldered immediately; and a perfect joint results. This wire has become available as litz, in which form its advantages are obvious. I know of one very large firm which now uses nothing else except "solder-through" wire for all the litz-wound coils which are produced by its coil-winding shop.

Mixing It

As the correspondence received at *The Radio Constructor* offices concerning the "Paragon" Tape Recorder has shown, many constructors are extremely interested in the technique of tape recording. Some readers have asked for circuits suitable for mixing several inputs into an amplifier, so that such effects as background music from a gramophone pick-up may be faded up and mixed with speech from a microphone.

The simplest form of mixer circuit is shown in Fig. 1. This circuit can be used with two input sources, so long as their voltage levels are reasonably similar. Thus, two similar pick-ups connected to the two pairs of input terminals would give excellent results; since their output voltages would be roughly equal, and would give the same signal level at the grid of the valve for similar settings of the

potentiometers. The purpose of the two series resistors, R3 and R4, is that of preventing the adjustment of one potentiometer from affecting, to any great extent, the output of the other. In use, it will be found that, if R3 and R4 each has the same value as the higher value of the two potentiometers, interaction between the controls is only slight, and is practically unnoticeable. Fig. 1 may be extended to three (or more) inputs, as shown in dotted line.

much of the noise in any amplifier appears in the grid circuit of the first valve. This valve would then be that which follows the mixer circuit of Fig. 1. If, therefore, either of the mixer controls in this diagram were turned to a low setting, the input voltage applied to the grid would be partly masked by noise.

A satisfactory solution to this problem is provided by Fig. 2. In this diagram, each of the low-level inputs is applied direct to the grids of the high-gain pentodes, V1 and V2.

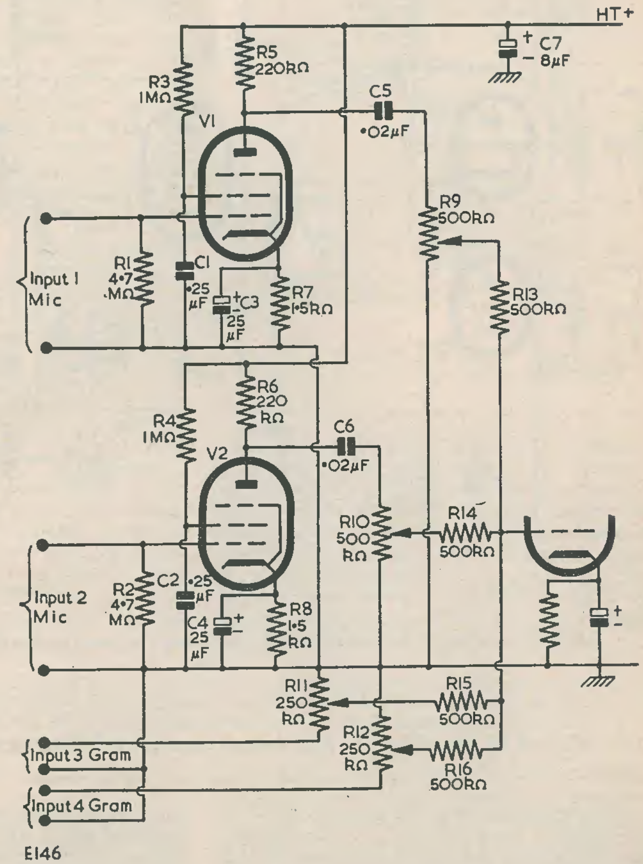


Fig. 2. *A practical fader-mixer circuit, capable of handling two microphones and two gramophone channels*

The greatest disadvantage with the circuit of Fig. 1 is that it causes a loss in input strength owing to the signal that is dropped across the resistors in series with the potentiometer sliders. Unfortunately this loss cannot be avoided. A second disadvantage is that the circuit is not advisable for use with low-level inputs, such as are provided by most microphones. The reason for this is that

It is the *outputs* of these pentodes which are then mixed in with other signal sources. The advantage of this arrangement is that input grid noise only becomes fully effective when the appropriate potentiometer is adjusted to its maximum setting. The input resistors, R1 and R2, for the low-level inputs in Fig. 2, are intended for crystal microphones. If moving-coil microphones are employed, the secondaries of the microphone transformers will connect to the input terminals instead. The high-level inputs could consist of high-impedance moving-iron or crystal pick-ups. If the latter are used, the necessary response correction circuits must be fitted between the pick-up and the input terminals of the mixer. (Inputs 3 and 4 would also be suitable for radio or FM tuners.)

Although it has been used quite frequently in the past, the circuit of Fig. 3 does not offer any really outstanding advantage over that of Fig. 1. This is due to the fact that low-level inputs still have to undergo a stage of amplification before they can be fed to the individual control potentiometers.

For the record, it should be mentioned that another version of Fig. 3 employs two or more variable-mu pentagrids, all feeding into the same anode load. In this case, however, individual volume levels are not controlled by potentiometers in the grid circuits, but by varying the grid bias voltages on each valve. Fig. 4 shows a typical example using two 6L7's. The main advantage to this circuit is given by the fact that volume control noise is prevented from reaching the amplifier, due to the presence of R5, C2 and R9, C5. Despite this, individual pre-amplifiers are still advisable for very low-level inputs.

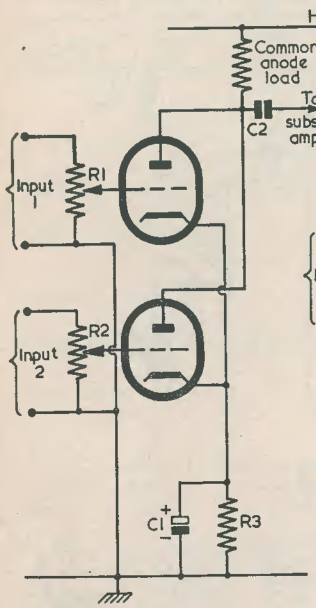


Fig.3

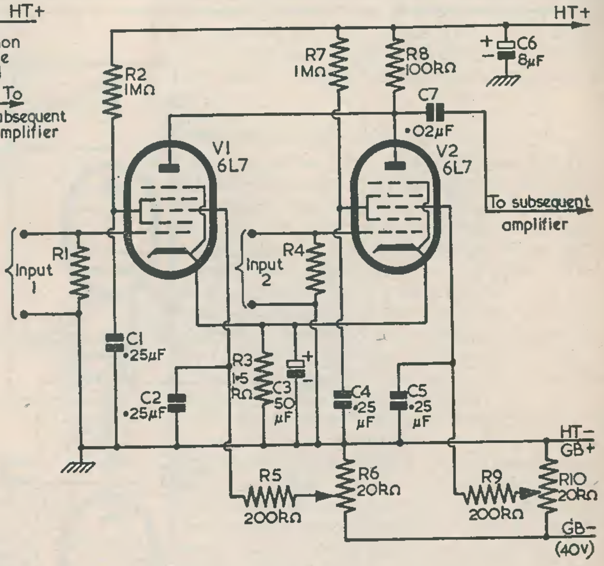


Fig.4

E147

Fig. 3. A popular mixing circuit in which two (or more) valves feed into a common load

Fig. 4. Another practical arrangement. In this circuit two vari-mu pentagrids feed into a common anode load, mixing being controlled by R6 and R10. The values of R1 and R4 should suit the impedances required by the input sources

Another popular type of mixer is shown in its simplest form in Fig. 3. This circuit provides mixing due to the fact that the two triodes have a common anode load, from which a connection to the subsequent amplifier can be made. (Three or more valves can also, of course, be used in a circuit of this type.) If greater gain in each valve is required they may both be made pentodes. The common anode load should have a value equal to that normally employed by one valve, divided by the number of valves used. All the valves employed should, of course, be of the same type.

Unfortunately, suitable valves for the circuit of Fig. 4 are not so easy to obtain these days. For instance the 6L7, which is probably the best valve for the arrangement, is now well on the way to obsolescence. A possible alternative is the CV1057 (ex-R.A.F. VR57).

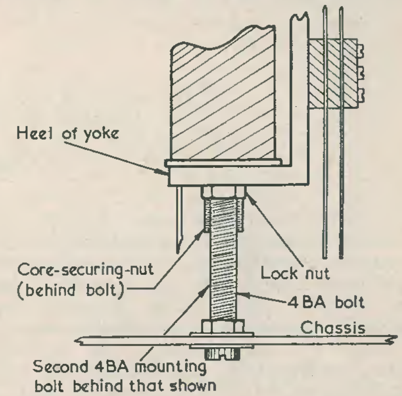
Tips with Taps

Although found in the amateur workshop only infrequently, a set of BA taps is one of the most useful accessories that can be added to any radio tool kit. Such taps are quite cheap, the most frequently needed sizes being, usually, 6, 4 and 2BA. For the amateur who cannot afford more than a modest outlay it is best to start off by buying taper taps only. Plug taps are seldom required for amateur radio jobs.

Two useful dodges employing taps are given here to complete this month's article. Neither could be described as being in the highest traditions of engineering practice, but they are both helpful when one is in a hurry.

When a component is being mounted behind a panel it sometimes happens that the constructor finds that one of the panel holes is just very slightly out of alignment. This is particularly annoying if the mounting holes of the component are themselves tapped. When this occurs, the constructor is usually faced with the necessity of having to drill out the offset panel hole to a larger size, so that it is then possible to insert the requisite mounting bolt. Unfortunately, the usual result of this is that part of the larger hole is not covered by the screw-head, and a scruffy-looking job results. A better solution consists of tapping into the panel hole with a tap having the same thread as that underneath. This will then cut away just sufficient of the panel to allow the mounting bolt to be fitted.

The second dodge concerns Post Office and similar relays. When mounted in the conventional manner, such relays require quite a lot of metal-work in order to enable their contact lugs to pass through the chassis. If they are mounted "up in the air," as shown in Fig. 5, this problem is cleared.



E148

Fig. 5. A quick and useful method of mounting a Post Office, or similar, relay

The method of fixing is somewhat inelegant, it is true, but the solution is adequate enough when time is short. The two mounting holes in the heels of most yokes are tapped 5BA, a size which is not always available to the amateur. However, it is quite a simple matter to dismantle the relay by unscrewing the single core-securing nut; whereupon the holes may be tapped out to 4BA with an ordinary taper tap.

RADIO AND TV INTERFERENCE

(*continued from page* 522)

upon which the present regulations are based, made the following recommendation: that information should be issued drawing attention to the importance of earthing in accordance with the Regulations for the Electrical Equipment of Buildings issued by the Institution of Electrical Engineers. For many types of appliances used in situations where earthed metalwork is present, these Regulations call, for safety reasons, for the exposed metalwork of appliances to be earthed; earthing is even more important when interference suppressors are fitted to an appliance. Exceptions to the earthing requirement are "all-insulated" and "double-insulated" appliances, and appliances used in "earth-free" situations. It is also important that components of suitable quality should be used for interference suppression, and that they should be connected in circuit in a suitable manner. These two aspects of interference suppression are dealt with respectively in BS. 613 "Components for Radio Interference Suppression Devices" and the shortly-to-be published B.S. Code of Practice on "The General Aspects of Radio Interference Suppression."

MODERN LINE TIMEBASE CIRCUITS

PART 2. by S. WELBURN

The second of two articles describing modern line timebase circuits which are intended especially for the home-constructor and experimenter

In last month's article, the writer devoted himself to a typical circuit application of the new Allen line output transformer type LO352 and scanning yoke type DC605/C. The circuit discussed was one which employed a multivibrator driving a PL81–PY81 combination, and is that which is particularly recommended by the manufacturers for home-constructor use.

Self-Running

Let us now consider the case of a self-running line timebase. Some constructors are not too keen on line output circuits of this type, their main objection being that such circuits are not so efficient as are those employing a separate oscillator. This view is reasonably true, of course. (To be fair, one has to add the fact that one can never be certain, when using a self-running timebase, that some rather weird and wonderful waveforms are not appearing in the transformer windings during the retrace period.) It is fairly safe to state that line output transformers employed in self-running circuits often become slightly warmer in operation than do those in which the line output valve is oscillator-driven.

On the other hand, self-running line output circuits save a valve and a number of components. It cannot be gainsaid that such a saving does represent a useful advantage.

A typical circuit showing a self-running timebase is given in Fig. 3. This employs the new line output transformer, but the application is quite general. The circuit functions in the following manner.

Let us assume that we commence to investigate its operation at the beginning of the line scan period. It is at this moment that the anode of the line output valve (V1 in Fig. 3) commences to draw current. In drawing this current it endeavours to set up a field in the combined inductance provided by the anode winding of the transformer, together with the deflector coils. Due to the inherent qualities of this inductance (Lenz's Law), the field set up does not build up to a maximum immediately; it builds up gradually, instead. During this period of build-up the anode of the valve draws a continually increasing current and is, in consequence, negative-going.

The "earthy" tap into the anode coil can be considered as being at terminal 7. Thus, if the anode of V1 is negative-going, the feedback terminal, tag 5, is positive-going. The increasing positive voltage at terminal 5 does not appear in quite the same form on the grid of V1, however, this being due to the presence of the small-value condenser, C6, and R4 and R5. Also, because of the diode action provided by the grid of V1 and its cathode, what voltage does appear on the grid is largely conducted to cathode. As a result of these points, the large positive-going voltage at terminal 5 of the transformer produces a bias voltage at the grid of V1 which is slightly positive only. This voltage is, nevertheless, still sufficient to allow almost full cathode current in V1, and the only limiting factor to its anode current is provided by the combined inductance of the line transformer and deflector coils themselves.

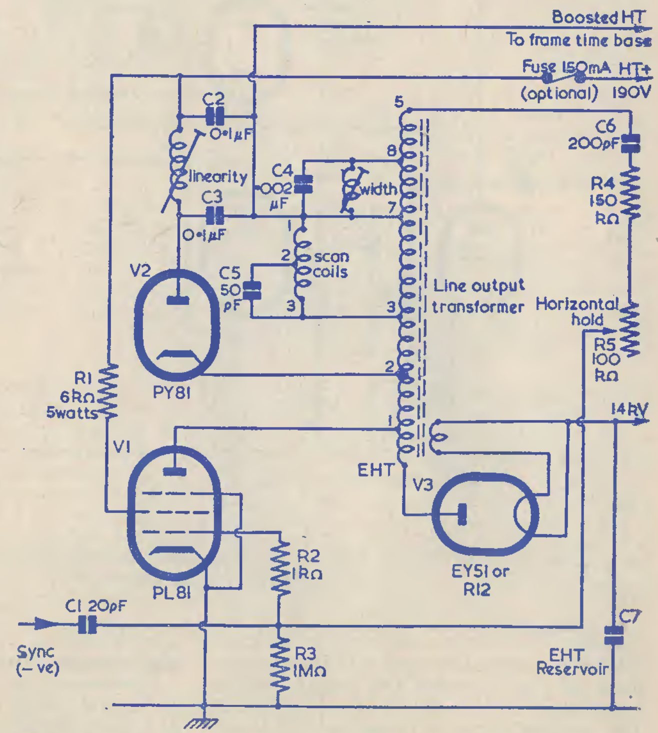
The building up of the field in the line output transformer cannot go on for ever, of course, and a time is reached when either the transformer core or V1 (with modern transformers usually the latter) becomes saturated, and the increase in anode current ceases. As a result, the field in the line output transformer becomes static and terminal 5 ceases to be positive-going. This terminal cannot remain at the positive potential it last held, however, as no voltage is now being induced in that section of the coil between itself and the "earthy" terminal, tag 7. In consequence, terminal 5 now becomes negative-going.

A small proportion of this negative-going voltage is applied, via C6, R4 and R5 to the grid of V1, and is sufficient to commence the retrace cycle. As its grid goes negative, the anode current of V1 drops. Immediately, the field in the transformer and deflector coils begins to collapse. This now causes terminal 5 to go violently negative, its swift rate of change of voltage being passed to the grid of V1 much more readily by C6 than was the relatively slow positive rate of change given during the scan period. V1 cuts off at once, whilst the field in the line scan inductance collapses completely and swings round to opposite polarity, causing the anode end of the winding (tag 1), and the EHT overwind to go violently positive. The field then swings back to its original polarity; V2, the efficiency diode, conducts, and the next scanning cycle gets under way.

(As may have been gathered from the above, self-running line output circuits lie, to a certain extent, in the "brute-force" category. Their operation is certainly not as elegant as is that of an oscillator-driven line output circuit).

An important detail in the description just given is provided by the fact that, when the circuit is nearing the saturation point, only a small negative voltage is required at the grid of V1 to trigger off the retrace cycle. Such a negative voltage can be given, of course, by negative sync pulses from the associated televisor's sync separator.

The length of time devoted to the scanning period (or the "speed" of the circuit) is controlled, within limits, by R5. This resistor varies the slight positive voltage appearing at the grid of V1 during the scan period (see above), and thus hastens or delays the moment of saturation. The main control of speed of the circuit is, of course, provided by the inductance of the line transformer anode coil itself (which has to be kept within close limits by the manufacturer); but R5 serves to give a final "fine" control, as it were.



E132

Fig. 3. Using the Allen LO352 line output transformer in a self-running timebase

The writer has tried out the circuit illustrated in Fig. 3 and it has given excellent results. The circuit is nearly as efficient as that of Fig. 2, so far as can be checked by measuring the cathode current of V1. To quote an example, a sample PL81 in the circuit of Fig. 2 takes a cathode current of 80mA. Under similar conditions in the circuit of Fig. 3 (same width of scan, and same EHT voltage) it takes a cathode current of 85mA.

(The manufacturers of the transformer state that the self-running application should only be used on an experimental basis by home-constructors, at this stage, as freedom from a slight fold-over of this type cannot always be guaranteed. The feedback terminal is provided mainly at the request of set manufacturers who can control the fold-over under production-line conditions.–Ed.).

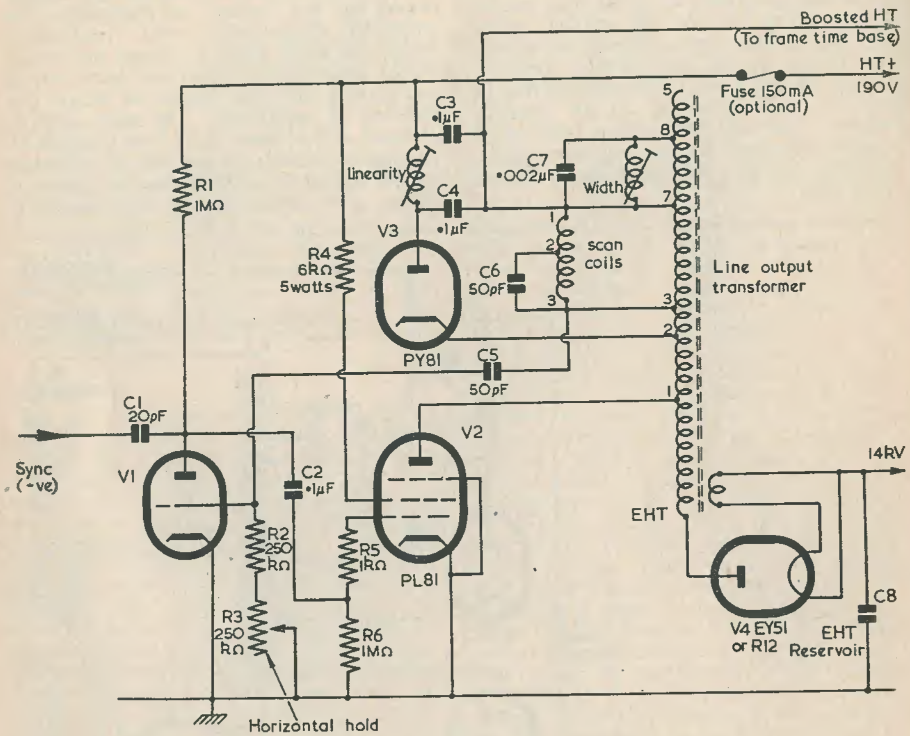


Fig. 4. An interesting circuit in which an unconventional multivibrator arrangement is employed. V1 is a low-mu triode

The only noticeable snag with the arrangement of Fig. 3 is that the retrace time is longer than occurs with the circuit of Fig. 2. The result of this is that about a third of the alternate white and black sections on the extreme left of Test Card C become folded over and are lost. The writer did not have time to experiment further with the circuit in order to try to clear this minor trouble. In any case, all that is lost is about an eighth of an inch in a fourteen-inch wide picture!

Multivibrator Output

Another interesting application is given in Fig. 4. This employs the transformer in a multivibrator arrangement.

If the circuit of Fig. 4 is examined closely it will be seen that it is, in practice, a somewhat unconventional type of multivibrator. The two valves forming the multivibrator are V1 and V2. A normal resistor is employed in the anode circuit of V1. The anode of V2, however, is loaded not by a resistor but by the inductance of the line output transformer itself. As the voltages on V2 anode would be too high to be taken directly to the grid of V1, this grid is tapped down the coil of the transformer, connecting to it, via C5, at terminal 3.

V1 may be any low-mu triode. A particularly interesting application would consist of using the triode section of an ECL80 for this valve. The remaining pentode section could then be employed for the frame output stage.

The results given by the circuit of Fig. 4 were equivalent to those of Fig. 2.

Valves

It will have been noted that the circuits discussed by the writer use PL81 and PY81 valves. It is possible that many constructors are, at present, employing 6CD6 and 6U4 valves in their existing line output stages and may wish to continue using them.

The writer has checked the performance of 6CD6 and 6U4 valves in the three circuits described in this and the preceding article. In every case it was found that a 6CD6 could be substituted directly for a PL81, and a 6U4 for a PY81, without any circuit changes whatsoever. The 6CD6 is somewhat under-run, of course.

So far as heater voltages are concerned, the PL81 and PY81 are rather "awkward" for purely AC receivers having single 6.3 volt heater lines. However, a transformer is available*, which gives 17 volts at 0.6 amps, and this can be used to provide the necessary higher voltages. A typical method of employing the transformer is shown in Fig. 5.

Warning

A few words of warning are advisable before these articles are concluded.

It will be noted that, in Figs. 3 and 4, the screen-grid of the PL81 is not decoupled to chassis by a condenser. The omission of the condenser is most important. If such a decoupling condenser were to be fitted, the drive to the line output transformer would rise considerably and it would generate far too high an EHT voltage. The possibility of consequent damage to the transformer and to its associated components will be at once apparent.

* *Allen Components, Type MT 212*

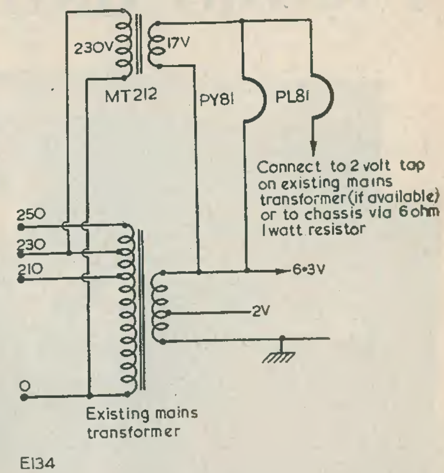


Fig. 5. The higher heater voltages needed for the PL81 and PY81 may be obtained, in AC receivers, with the aid of a small transformer having a 17 volt secondary

A second point of importance is given by the fact that the HT rail voltage should be kept below 195 volts for the circuits discussed, or too high an EHT voltage will be generated. An HT rail voltage lying between 180 and 190 volts is normally that which is most desirable.

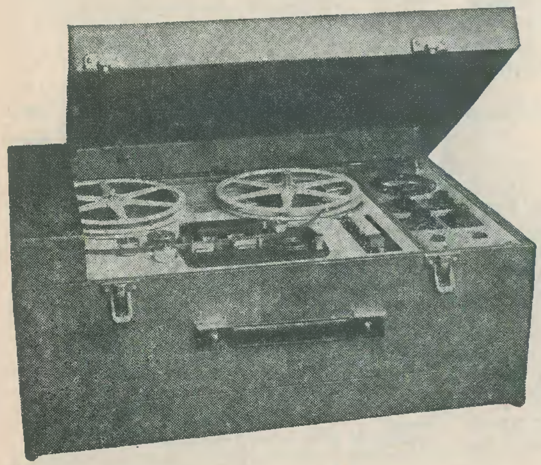
Finally, it must be emphasised that a series resistor of 6kΩ is recommended in all the circuits for supplying the screen-grid of the PL81. As was mentioned earlier, this resistor serves the important function of limiting the screen-grid current of this valve during the period when the PY81 is warming up. Whilst the value of the screen-grid resistor specified may always be increased quite safely, it should never be decreased or the PL81 will suffer damage.

Commencing next month . . .

The "FULL-TONE" 8 watt AMPLIFIER

An inexpensive design for which all components, including a pre-punched chassis, are readily available

A RADIO UNIT FOR THE *Paragon* TAPE RECORDER



by **J. W. WALKER**

This article describes a simple, plug-in radio feeder unit designed for the Paragon Tape Recorder. With slight circuit modifications, it may be employed also with other tape-deck amplifiers

IN THE LAST ARTICLE OF THE SERIES DEVOTED to the Paragon tape recorder it was stated that the design of a suitable radio feeder unit was being undertaken. This feeder unit has now been completed, and a general idea of its construction and method of connection to the tape-deck amplifier can be obtained from the diagrams which accompany this article.

As may be seen, the feeder unit consists quite simply of a compact metal case, to which is fitted a jack plug capable of being plugged directly into the recorder amplifier. The only other connection needed is that of a suitable aerial to the terminal on the front panel of the unit. Stations are selected by means of the small knob mounted above the aerial terminal.

THE CIRCUIT

The circuit of the feeder unit is given in Fig. 1. As is to be expected this is extremely simple, consisting only of the tuned circuit arrangement, the germanium detector, and the RF decoupling components.

The coil employed is worthy of comment, it being the Teletron type "HAX," which has been especially developed for applications such as this. The Teletron coil has three windings, the first of these, between coil tags 2 and 1, being the aerial coupling winding. This is coupled very loosely to the tuned circuit winding, thus ensuring that the latter is damped as little as possible by the aerial loading. On the other hand, the third winding which feeds the germanium detector (that between coil tags 3 and 1), is very tightly coupled to the tuned winding, and consequently ensures maximum transference of signal energy. Due to the relative positioning of these three windings it is possible to obtain a high degree of tuned circuit "Q" without excessive losses in sensitivity.

A further point which requires a few words of explanation is given by the unusually high value of diode load resistor, R1. The high value specified here has the advantage of ensuring still further reduced tuned circuit damping; and it is permissible since the input resistance of the Paragon amplifier at "Input Jack A" is 4.7MΩ. This input resistance, combined with R1, provides an AC/DC diode load ratio of approximately 5:6; thus obviating peak-clipping for modulation depths up to 83%.

Practical Points

Although the components needed for the feeder unit are few, there are still one or two minor difficulties to overcome before they may be efficiently mounted in their metal case. This is due to the fact that, in a unit of this type, it is necessary to meet two conflicting requirements. The first of these is that care must be taken to provide efficient screening of all leads and components which carry AF, as, otherwise, hum pick-up will be evident when the unit is plugged into the tape-deck amplifier. The second requirement is that no screening should approach the tuning coil too closely or it may cause damping, with consequently reduced sensitivity and selectivity.

These two requirements have been met in the existing unit by fitting the case with a back plate which is made of insulating material. The coil is mounted close to the back and therefore suffers the minimum damping possible in a compact assembly of this type. The AF-carrying components, alternatively, are mounted well away from the back and are sufficiently screened to obviate any hum pick-up. (It should be remembered that the coil itself will not pick up hum, as all its windings are at chassis potential so far as AF is concerned.)

In the prototype, the back plate was made from "Perspex." This gives a rather effective and individual appearance to the unit; although it necessitates a certain amount of care in wiring, which is always in full view! Alternative materials, such as bakelite sheet, paxolin, etc., will at once suggest themselves to the reader.

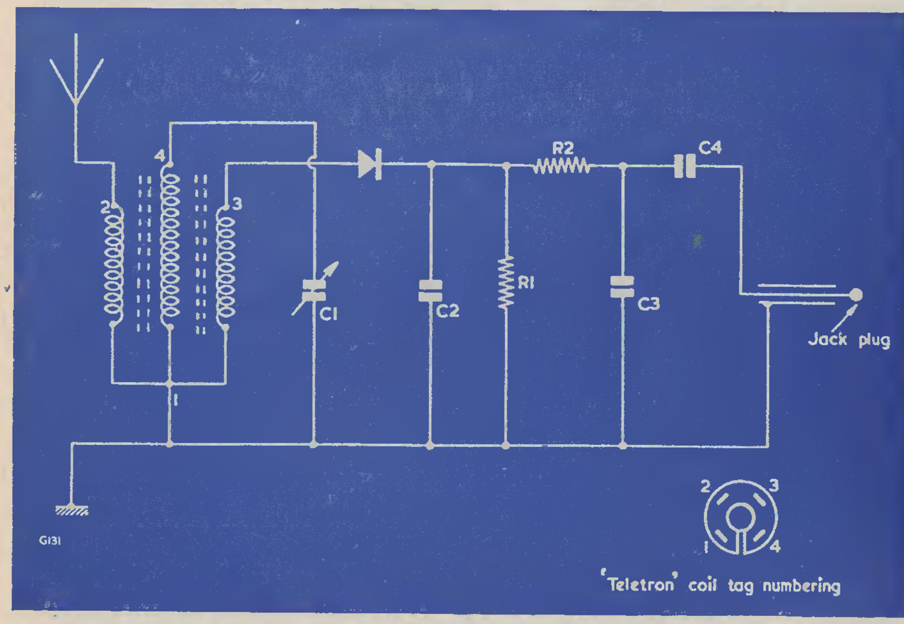


Fig. 1. The circuit of the radio feeder unit

Component List

Resistors
R1 1MΩ ⅛ watt, Dubilier
R2 33kΩ ⅛ watt, Dubilier

Condensers
C1 500 pF solid dielectric, Jackson Bros.
C2 100pF type SMP 101, T.C.C.
C3 200pF type SMP 101, T.C.C.
C4 0.001μF type 543, T.C.C.

Other Components
Aerial terminal, 2BA, Belling-Lee
Jack Plug, Igranic
Coil type HAX (Medium-wave), Teletron.
3-way tag strip, centre earthed
Germanium diode type GD3, Brimar
Panel-signs transfers Set No. 1
Tuning Dial, 0–10 Reaction type.

The Case and Plug

It is probable that some constructors may have on hand small metal boxes suitable for this unit which they would wish to put into use as they stand. This is perfectly in order, of course, so long as the points made above concerning coil damping and hum pick-up are observed. Others may prefer to make their own cases for the unit, and the necessary instructions are given in this article. If constructed at home, the case should be made of aluminium sheet, this having any reasonable thickness up to 16 swg.

For a professional-looking finish, the jack plug which is integral with the feeder unit must be mounted firmly and reliably, and without the use of unsightly brackets or similar accessories. The writer found that the easiest way of ensuring this was to employ an Igranic jack plug. This plug is fitted with a threaded bush and flange which may be secured comfortably in a hole of 3/8-in diameter. The black bakelite cover, cut down, then acts as a securing "nut."

Dimensions

The front panel, and top and bottom, are made of one piece of aluminium. The dimensions and drilling required are shown, before bending, in Fig. 2.

There is little which deserves especial mention in this diagram apart, mainly, from the hole intended for the Belling-Lee aerial terminal. This terminal has a small locating projection on its insulating bush for which provision should be made when the hole is being prepared. If this is not done, the terminal body is liable to rotate when its finger nut is being tightened.

The 3/8-in diameter hole intended for mounting the Igranic jack plug should be cut out cleanly and accurately, since the flange on the metal part of the plug is not very wide. A 3/8-in Q-Max chassis cutter, if available, is ideal for this particular job.

The two sides of the box come next, their dimensions, before and after bending, being illustrated in Figs. 3 (*a*) and (*b*). It should be noted that *outside* dimensions are given in Fig. 3 (*b*), as it is necessary for the sides to make a snug fit to the panel assembly. This point is of especial importance if thick aluminium sheet is being employed.

The two sides are fitted to the front panel by six self-threading screws along each edge (two on each side of the front, and two on each side of the top and bottom). The positioning of the 12 clearance holes for these bolts was given in Fig. 2. The two side pieces may be marked out by using the front panel assembly as a template. After drilling the tapping-size holes in the side panels, the case may be temporarily assembled. It will be noted that the top and bottom are slightly proud of the two sides at the back. This is intentional, and allows the insulated back plate to make a better fit than would occur it all edges were flush

All that remains is the back plate itself. This should be cut out as illustrated in Fig. 4. It is secured to the metal case by four more self-threading screws, these being applied through the holes shown in the diagram. For the purpose of marking out the four corresponding holes in the metal side pieces, the back plate may be used, in its turn, as a template.

Wiring

The next job consists of mounting the components and wiring up the unit. This process is very simple, and the constructor should encounter no snags whilst carrying it out.

Due to the compact nature of the unit, it will be found easier to wire it up with the two side pieces removed. These may then be refitted after wiring has been completed.

The first components to mount are the tuning condenser and the Belling-Lee aerial terminal. To prevent the tuning condenser body from rotating after it has been fitted, it is a good plan to fit a shake-proof washer to its bush *behind* the front panel. This washer will bite into the aluminium of the panel and the brass flange of the tuning condenser bush, thereby ensuring a rigid assembly.

The next item is the jack plug. Using the Igranic component, it is necessary to carefully cut a section one half-inch long from the bottom, threaded, part of the bakelite cover to provide a securing "nut." The remainder of the cover is not then needed.

Also to be mounted at this stage are the coil and the three-way tag strip (for which components three 6BA clearance holes were drilled in Fig. 2). The whole assembly should then take up the appearance illustrated in Fig. 5. It will be noted that the jack plug is fitted such that its "sleeve" terminal is shown, in this diagram, as being to the right. This is not essential, of course, but it enables the two diagrams which follow to represent the wiring layout used in the prototype. Fig. 5 shows also the recommended position for the "slot" in the Teletron coil tag-ring.

Figs. 6 and 7 illustrate the wiring, as viewed from either side of the unit.

Testing

After completion, the unit may be tested by connecting an aerial to its terminal, and by plugging it into "Input Jack A" of the Paragon amplifier. If the latter is set to the "Record" position it will be possible to tune in one or more local stations immediately.

It should be emphasised at this point that, in some districts, it will be necessary to use a fairly large aerial to obtain optimum results.

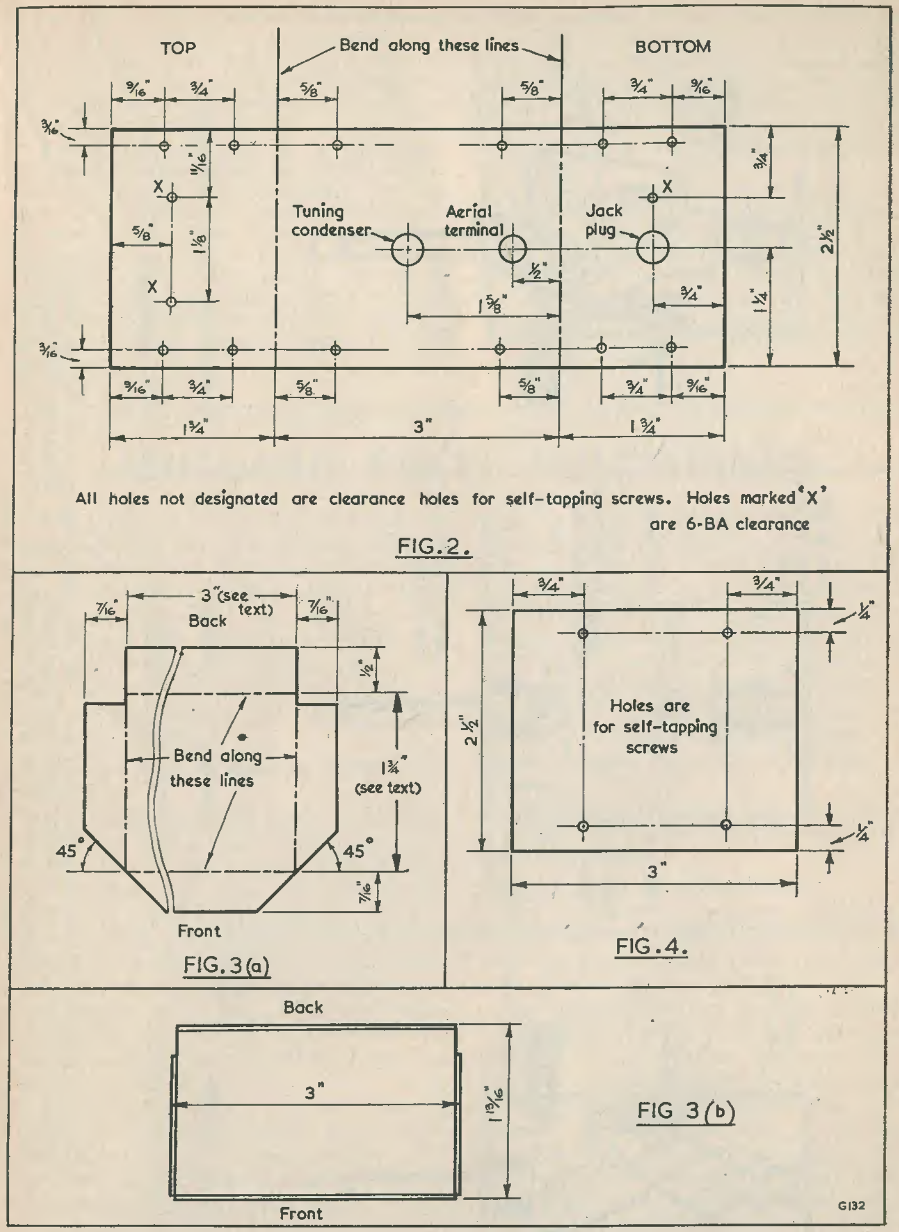


Fig. 2. The dimensions of the front panel and top and bottom. The two flanges should be bent down, away from the reader. All holes not otherwise designated are clearance for self-threading screws, whilst those marked "X" are 6BA clearance. Further details are given in the text. Fig. 3. (a) Dimensions of the side pieces before bending. (b) Outside dimensions after bending. Fig. 4. How the insulated back plate is cut out. The four holes should be clearance size for self-threading screws

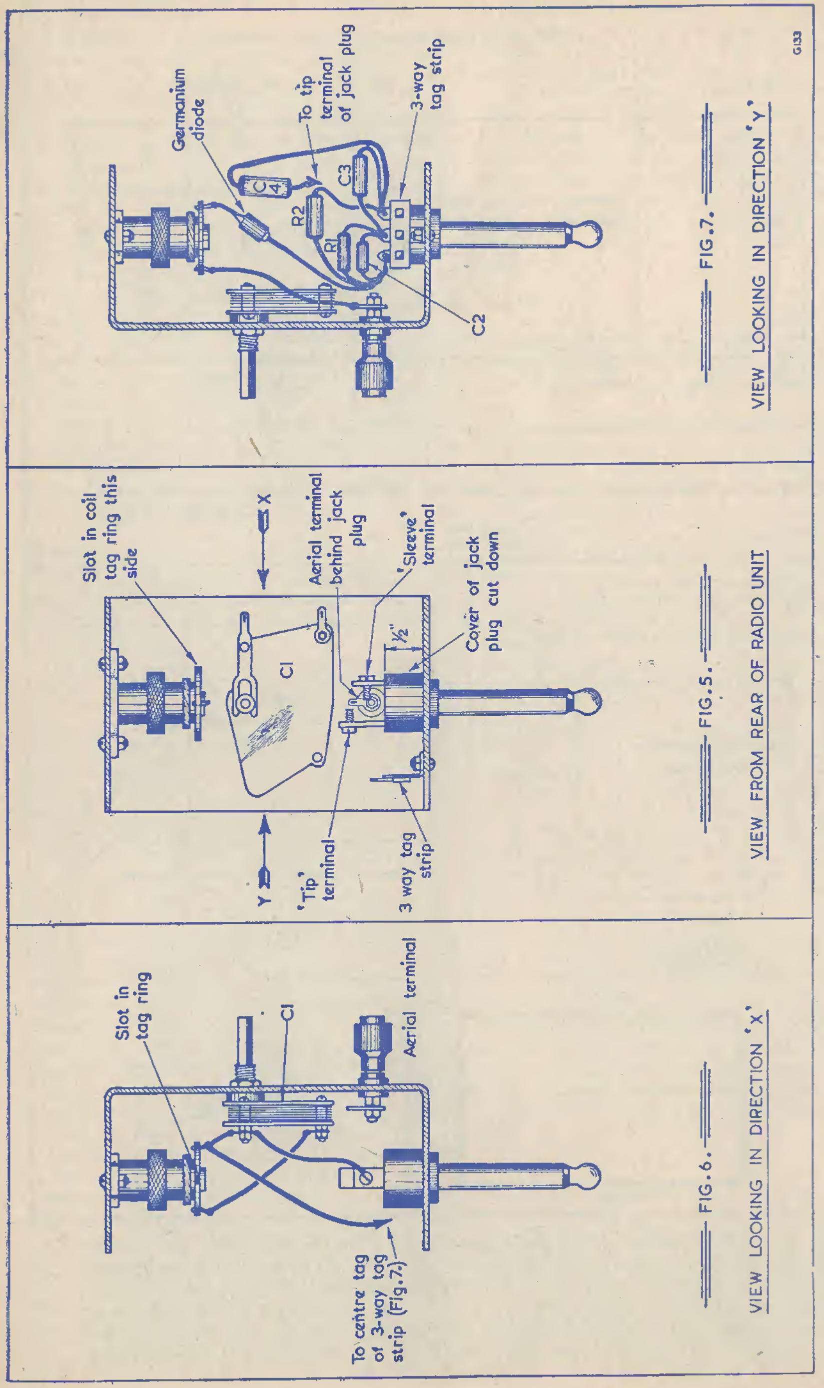


Fig. 5. Layout of components in the radio unit. The side pieces are removed. Fig. 6. Wiring of the unit, as viewed from the right-hand side (from back). Fig. 7. Wiring as seen from the left-hand side. Although the counterparts are shown spaced out for clarity, they should, in practice, be kept well forward and close to the back of the front panel

Normally, however, some twelve to twenty feet of wire should be quite adequate. If a very large aerial is used, selectivity may be improved by connecting a fixed condenser of approximately 200pF between the aerial and the aerial terminal.

Due to the high gain of the subsequent amplifier, it is possible for modulation hum to occur in one or two localities. This can usually be cured by reversing the mains plug. In severe cases it may be necessary to clear the hum by earthing the Paragon chassis. A "capacity earth," such as is obtained by connecting to a large mass of metal or, even, by merely placing the hand on the amplifier panel, is usually quite sufficient for this purpose.

Other Amplifiers

As was mentioned in the heading, this radio unit may be used with other amplifiers after slight circuit modifications have been carried out. This procedure is necessary since it is doubtful if input impedances as high as 4.7MΩ will be encountered in most amplifiers available.

Assuming an amplifier input impedance of 250kΩ, the tuner unit may be modified by reducing the value of R1 to 47kΩ, R2 to 10kΩ, and increasing C4 to 0.01μF (T.C.C. type 543). Such changes will slightly reduce the selectivity obtainable, but they are essential if the high fidelity reproduction possible with a tuner unit of this type is to be successfully realised.

MULLARD VALVE VOLTMETERS

The Equipment Division of Mullard Ltd. announce three valve voltmeters of unusually good performance. Two of these are general purpose laboratory instruments capable of measuring both direct and alternating voltages with a high degree of accuracy. The third, which measures only alternating voltages, incorporates a wide band amplifier to provide high sensitivity. All three voltmeters are mains operated.

Wide-range Valve Voltmeters E7555/2 and E7555/3

These instruments differ only in the range of voltages which they can measure. The E7555/3 covers the range 100mV to 500V DC or peak AC, while the E7555/2 has additional ranges up to 15,000V. An input of 0.5V peak AC and DC gives full scale deflection on the most sensitive range, and stabilities of zero setting and calibration are exceptionally good. Both positive and negative direct voltages can be measured with respect to earth or other reference potentials, up to a maximum of 500V.

For AC measurements, a probe is provided which incorporates a double diode valve. One diode is used as a peak rectifier, while the other balances out the effects of contact potential and residual diode current. Careful design ensures a frequency response which is level between 30c/s and 100Mc/s.

The probe input resistance (AC) is 3.5 Megohms at frequencies up to 50kc/s, falling to 8.5kilohms at 45Mc/s. The capacitance is constant at 9pF.

The DC circuit of the voltmeters takes the form of a balanced four-valve amplifier. Two EF86 pentodes connected as a "long-tailed pair" are directly coupled to balanced cathode followers. The output of the cathode followers is connected back to the grids of the long-tailed pair, providing virtually 100 per cent negative feedback. This arrangement results in a high input impedance (10 Megohms on the 0.5V DC range) and exceptional stability. Variations of mains voltage and ageing of valves have very little effect on accuracy.

The meter, which has a 5-in mirror scale, is connected between the cathodes of the cathode followers.

High Sensitivity Voltmeter E7556

This instrument measures alternating voltages between 0.5millivolt and 300V in the frequency range 20c/s to 1Mc/s with a total error of less than 4 per cent.

The circuit consists of an input cathode follower feeding into a three stage wide band amplifier with negative feedback. The amplifier output is rectified by a diode and displayed on a 5-in mirror scale meter. The frequency response is flat within two per cent over the range 20c/s to 1Mc/s. The input resistance on the lowest range (10mV f.s.d.) is 1.5 Megohms at 20kc/s and 0.7 Megohms at 1Mc/s, the input capacitance being 15pF. On ranges of 3V f.s.d. and over, the corresponding values are 1.9 Megohms, 0.7 Megohm, and 6pF.

A lamp bridge circuit provides an accurate calibrating voltage of 10mV at mains frequency.

Radio Miscellany

CENTRE TAP *talks about* CABINET DESIGNS / MONOPOLIES / CHEAPJACKS

A FEW DAYS AGO I VISITED SOME FRIENDS whose new TV set is disguised as a cocktail cabinet. Feminine influence, of course. Quite why so many women are imbued with a passion for camouflaging any form of "machinery" to look like something else is beyond me. Perhaps there was some justification for it in the early days when "wireless sets" were made up of ebonite panels, brass terminals, numerous knobs and horn speakers, which had insidiously crept into the living room from the workshop. The more tolerant of women would insist at least on covering it up with a cloth, while the more exacting demanded concealment by a screen or polished panels. Women have funny ideas about the dangers of "electrocution," but as it was only the man of the house or his schoolboy son who could make the thing work, "wireless" was considered as simply an eyesore.

As far as many housewives were concerned, radio stopped in that stage for enough years to start the tradition that it must either be out of sight or hidden away in a pretty cabinet. In the early days, none of the family ever really listened to the thing. The enthusiast pulled it down and re-assembled it in slightly different form whenever he had a free evening. Sets were so simple that this might easily be achieved in a matter of two or three hours. The rest of the time they wanted to hear everything —and listen to nothing. A set was judged by its ability to get a large number of stations at "loudspeaker" strength. A big signal was far more important than quality—anyway the broadcast quality was pretty awful. The accompanying crackles and bangs, plus the whoops of other people's reaction, were all taken as part of the fun. The things that mattered were the number of foreigners and their volume. No wonder it was years before many serious musicians could be persuaded to broadcast at all.

From such a beginning it is little wonder that the house-proud woman, yearned to hide the wretched thing away. The habit of having it on "for company" had not yet been formed and homes generally were still quiet and restful places. Radio edged its way in. As a sop to housewives, the manufacturers began to make loudspeakers look like flower bowls or lamp-shades, and later, to look like firescreens. Then came the sets with polished cabinets and pretty dials; and for the more opulent, sets masquerading as Jacobean cabinets, escritoires, oak-chests and what-have-you.

With TV the manufacturers, who are much wiser about these things than I am, decided right away that even the knobs of receivers were unsightly, and hid them away at the back, even at the cost of the user only being able to adjust the picture at considerable inconvenience. If you are not the possessor of a telescopic rubber neck, you want a little boy to hold a mirror for you whenever you start knob-twiddling.

The cocktail-cabinet disguise which started all this is surely going a bit too far! For my part I would much rather it held cocktails.

Blank Screens

Thinking of the inaccessibility of TV receiver controls reminds me that in recent weeks I have made quite a study of picture reproduction in the houses I have visited. Over fifty per cent of the video reproduction was markedly bad, and in most cases the viewers not only realised it but the handiest member of the household had jiggled all the adjustables without success. Picture distortion, which the frame or linearity controls would not correctly proportion, was by far the commonest complaint.

When one also reads newspaper reports of the many thousands of sets out of use because of CRT failure or other faults—with owners unable or unwilling to pay for replacements or repairs—one begins to wonder what is going to happen when we have the additional complication of colour.

Conversion

This autumn we shall see a big revival in constructional activity. Not only will all the many thousands of home-built TV owners be busy on converters to enable them to see the Alternative programme, but many of those who fought shy of tackling the job and bought their sets, will be anxious to re-establish their self-esteem by at least building the converter. The man who built his own set may well have a big advantage by being able to find space to squeeze the additional parts on to his existing chassis. As usual, this won't be a very difficult task for those with the deep junk boxes. Every experienced constructor knows that to be of any real use a self-respecting junk box has to contain two or three of everything. Nowadays, when the world of radio has become so complicated, the little junk box of yesteryear is hopelessly inadequate. The compleat junk box of 1955, even though it takes up two-thirds of the average workshop, can only be depended on to yield up about half the bits you need. If it contains only one of everything, it is certain that one will be of the wrong shape, or just that bit too big.

Not a Precedent

Although Independent TV programmes will be a reality in a few short months, the rumbles about the Wickedness-of-it-all from our would-be Dictators are still to be heard. Disregarding those who feel they have a mission in life to interfere with what others are doing, quite a number of well-intentioned people seem to think that because the BBC has been a monopoly for so long, it must be the right and proper thing. Have they ever stopped to consider that the BBC became a monopoly by accident, not by design? It was born as such, not because the idea of a single body was good in itself, but to avoid the suspicion of favouritism by an embarrassed Post Office.

Our earliest broadcasting (that is, the transmission of a programme for purely entertainment purposes) started in 1920. The use of such a serious thing as wireless for the frivolous purpose of "concerts" soon incurred the displeasure of official authority. After this first taste it was the amateur experimenters who organised the clamour to allow broadcasting. They claimed to number some 4,000, although few people really believed there could be that many. At that period there were only about 150 licensed transmitting amateurs. Officialdom moved slowly and nothing much happened until early 1922, by which time there were about a hundred broadcast stations operating in the U.S.A.

Not unnaturally, the British radio manufacturers wanted to get cracking and the Post Office was bombarded by numerous applications for licences to broadcast. Among the applicants was at least one newspaper and several departmental stores. It was the job of the Post Office to allocate station sites and wavelengths. They sidestepped this job by persuading the keenest (and most deserving) applicants, the radio manufacturers, to merge into a single body. Thus it became a company with an authorised capital of £100,000, comprising a few big shareholders and about 1,600 little ones.

It was in this way that the interest of broadcasting was handed out on a plate as a monopoly. Any impression that it was consciously planned as such, or desirable for programme standards or any other reason, is mistaken. Now, as the Irishman said, it looks as if we are going to have two "monopolies" instead of one.

Never a Break

It was once accepted that fools made their entry into the world at the rate of one a minute. In common with most other things it seems the production schedule has been stepped up to suit the tempo of these modern times. I have previously commented on the market place cheap-jacks who sell obsolete low-voltage capacitors as "wonder aerials" at many hundreds per cent profit. Recently I saw two of them doing brisk business within 50 yards of one another! It is true the mugs do not rush in to throw their half-crowns on the stall without a little persuasion. But they swallow a plausible line of sales talk, hook, line and sinker. "Every one set-tested," urges the wily vendor, "and clearly marked tested to 250 volts. They give greater selectivity. They reduce interference and give a purer tone. Every one is guaranteed to contain so many yards of aluminium foil specially wound, and an earth wire is no longer needed."

Actually all these claims are more or less true, but not quite in the way the cheap-jack implies or his victims believe. Yet they not only get away with it, but find it so profitable that they are increasing in number—presumably in the same ratio as the mugs' birthrate!

The amazing part of these catchpenny

(continued on page 543)

A SIMPLE WOBBULATOR

by **J. W. BAGNALL**

A useful piece of Test Gear for the enthusiast

WHILE MOST AMATEURS WILL BE FAMILIAR with the use of a wobbulator, it would not be out of place to describe the uses and working of the instrument for the benefit of the uninitiated.

A wobbulator may be described as a frequency modulated RF generator designed to enable the IF amplitude frequency response curve to be displayed on the screen of an oscilloscope. Fig. 1 shows in diagrammatic form the connections between the wobbulator, receiver and the oscilloscope. If the timebase generator is ignored, the oscilloscope may be regarded as a DC voltmeter for measuring the rectified output of the detector resulting from an unmodulated RF signal.

If the frequency control knob of the generator were turned from one end of the scale to the other, as the resonant frequency of the IF transformers was approached the vertical deflection of the spot on the CRT would increase; and would decrease as resonance was passed. If instead of varying the RF frequency manually the timebase generator is used to sweep the CRT and also to sweep the signal generator frequency, then the voltage measurement given by the oscilloscope will present a picture of the IF response curve, clearly showing any lack of symmetry or other similar defects.

It will immediately be realised that the user of the wobbulator, who is able to see the effect of each individual trimmer adjustment on the response curve, has a tremendous advantage over the "trimmer twiddler" who relies on his ear and the BBC for alignment.

Circuit Operation.

It will be seen from the circuit diagram that V_1 is a conventional RF generator covering a frequency range of 400 to 500kc/s. Across the grid-tuned circuit is connected a network R_3 and C_4. The value of R_3 is large compared to the reactance of C_4, so that the RF current through the chain R_3–C_4 is practically in phase with the RF voltage across the tuned circuit. The RF voltage across C_7 lags the current by 90°. The lagging voltage across the condenser is applied to the control grid of the reactance valve V_2 whose anode RF current is in phase with the grid voltage, and so 90° behind the tuned circuit RF voltage. The lagging current being drawn through the tuned circuit gives the same effect as if a further inductance was connected across the tuned circuit. The value of the lagging current is controlled by the voltage on the suppressor grid of V_2.

The application of a sawtooth voltage to the suppressor grid causes the frequency of the oscillator to sweep over a band of frequencies, returning on the flyback to the starting frequency. The amount of sawtooth voltage applied is controlled by the deviation control VR_2, while a low impedance output is provided by the coupling winding L_1, which consists of two turns of 22 swg insulated wire wound around the base of the oscillator coil. Control of the output is provided by the potentiometer VR_1, which together with the output socket is screened from the oscillator proper. The output lead consists of a length of coaxial cable terminated with two crocodile clips.

As the power requirements are so small, the required supplies were obtained in the prototype from the oscilloscope, an octal plug being fitted for this purpose. If it is intended to fit a self-contained supply in the wobbulator, it should be well smoothed in order to avoid hum modulation on the final trace.

Operation

The superhet receiver is set up with the "Y" plate amplifier of the oscilloscope connected to the "live" end of the detector diode load, the volume control being set at minimum. The receiver oscillator is stopped by connecting a 0.1μF condenser from the oscillator grid to chassis. The IF transformers are then roughly aligned to the correct frequency by either using an ordinary signal generator or the wobbulator without the sweep being applied. Although the wobbula-

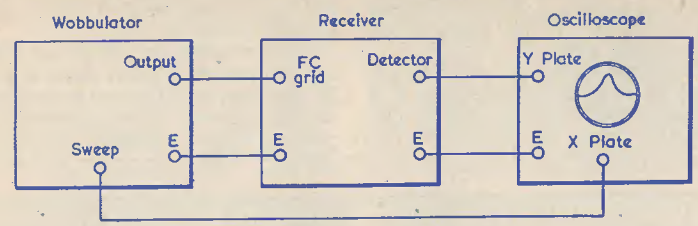


FIG.1.

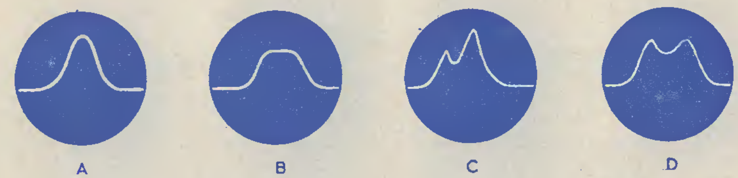


FIG.2.

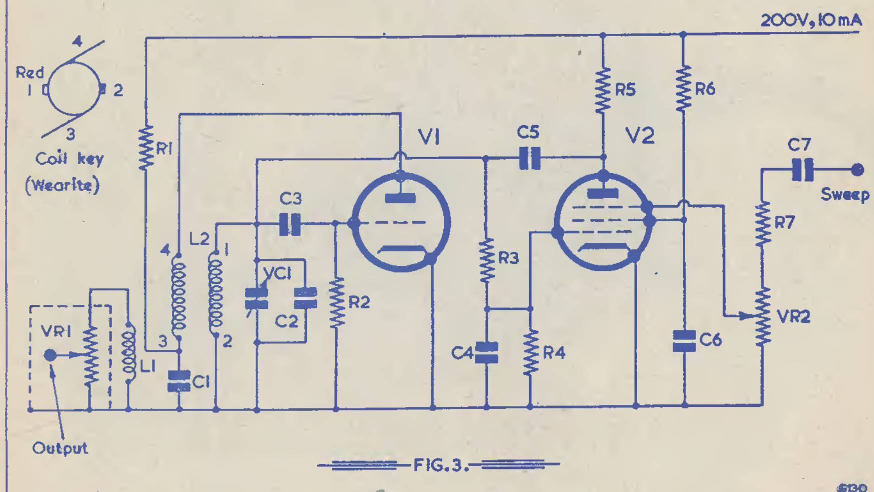


FIG.3.

Component Data

Resistors			Condensers				
R_1	22kΩ ½W		C_1	0.1μF 350VW		VR_1	100Ω pot
R_2	47kΩ ¼W		C_2	500pF mica		VR_2	500kΩ pot
R_3	47kΩ ¼W		C_3	47pF ceramic		VC_1	500pF variable
R_4	470kΩ ¼W		C_4	33pF ceramic		L_1	see text
R_5	10kΩ ½W		C_5	200pF mica		L_2	Wearite PA2 or Teletron WA5
R_6	100kΩ ½W		C_6	0.1μF 350VW		V_1	6C5
R_7	47kΩ ½W		C_7	0.1μF 350VW		V_2	EF50

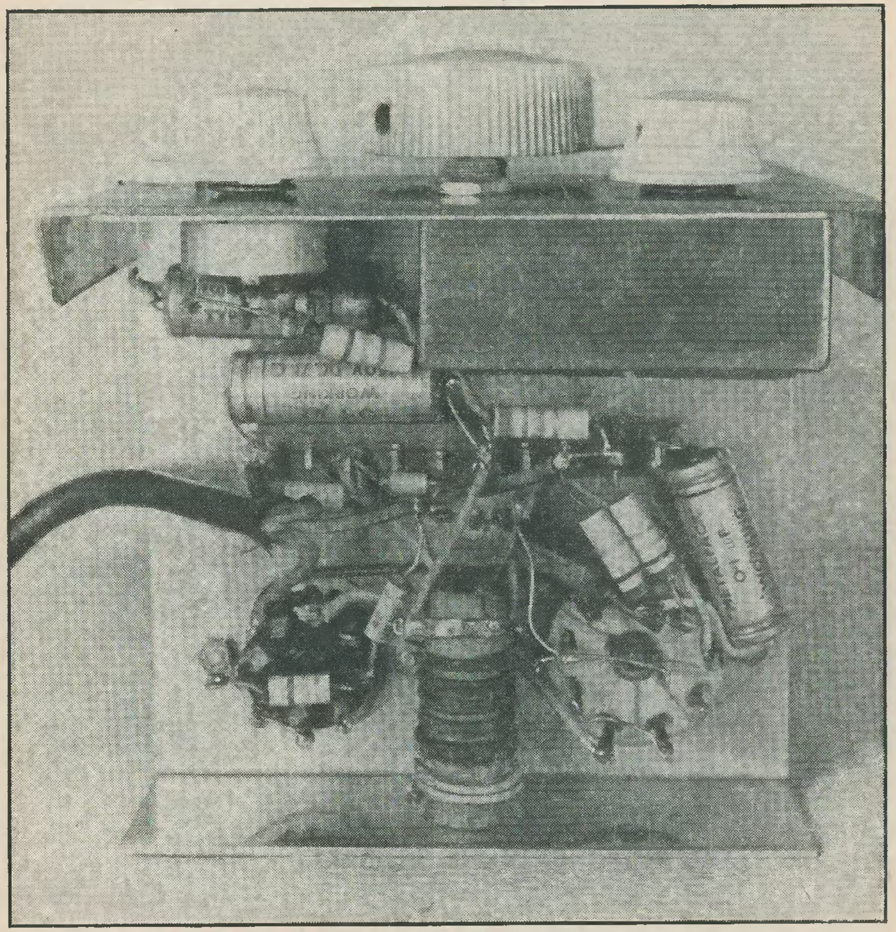
tor output is not modulated the correct frequency can be seen by a lift of the whole trace level on the CRT and also by the appearance of noise along it.

When the IF's have been roughly aligned, the output lead from the wobbulator, if it has not already been used, is clipped one to chassis (true earth in the case of AC/DC receivers, or via a 0.1μF 750V to chassis) and the live side to the grid of the frequency changer. There is no need to disconnect the aerial coil. A lead is then connected from the "X" plate of the oscilloscope to the sweep socket of the wobbulator, the earth connection being made via the receiver and the output lead. A sweep speed of about 50 per second should be used, as too high a timebase speed tends to give an untrue response curve.

The attenuator and deviation controls are set for maximum, and the tuning control VC_1 rotated until the response curve appears on the screen. The attenuator is then reduced to the minimum possible position consistent with good results, to avoid operation of the AVC—or alternatively the AVC line could be shorted to ground. Adjustment of the deviation control will enable the response curve to be widened out, to enable more detailed examination.

Fig. 2 shows some typical curves which may be expected. The curve Fig. 2A indicates a good all-round response. Fig. 2B shows overloading, and the wobbulator output should be reduced. The curve of Fig. 2C indicates a poorly aligned IF transformer, and the side hump should be tuned out. The double-humped curve of Fig. 2D is caused by staggering the IF transformers too widely apart. After a little practice the user will soon become familar with the controls and be able to interpret the resulting traces with ease.

The layout of the device is in no way very critical, and an idea of the original set-up may be obtained from the photographs. It is, of course, essential to enclose the unit in a metal case to prevent unwanted radiation. The time spent on building this piece of test gear will soon be repaid in quicker and more efficient radio servicing.



Underneath layout of prototype

RADIO MISCELLANY

(*continued from page 539*)

schemes is that no matter how much they are exposed, or however many times the suckers fall, they go on with undiminished profits. At every fair one sees the "milk-bottle" skittles which have to be knocked down with a small ball. Three of them go down easily but the last two (painted white and outwardly just like the wooden ones) are made of iron. You'd stand a fair chance of dislodging them with a hand grenade. Then there is the hoop-la with the prizes nicely set out on cunningly contrived wooden stands. The showman demonstrates how easily the ring will pass over them. So it will if it is thrown from the same way as he puts it on—from the back. The mugs can never win the gold watch. Even a superman would want a lucky ricochet to do it.

Whilst the public still fall for these tricks which must be centuries old, it is obviously asking too much to expect them to get wise to "wonder aerials" in a single generation. Nor do their best friends warn them. Either they are ashamed to admit they have already been caught, or else they find there is something amusing in seeing someone else sold the same pup as themselves.

CLUB NEWS

Details for insertion in this section should reach us not later than 7th of month before publication.

BARNSLEY AND DISTRICT AMATEUR RADIO CLUB

Forthcoming Meetings

15th April, "Q". Demonstration of Whys and Wherefores—D. Westwood, B.Sc., G8WF. 29th April, Propagation of Radio Waves—C. T. Malkin, G5IV. 13th May, Practical Demonstration of IF Xtal Filter Operation—H. H. Eyre, G5KM. Meetings at King George Hotel, Peel Street, Barnsley. Secy.: M. P. Carbutt, G2AFV, 33 Woodstock Road, Barnsley.

TORBAY AMATEUR RADIO SOCIETY

The annual general meeting will be held on 16th April, at the Y.M.C.A., Torquay. Hon. Secy.: L. H. Webber, G3GDW, 43 Lime Tree Walk, Newton Abbot.

BRITISH TWO CALL CLUB

Lt.-Col. Sir E. Y. Nepean, G5YN, has been elected President, and Major K. E. S. Ellis, G5KW, Vice-President, for 1955. Membership is open to all British subjects holding two call-signs in any two countries or B.E.R.U. call areas. Hon. Secy.: G. V. Haylock, G2DHV, 63 Lewisham Hill, London, S.E.13.

RAVENSBOURNE AMATEUR RADIO CLUB (Downham)

Meetings are held on Wednesdays, 8–10 p.m., at Durham Hill School, Downham, when R.A.E. lectures, Morse instruction and discussions take place. The club transmitter is operated under licencees G2DHV, G3FTI or G2WI. Hon. Secy.: J. Wilshaw, 4 Station Road, Bromley, Kent.

CLIFTON AMATEUR RADIO SOCIETY

Proposed programme for April

1st, "Single Sideband Techniques," by S. Horne, G3IXL. 15th, "Direction Finding," by C. Hatfull, G3HZI. 22nd, Junk sale. 29th, Constructional evening and ragchew. Meetings are held at the clubrooms, 225 New Cross Road, S.E.14, at 7.30 p.m. Hon. Secy.: C. H. Bullivant, G3DIC, 25 St. Fillans Road, Catford, London, S.E.6.

The "CLIPPER"

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

A 10-valve communications type receiver using the Mullard B8A valves, designed and constructed for those readers who contemplate building such equipment, either for use as a standby to the normal installation or as the main receiver

THIS RECEIVER, WHICH WE HAVE TERMED "The Clipper," has been designed and constructed to provide readers with an up-to-date design of a communications type receiver. It is a straightforward design, and as such, it is capable of being constructed by the average radio enthusiast provided previous experience of superhet construction and access to a reliable and accurate signal generator is available. In any event, the beginner could, with every chance of success, construct the mixer, first IF, detector, output and power circuits in the first instance and add the other stages as time and available cash allowed.

Design—General Considerations

In this article, only the circuit diagram is given; no chassis or panel dimensions are included, this being left to the individual preferences of the constructor. It is capable of being built either as a compact or as a receiver of the larger layout type. The design is merely presented as a basis from which a good class receiver may be derived.

The coil pack, using the latest Denco coils, each of which is enclosed in a metal can supplied with the individual coils, was wired to a 3-bank 5-way Yaxley type switch. Only one such coil is shown in the circuit diagram for purposes of clarity. Those used were of the chassis mounting type, although other types are available using either an octal or B9A valveholder as a base for the coil. (See advert. on page 514). The great advantage of this method of coil assembly is that it allows the home constructor some choice of frequencies according to the coils purchased; e.g., in the prototype we have omitted the long wave range. The fifth position on the wavechange switch is connected to earth, this contact acting as the standby control when in this position. There is no reason, of course, why a fifth coil should not be connected in this fifth position and a standby switch inserted in the HT line in the normal manner, this again being a matter of personal preference.

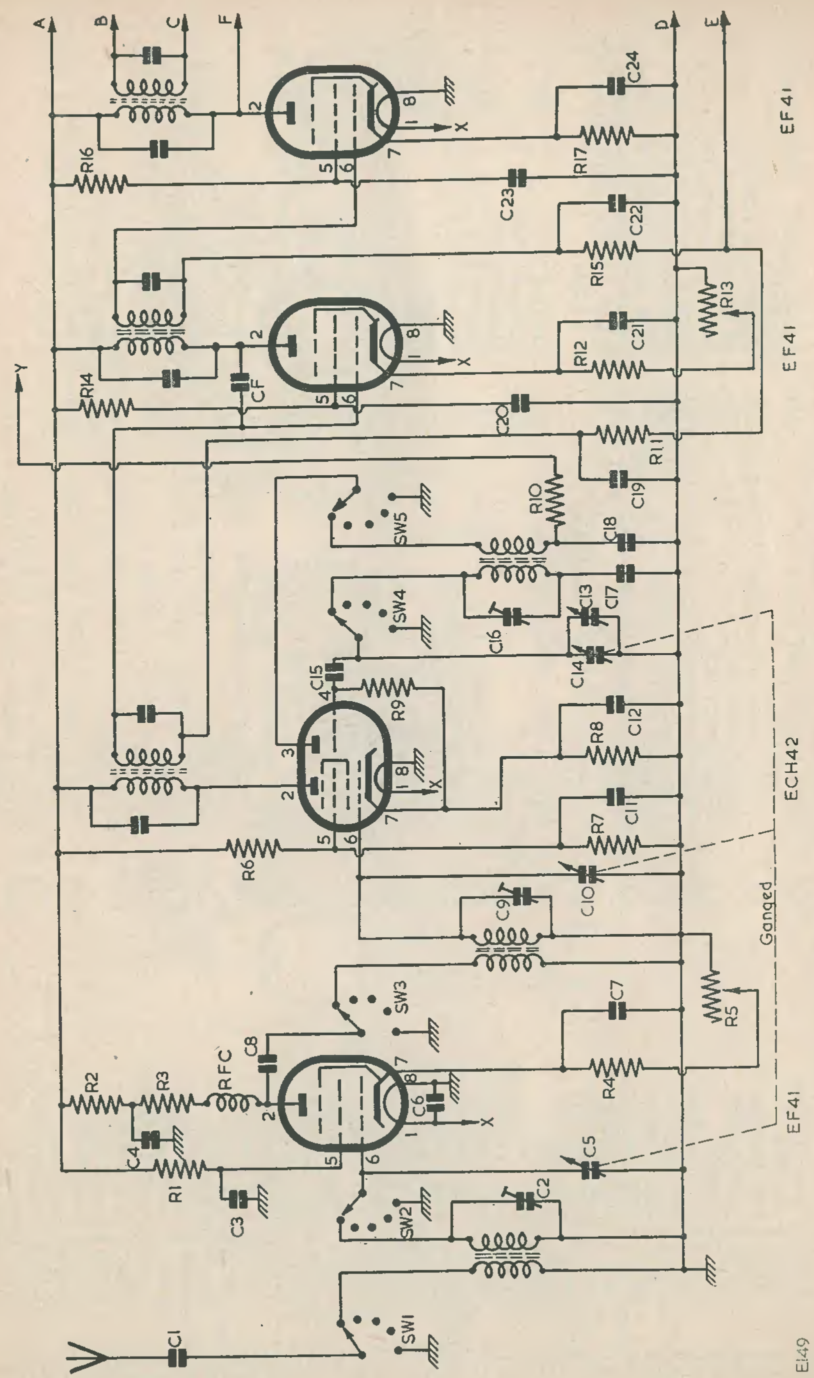
If plenty of panel space is available, then the latter course is preferable. The BFO/AGC on/off controls have been incorporated into one Yaxley type switch in order to conserve panel space, and here again, these could equally be separated into two distinct panel controls if desired—according to whether a compact or otherwise design is envisaged.

It is always advisable in a receiver of this type to include some form of visual aid to signal strength reception, and in the design presented herewith we have included the Mullard EM34 "Magic Eye." This should be mounted on the panel in a position that is most convenient for perception purposes.

Catering for selectivity, which must be of a high order in a set of this nature, there are two IF stages using high "Q" transformers of the latest design. The first stage is variable, with a gain control inserted into the cathode line, and this, together with the small amount of anode to grid feedback introduced by a short length of PVC wiring, produces a very satisfactory selectivity curve. The second IF stage is not controlled by the IF gain but is working just short of maximum, both in the interests of stability and gain factor.

For stable operation of the local oscillator a regulator valve has been included and, in addition, the oscillator section has been designed to operate with a low voltage on the anode, thus producing an efficient overall performance from this stage.

Four wavebands were considered to be ample and these are: Band 1: 31.5–10.5Mc/s, Band 2: 15–5Mc/s, Band 3: 5.3–1.67Mc/s, Band 4: 195–580 Metres. With this wide coverage most of the broadcast and amateur bands, not to mention the trawler and aircraft frequencies, are covered. In order to facilitate accurate tuning and the ability to return to any particular station or frequency, there is, apart from the main dial, another aid in this direction. This is a small bandspread condenser control to which has been added a small dial marked

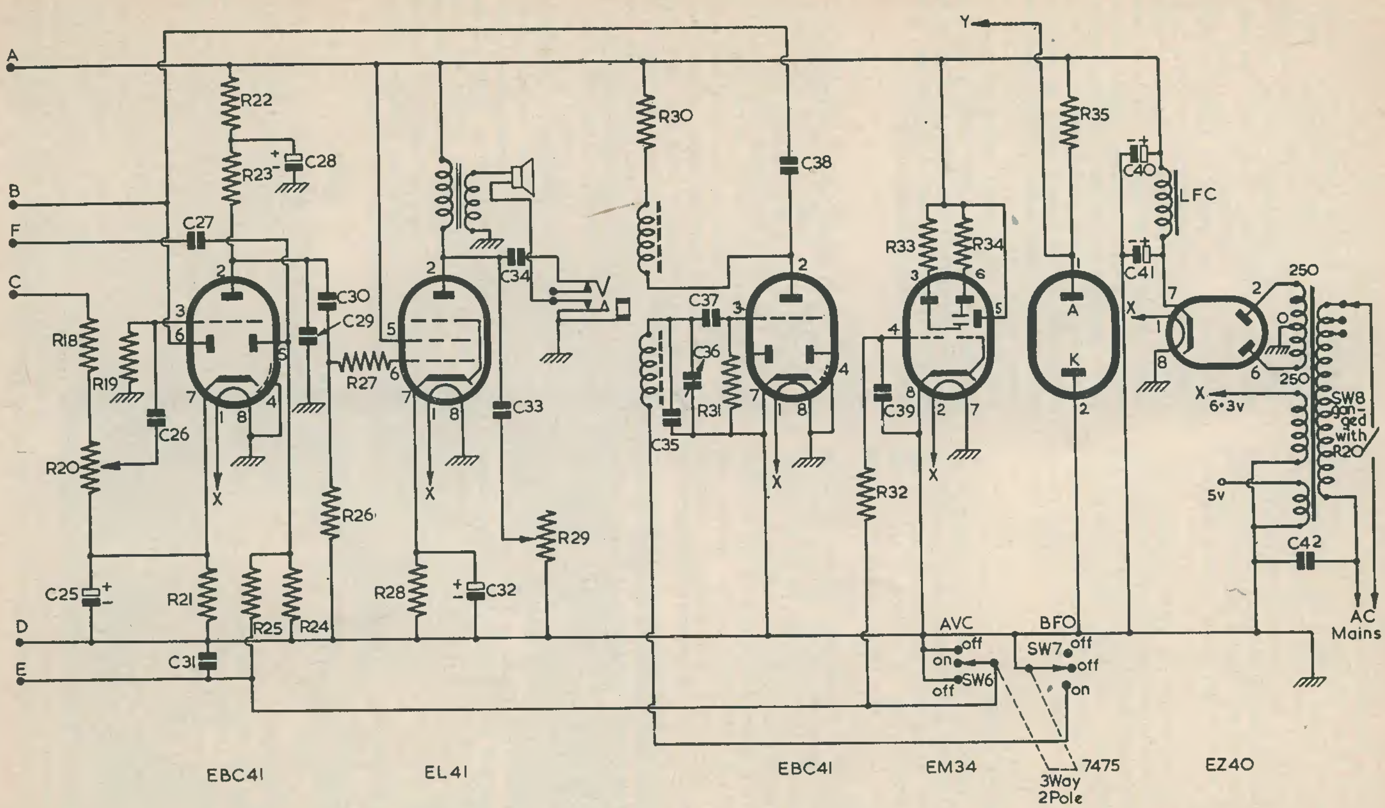


The "CLIPPER" — RF and IF stages. For component values see next page.

COMPONENT LIST—set out for easy reference to circuit diagrams

R1	100kΩ ½ watt Dubilier
R2	15kΩ ½ watt Dubilier
R3	10kΩ ½ watt Dubilier
R4	150Ω ½ watt Dubilier
R5	5kΩ pot Dubilier
R6	33kΩ ½ watt Dubilier
R7	47kΩ ½ watt Dubilier
R8	100Ω ½ watt Dubilier
R9	47kΩ ½ watt Dubilier
R10	5kΩ ½ watt Dubilier
R11	100kΩ ½ watt Dubilier
R12	150Ω ½ watt Dubilier
R13	5kΩ pot Dubilier
R14	33kΩ ½ watt Dubilier
R15	100kΩ ½ watt Dubilier
R16	47kΩ ½ watt Dubilier
R17	300Ω ½ watt Dubilier
R18	47kΩ ½ watt Dubilier
R19	470kΩ ½ watt Dubilier
R20	500kΩ pot with switch
R21	3.3kΩ ½ watt Dubilier
R22	20kΩ ½ watt Dubilier
R23	150kΩ ½ watt Dubilier
R24	1MΩ ½ watt Dubilier
R25	1MΩ ½ watt Dubilier
R26	470kΩ ½ watt Dubilier
R27	47kΩ ½ watt Dubilier
R28	150Ω ½ watt Dubilier
R29	50kΩ pot Dubilier
R30	10kΩ ½ watt Dubilier
R31	47kΩ ½ watt Dubilier
R32	1.5MΩ ½ watt Dubilier
R33	1MΩ ½ watt Dubilier
R34	1MΩ ½ watt Dubilier
R35	5kΩ 10 watt Dubilier
C1	100pF silver mica TCC
C2	3-30pF concentric trimmer
C3	0.1μF tubular 350V wkg, TCC. Type CP45N
C4	0.1μF tubular 350V wkg, TCC. Type CP45N
C5	370μF, 3-gang variable, Jackson Bros.
C6	0.001μF Mica, TCC
C7	0.001μF mica TCC
C8	100pF silver mica TCC
C9	3-30pF concentric trimmer
C10	As for C5
C11	0.01μF tubular 350V wkg, TCC. CP32N
C12	0.01μF tubular 350V wkg, TCC. CP32N
C13	60pF variable, Eddystone Cat. No. 582
C14	As for C5
C15	100pF silver mica, TCC
C16	3-30pF concentric trimmer
C17	Padder (see Table I)
C18	0.01μF mica TCC
C19	0.1μF mica TCC. CP45N
C20	0.1μF mica TCC. CP45N
C21	0.01μF mica TCC. CP32N
C22	0.01μF mica TCC. CP32N
C23	0.1μF mica TCC. CP45N
C24	0.01μF mica TCC. CP32N
C25	25μF electrolytic, 25V wkg
C26	0.01μF, tubular, 350V wkg, TCC. CP32N
C27	50pF ceramic
C28	2μF, electrolytic, 350V wkg, TCC. CE18P
C29	100pF mica, TCC
C30	0.01μF tubular, 350V wkg, TCC. CP32N
C31	0.01μF tubular, 350V wkg, TCC. CP32N
C32	25μF electrolytic, 25V wkg, TCC
C33	0.1μF tubular, 350V wkg, TCC. CP45N
C34	0.1μF tubular, 350V wkg, TCC. CP45N
C35	100pF mica, TCC
C36	12.5pF, Eddystone, Cat. No. 580
C37	100pF silver mica, TCC
C38	Approx. 1pF—see text
C39	0.002μF tubular, TCC
C40	16μF electrolytic, 350V wkg, TCC
C41	8μF electrolytic, 350V wkg, TCC
C42	0.1μF tubular, 350V wkg, TCC. CP45N
V1	Mullard EF41
V2	Mullard ECH42
V3	Mullard EF41
V4	Mullard EF41
V5	Mullard EBC41
V6	Mullard EL41
V7	Mullard EBC41
V8	Mullard EM34
V9	Mullard 7475
V10	Mullard EZ40

Transformer—Ellison, Type MT190
LF choke—Electrovoice, Type 101; H. L. Smith & Co. Ltd.
Valve bases—McMurdo.
Speaker—Goodmans 8-inch
IF transformers—IFT11 Denco (Clacton) Ltd.
BFO coil—Denco (Clacton) Ltd.
Output transformer—Goodmans Type 74/243
Phone jack—Igranic
RFC—Osmor type QC1
Coils—Denco (Clacton) Ltd., Blue, Yellow and Red for ranges 2, 3, 4 & 5.



E150

The "CLIPPER" — Detector, BFO and Audio stages.

from 0 to 100. This latter control is really intended as an oscillator shift, thus allowing the main dial reading to be accurately set or reset at any given time. It was found in practice, however, that this control allows a fair degree of bandspread, particularly on the higher frequency ranges. Allowance for the inclusion of this condenser however must be made when lining up the complete receiver.

The audio output is approximately four watts—rather more than is normally required, but often handy to have in reserve in certain circumstances. An eight-inch speaker is desirable for use with this stage in order to obtain full benefit from the audio power delivered.

Circuit—RF Stage

This stage is constructed around the Mullard EF41 valve which is very efficient on short waves and particularly so at the higher frequencies. A glance at the circuit will show that this valve has been chosen both for this and the IF stages. The EF41 is a variable-mu pentode and has excellent properties from the point of view of cross modulation—that bugbear of RF stages. The entire electrode system is enclosed within an internal shield and therefore no external shielding is necessary. The anode and control grid leads are screened, thereby resulting in a grid-to-anode capacitance of only 0.002pF maximum.

The RF gain control is inserted in the cathode line (R5) and this, together with R4 and C7, ensures a smooth and adequate control of the overall RF stage gain. The RF heaters are bypassed to earth by means of C6, thus preventing modulation hum at the higher frequencies. The anode HT supply is not fed through the coil primary as is the usual practice; instead, the anode has its own separate supply line together with the associated components. This ensures that the RF stage is working at peak efficiency and the small extra cost involved is felt to be worth while. The resulting signal is fed via C8 to the grid of the Mixer stage via the coupling winding.

Mixer/Oscillator

This portion of the receiver has been constructed around the ECH42 which is an extremely good mixer valve, particularly for the short wave ranges. An important point to note here is that the screen grids should be fed by means of a potentiometer. The recommended values are that given for R6 and R7. AVC is not applied to the mixer stage.

The oscillator voltage is applied via R10 and C18, the HT source in this instance being regulated via the 7475 valve. For maximum efficiency in operation, it is essential that the oscillator voltage be kept at a minimum, hence the inclusion of R10. By these means, i.e., no AVC on the mixer portion, and stabilised voltage on the oscillator, oscillator frequency variations are absent. Temperature, the third consideration in the design of mixer oscillator stages, may also be catered for by the actual physical layout adopted. Thus, a metal screen above the chassis would adequately shield the frequency changer stage from the heat generating power supply section. Mechanical stability of this stage is of prime importance if full benefit is to be obtained from the aforementioned design considerations.

The 7475 neon-filled stabiliser has an ignition voltage of 140V with a burning voltage of 110V. The resistor R35 drops the line voltage to that required for satisfactory operation of the 7475.

IF Stages

These two stages both incorporate the EF41. The first stage is made variable by means of R13 in the cathode line. In addition to this, the small condenser shown in the circuit diagram as CF (a short length of PVC wire soldered to the grid, with the free end placed near the anode connection—distance determined by trial and error with the RF gain control at near maximum, or just below the point of oscillation), acts as a positive feedback device, thus considerably sharpening the selectivity curve. This stage is AVC controlled. The second stage is so arranged that it is operating at maximum efficiency and therefore no control of the gain (other than AVC) is incorporated. For those who prefer control of both stages, the cathode circuit of the second IF stage would require the same value components as are contained in the first stage. With the miniature IF transformers specified ample gain and selectivity are available.

Detector

Here, the EBC41 functions as the first AF amplifying stage, detector and AVC respectively. As an AF amplifier, the EBC41 has an approximate gain of 50, rather more than is normally met with in this type of valve. With the values of components specified, however, most of this gain is utilised and passed to the output stage, via C30 and R26. AVC rectification is obtained in the normal manner from one diode and is fed into a Yaxley type switch (see under BFO). The variable resistor R20 is the AF gain control with which SW8 is incorporated (Mains On/Off). Little more need be said about this stage except that care should be taken to earth the internal screen of the valve which is brought out to pin 4. This effectively prevents any unwanted interaction with surrounding components and considerably reduces the risk of microphony and AF instability.

Output Stage

The EL41 output pentode has a slope of 10mA/V and is capable of giving some 4 watts of audio. With the high gain of the previous stage, it will be found necessary to incorporate R27 as a grid stopper. Tone control is incorporated, C33 and R29, whilst insertion of the headphones into circuit automatically mutes the loudspeaker. Care should be taken to keep the leads to the various electrodes short and direct, thus avoiding undesirable coupling or parasitic oscillations. Ample audio gain with a good measure of reserve is a feature of the audio side of this receiver.

BFO Stage

In order to keep the number of valve types used in the circuit to a minimum, an EBC41 is used here as a triode oscillator. The condenser C38 is formed by twisting a length of PVC wire around the detector diode lead and finding, by trial and error, the most suitable injection for the layout adopted.

The earthy end of the BFO coil secondary is taken to the Yaxley type switch as shown in the circuit diagram. This switch is so arranged that it provides an "AVC/BFO Off" position, an "AVC On-BFO Off" and a "BFO On-AVC Off" position. By this means, one panel control serves where two are normally used. C36 is the BFO pitch control. Care should be taken to earth the internal screen of the valve in order to avoid unwanted radiation from this stage when the BFO is in use.

Magic Eye

The EM34, in a purely conventional circuit, serves well both as a signal strength indicator and as a tuning device. Both strong and weak signals are catered for in separate indicators.

Power Supply

The EZ40 delivers up to a maximum of 90mA DC. The pack will be found to run fairly cool even after prolonged periods of operation. It is reasonably hum free and delivers adequate power to the receiver.

A PROGRESSIVE RECEIVER

PART I

by A. S. CARPENTER

This short series of two articles is intended primarily to assist the budding constructor, who, although experienced in building straight receivers, has not yet ventured into superhet construction. It is assumed that no testing equipment, such as signal generators, etc., is available. It is also assumed that the reader interested can build from a circuit diagram.

The receiver will cover both Medium and Long wavebands. After the first circuit has been made up and got working, it can easily be modified to the second as time and funds permit. The question of expense has also been considered, and with careful purchasing of components it ought not to cost much for the finished receiver.

Some constructors may prefer to leave it at the first stage; in which case it will be cheaper still, of course.

Stage 1

The circuit diagram is shown in Fig. 1, and consists of a 5-valve arrangement—frequency changer, IF amplifier, crystal diode, output valve and, finally, the rectifier. This covers the medium waveband only. The output from this will be found quite sufficient for bedside listening, for example. Later, an LF stage will be incorporated, also AVC and provision for long wave reception.

A brief explanation of how it works follows:

The signal fed to the grid of V1 from the aerial and aerial coil, selected by C3, is mixed in the valve with local oscillations produced by its triode section. The frequency of these is adjusted (mainly by C3 and L2, etc.) to ensure that at all times they are higher than the signal frequency sufficiently to produce an IF of 465kc/s. This is passed on to V2 via IFT1. Greatly amplified, the IF is fed via IFT2 to the crystal diode V3. After filtering out any remaining IF, the now AF passes, via the volume control, to the output valve which amplifies it sufficiently to operate the loudspeaker.

Power Supply

Full-wave rectification in conjunction with a mains transformer is used. This allows much easier smoothing and a lower hum level compared to half-wave rectification. The receiver is also isolated from the mains—a point of some importance in my opinion! Any small transformer capable of supplying some 60–80mA at 250 volts or so can be employed. The upright type is much easier to fix compared to the drop-through variety, and generally takes up less chassis space.

Chassis

The whole thing can be built on a chassis approx. 10in. by 5in. by 2in. Maybe you would like to purchase a cabinet, dial assembly and chassis already made. That is a good idea, but it will add to the cost a bit.

Anyway, 5 holes, the size of a florin, are required—something like that shown in Fig. 2. Two holes are required in the front too—one for the volume control and one for a wavechange switch to come later. One of the top cut-outs is a spare, too, but it is easier to cut it out at the start than when other components are in the way. Incidentally, if an 18 swg aluminium chassis is used the holes can be cut out with a fretsaw if care is taken.

Components can now be fitted and wiring up commenced. Leave some space round V1, as the long wave coils have to go in presently—and don't forget a space for a small rotary switch. Make sure you include the torch bulb in the mains section.

When soldering in the crystal diode V3, hold the wire ends tightly between a pair of pliers to keep the heat from the crystal, or it may be permanently damaged. It can be supported in the wiring.

Testing and Setting Up

Before switching on, check the wiring over carefully and then make sure that there is no direct connection from the HT+ line to chassis or from either side of the mains

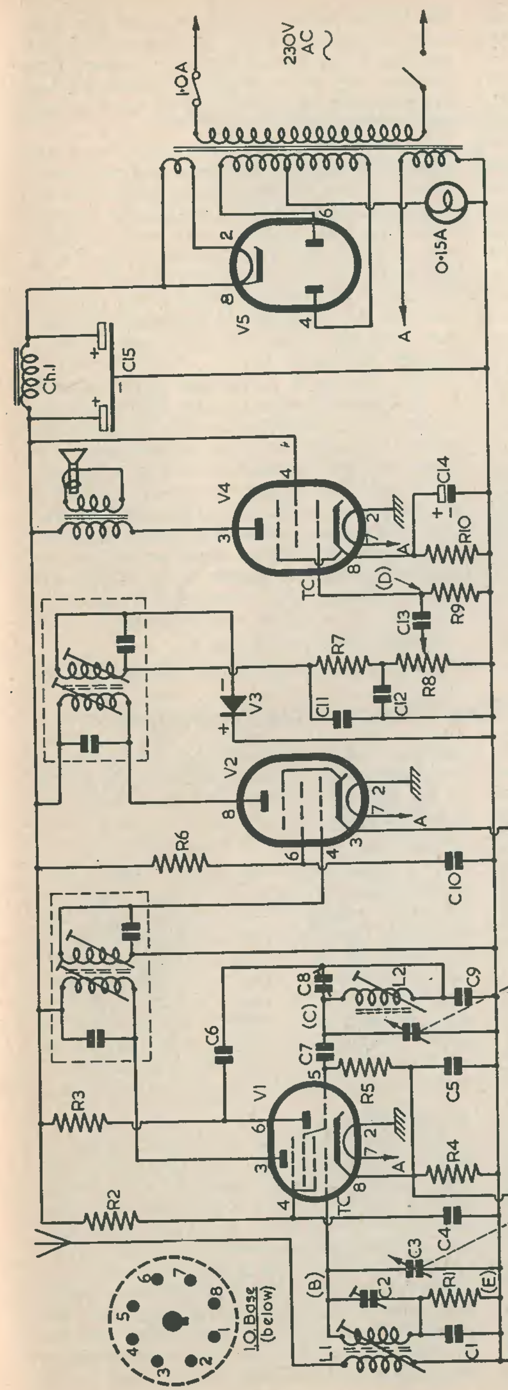


Fig.1

List of components

R1, 2, 3, 5, 7 — 47kΩ
R4 — 220Ω
R6 — 100kΩ
R8 — 500kΩ pot & switch
R9 — 1·5 MΩ
R10 — 470 Ω

C1, C13 — ·01μF
C2, C8 — 50pF trimmers
C3 — ·0005 twin gang
C4, C5, C10 — 0·1μF 350V
C6 — 250pF
C7, C11, C12 — 100pF mica
C9 — 500pF mica
C14 — 50μF 25V
C15 — 12 x 24μF 450V

V1 — 6K8, ECH35, EK32
V2 — 6SH7
V3 — Germanium crystal diode
V4 — EL32, 6V6
V5 — 5Z4

One pair 465 kc/s IFT's
LF choke — 10 henrys
Tapped output transformer — 8000Ω — 3Ω
Coils L1 — Osmor QA8
L2 — Osmor QO5
Mains transformer — see text — 250-0-250V, 60–80mA; 6·3V, 1·5A; 5V, 2A
Chassis — see text

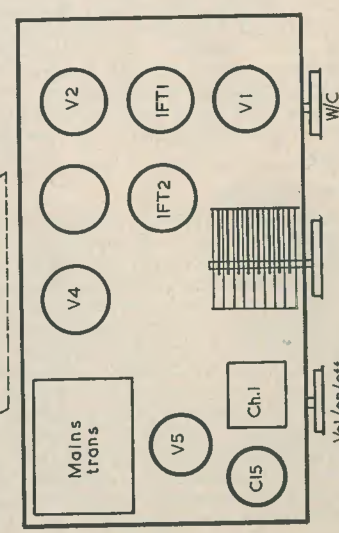


Fig.2
Suggested layout—top of chassis

E151

plug to chassis. This is best done with an ohmmeter, but if one is not available then a battery and bulb will have to do.

If everything is all right the receiver can be switched on and lining up commenced. A rough check that the receiver is working can be made by scraping the blade of a penknife on the top cap of V1 with the volume control fully advanced. The noise, greatly amplified, should be audible from the loudspeaker. If not, something is wrong with the wiring and this must be put right before anything else can be done.

Rotate the twin gang with one hand and adjust the core of L2 at the same time with the other until some kind of station is heard. It doesn't matter what it is as yet. The IFT's can now be roughly peaked up by means of their cores or trimmers, using a plastic knitting needle sharpened like a screwdriver. Now try and identify the station. You will find you can move it up and down the dial, within limits, by means of the core of L2. This must be done gradually, by weakening the power of the signal a little by moving the core slightly then bringing it back to full strength with the main tuning knob. If the core is moved too quickly the station may be "lost" altogether.

If the station being received is, for example, the Welsh Home Service try and get it in such a position that the condenser vanes are about one half enmeshed. A good time to carry this out is when the Home Services are radiating their own particular Regional News Bulletins.

When this has been completed open the condenser vanes of the main tuning control almost all out and select a station somewhere in that position. Peak up the trimmers across the aerial and oscillator coils on this—leave the core of L2 alone. Now try to find a station with the condenser vanes as far closed as possible and peak it up with the core of L2, leaving the trimmers as they are. Repeat these two last operations a couple of times.

The receiver is pretty well lined up now. It is doubtful whether the IFT's are set accurately to 465kc/s, but that is something preferably done with a signal generator. However, they should be in line with each other and the exact frequency is not as important as may be imagined. The iron cored coils are capable of sufficient variation to compensate for the small error.

Note:—Ignore the letters B, C, D, E, on the circuit diagram. They are only intended to assist you when we start on Stage 2.

(*To be continued*)

Mullard Introduce Dual-trace Oscilloscope

The Equipment Division of Mullard Ltd. announce a new high-grade general purpose oscilloscope, type L.101, which incorporates a dual-trace facility, and features wide-band amplifiers, sweep expansion, and stabilised HT and EHT supplies. A tubular steel movable floor stand and an oscilloscope camera are available as accessories. The instrument should be of great value for the comparison and measurement of complex waveforms.

Dual-trace Working

The dual-trace facility is provided on a conventional 5¼in tube by means of two identical Y amplifiers and an electronic switch. Each amplifier is switched through to the cathode ray tube on alternate sweeps, the electronic switch being operated during flyback. There is no interaction between the channels, each of which has a frequency response from 10c/s (1db down) to 4Mc/s (3db down). The rise time of the amplifiers is 0.1 microsecond. Identical attenuators embodying close tolerance high stability components are provided for each channel. These permit the sensitivity to be adjusted from 0.02V peak-peak/centimetre to 100V peak-peak/centimetre in twelve steps. The frequency response of the amplifier channels remains constant for all attenuator settings. Voltages can be measured within five per cent.

The dual-trace facility can be switched out when not required.

Time Base

The Miller time base can be free-running, synchronised or triggered. Sweep velocity is variable between 10cm/microsecond and 0.1cm/millisecond. The sweep length may be expanded in three switched steps to 10cm, 20cm, and 50cm. Velocity adjustments have negligible effect on sweep length. Time can be measured with an accuracy of +10 per cent. The time base output stage can also be used as an X amplifier with a sensitivity of 0.7V/cm and a bandwidth of 2c/s to 300kc/s.

Construction

The oscilloscope is self-contained in an aluminium alloy cabinet (height 14in, width 10.5in, depth 27in, weight 60lb). The power unit is located at the rear of the case and shielded from the tube. It is easily removable for maintenance, connections to the rest of the oscilloscope being by plug and socket.

Amplifiers and time base units are easily accessible. High quality components are employed throughout, and there are no electrolytic capacitors. The oscilloscope is suitable for semi-tropical use.

Query Corner

A *Radio Constructor* Service for Readers

Distrene

I have seen the use of distrene glue recommended in coil-winding specifications for retaining the turns in position. However, repeated attempts to buy this glue from local radio dealers have proved unsuccessful; is there a suitable substitute?

E. Crowther, Bristol

Distrene glue is sometimes recommended to fix the turns on low loss RF coils, and particularly on those wound on one of the polystyrene type formers. The type of glue is not readily obtainable, but some may be easily made by dissolving polystyrene in trico-ethylene. To speed up the process of dissolution it is desirable to use polystyrene filings, adding them to the mix and stirring until the correct consistency has been obtained. This results in a quick-drying glue having very low electrical losses. However, for most television and FM coils—which are used in relatively low impedance circuits—it is not essential to use very low loss coils, and in such cases a normal glue is entirely satisfactory. The writer uses Durofix for such purposes and can thoroughly recommend it from personal experience.

Germanium Diodes

I notice that the use of germanium diodes in television receivers is becoming increasingly popular. What are the advantages which these crystals possess over the normal valve diode, and are they to be recommended to the home constructor?

E. Foreman, Bradford

It is true that during the past two or three years the germanium diode has been gaining in popularity. The reason for this is not only to be found in the fact that two germaniums are cheaper than one double diode valve, plus its associated holder. The technical advantages and disadvantages of these crystal diodes must also be taken into account and may be listed as follows:

(1) As germanium diodes have no heaters they are less susceptible to pick up hum than valve rectifiers:

(2) Having no heaters the wiring is simplified.

(3) They are relatively small and may be connected close to their associated tuning coils, sometimes even in the coil cans, thus reducing the possibility of instability due to stray capacitances.

(4) The shunt capacitance is less than that of a valve and holder.

Query Corner
RULES

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

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

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

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

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

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

There are disadvantages, however, and in some applications these are sufficiently great to render the germanium diode totally unsuitable. The chief disadvantage is that the ratio of forward to backward resistance is very much less than that of the thermionic diode. To put this another way, if it is assumed that both diodes have the same resistance when a positive potential is applied to them, the valve diode will have a considerably larger back resistance under negative potential conditions. This relatively low reverse resistance of germaniums makes them generally unsuitable for use in high impedance circuits. A further disadvantage is that the crystal is more susceptible to damage due to short term overloads. For example, one may be used as a video detector in a television receiver, and can be damaged by arcing within the video valve. Arcing, if between grid 1 and screen or anode, can momentarily drive the grid positive and in turn overload the crystal. Instability in the vision channel causing a high oscillatory voltage to appear across the crystal is another possible cause of failure.

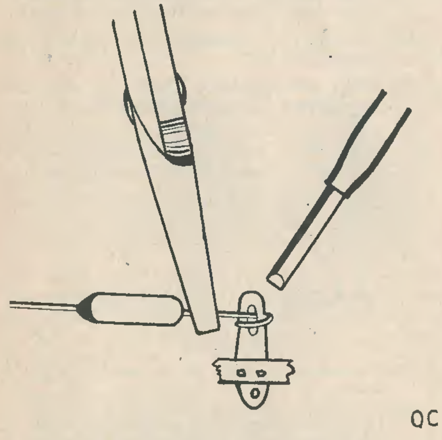


Fig.1: Showing use of pliers as a "heat shunt"

Occurrences such as these are fortunately rare, and the life of germanium diodes in television receivers is certainly no cause for concern. Should a germanium be suspected of having developed a fault it is a relatively simple matter to uncouple one end of it from the circuit and measure its forward and backward resistance. The manufacturer's published data should be consulted for an indication of these resistance values, which are usually quoted for at least two voltages, +1 and –10V. If this data is not available the following figures may be taken as a reasonably accurate guide. A vision detector diode should have a forward resistance at +1V of less than 500 ohms, and a reverse resistance at –10V of greater than 20kΩ. Diodes of the sound detector and sound and vision limiter type should have a forward resistance of less than 1kΩ and a back resistance of greater than 80kΩ at the voltages mentioned above. Many diodes are not intended for use at reverse voltages in excess of 60V, and of course no attempt must be made to measure their back resistance with a "megger."

Before leaving this subject it is worth making a few comments upon the care necessary in soldering germanium diodes into the circuit. If a diode should become defective it is most likely due to the generation of too much heat at the point where contact is made to the germanium itself. This heat may have been generated by the application of too great a voltage, or it may come from a soldering iron. The leads coming from the diode are of necessity good thermal conductors, and can quickly carry the heat from iron to the germanium. Damage from this cause can be prevented either by making the solder joint very quickly before the lead has time to warm up, or better still, by employing a heat shunt. A heat shunt may conveniently consist of a pair of pliers gripping the lead between the solder joint and the diode itself. This is illustrated in Fig. 1. The presence of the pliers greatly adds to the thermal inertia of the lead and prevents any undue rise in its temperature.

Tone Control Potentiometer

The two-stage audio amplifier which I use has, during the past few months, required two replacement tone control potentiometers. The control is of the standard series resistance-capacitance arrangement shunted across the primary of the speaker transformer. Have I just been unfortunate in obtaining poor components or is the circuit at fault?

K. Gorridge, Brighton

So often the tone control of a radio or amplifier is set to the position which gives the most "mellow" reproduction. In other words, the position in which the top cut is at maximum. With the popular series R–C combination shunted across the output transformer the resistance is adjusted to somewhere very near its minimum value under these conditions. This resistance is then required to dissipate a surprisingly large proportion of the audio power developed by the output valve. Now the resistance is usually a normal potentiometer, and whilst it may be of the ½-watt type this does not mean that it can dissipate anything like this energy across a small proportion of its element. Thus if a carbon potentiometer is used in an amplifier capable of over 4 watts output, a 1kΩ ½-watt resistor should be connected in series with it. Alternatively, a wire-wound potentiometer should be employed.

Can Anyone Help?

DEAR SIR,—Have any of your readers any information (data or circuit) on the Receiver type 78?—R. Prowse, 5 Tresluggan Road, St. Budeaux, Plymouth.

DEAR SIR,—I have recently come into possession of an Emerson 6-valve superhet serial no. B940374 and wish to carry out repairs. Can anyone give me any information on the set or the address of the manufacturing company for the circuit?—4110334 Cpl. Liell, D., A.P.P.U. R.A.F. Element, 62/44 H.A.A. Regt. R.A., New Barracks, Burton Road, Lincoln.

DEAR SIR,—Could any of your readers supply me with technical details of the Army Wireless Set No. 46, please?—A. W. Dyson, 139 Hamlin Lane, Exeter, Devon.

DEAR SIR,—I have just acquired a type 78 Ref. 10D/1307 Receiver, and any gen at all on the circuit, valve line-up, Jones plug connections, etc., would be most gratefully received.—Edward G. Hopkins, 14 Aldred Road, West Hampstead, London, N.W.6.

DEAR SIR,—For a long time now I have tried to "beg, borrow or steal" circuit details of the Army Sender type 12 and of the Transmitter-Receiver type 58, and I am wondering if any reader of "*R.C.*" could help me?—J. Ayres, G3DQT, 7 Berrylands Road, Surbiton, Surrey.

DEAR SIR,—I am anxious to read some missing instalments of a series published in *Wireless World* in 1929-30 called "The Properties of Tuned Circuits," by W. H. Pearson. They were part of a general series called "Wireless Theory Simplified." The issues I seek are dated 25th September, 1929 (Part 7), up to 18th December, 1929, and 7th and 15th of January, 1930. If any reader of *The Radio Constructor* has these issues and could make them available for me to read, or would part with them (on payment, of course), I should be very grateful.—R. I. Hall, 6 Princes Road, Wimbledon, London, S.W.19.

DEAR SIR,—I would be extremely grateful if any reader could supply me with the circuit or any data on the R-26/ARC-5, 6–8Mc/s, 28 volts.—J. Salt, "Wyoming," Highfield Avenue, Stockton Brook, Stoke-on-Trent.

DEAR SIR,—Have any of your readers any information (data or circuit) on the A.M. Receiver type 1084, ref. no. 10A/8301?—J. G. Lambert, G3KBD, 81 Station Road, Billingham, Co. Durham.

DEAR SIR,—Can anyone provide me with any data on the Philips PCR3L (two short, one medium) Communications Receiver?—E. C. Hook, 34 Windsor Road, London, N.W.2.

DEAR SIR,—I would be pleased if you could ask, through your paper, if any of your readers could provide any information or instruction book on the R.C.A. Receiver type C.U.R. 46148, range 4/27Mc/s. I would be pleased to pay any reasonable amount requested in return.—D. S. Provan, Cromrach, Brook's Drive, Hale Barns, Cheshire.

DEAR SIR,—I am very anxious to obtain a circuit or information on the Loran APN4 Indicator, and data on the rectifier CV54.—S. Medford, VK7SF, 4 Mark Street, Hillcrest, Burnie, Tasmania.

DEAR SIR,—I have searched everywhere for a circuit of a Battery Tape Recorder, based on the B7G or 3Q5 octal type of valve, but I have had no luck. I would gladly pay to have one designed. Can anyone help?—F. Richards, 34 Edward Street, Warsop, Mansfield, Notts.

DEAR SIR,—Could any fellow reader please help me with any information on the R.A.F. Amplifying Unit type 229, Ref. No. 10UB/6056? The valve line-up is (1) 5U4G, (3) 6J7G, (1) 6V6G and (2) KT66.—N. Filek, 935 Romford Road, Manor Park, London, E.12.

DEAR SIR,—Can any of your readers sell or lend me the circuit and the valve line-up of the Navy Receiver M361?—James McFee, 21 Primula Way, Liverpool, 14.

DEAR SIR,—I would be grateful if you could insert under "Can Anyone Help?" that I am wanting a manual for the Set R107, or any information as to where one can be obtained. I am quite willing to purchase same.—R. J. Jennings, 206 Willesden Lane, London, N.W.6.

DEAR SIR,—Can anyone help me with data, to borrow or buy, on the ex-R.A.F. Battery Receiver R1224A?—P. W. Thomas, 1 Purdown Road, Horfield, Bristol, 7.

NOTES ON RADIO CONTROL

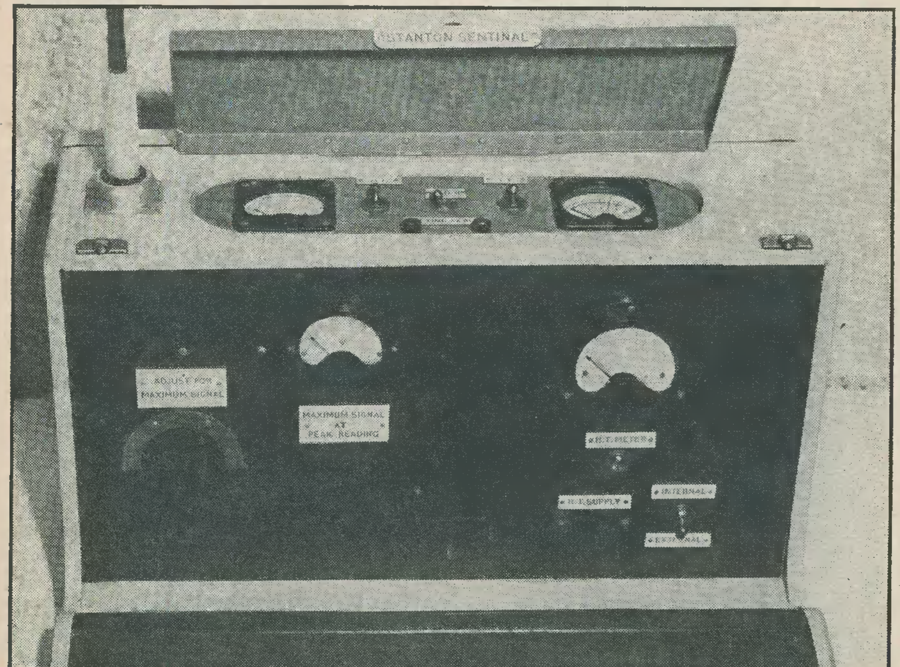
6: *The "Two-Four" Transmitter*

by QUENCH COIL

THIS TRANSMITTER CAN BE OPERATED either as a four valve unit or at lower power, using two valves only. As can be seen from the photographs, every effort has been made to incorporate distinctive appearance and, in use, it has given a first-class performance. It will meet the demands of the more fastidious and those who are prepared to spend a little more on their equipment. By paying particular care to the layout and using only the best of components, losses have been reduced to a minimum and, when operating as a four valve unit, the signal strength is greatly improved on previous models, being well worth the extra cost and the slightly increased battery drain.

The two meters shown in the photo on top of the unit indicate HT and LT current. They, and their associated switches, can be covered when not in use by the snap fitting lid as shown. To assist in the correct tuning of the transmitter to 27Mc/s, a built-in wavemeter is provided. The tuning control for this and the indicating meter are shown on the left of the front panel.

During operation, two Batrymax radio batteries are used for the HT supply. These, connected in series, give a voltage of 135 volts. In order to economise on batteries during tests, a standard type 120 volt battery is used. For this reason external battery sockets are fitted, together with a DPDT switch to change from one to the other.



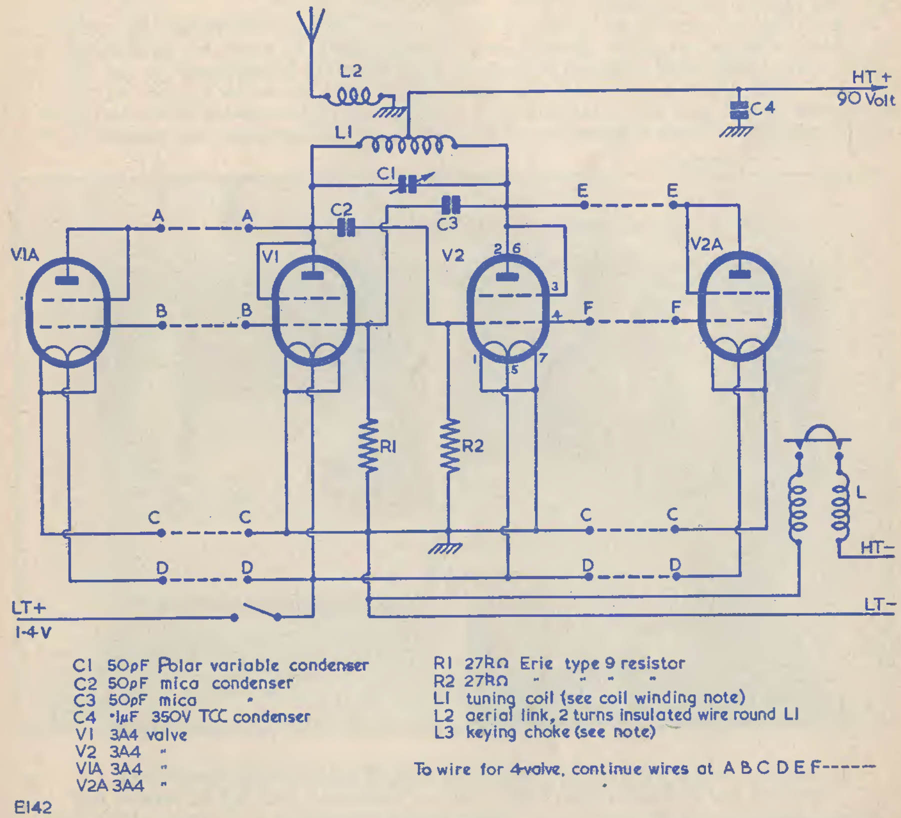
This photo shows the neat appearance and finish. Note aerial mounting and meters, etc. HT meter and external supply plugs are seen on the right panel

These are seen on the right of the panel, above which is the anode current meter. The LT battery is a 1.5 volt Alldry, type AD4, the LT supply of the Batrymax not being used. Both batteries are held in metal clips which can be clearly seen in the photograph of the rear of the unit.

The carrying case is of wood, aluminium lined, with drop-down lid back and front. The size is 17in. by 9½in. by 7in. The top panel and cover are of aluminium, grey crackled. The front panel is of brown high grade paxolin. Paxolin or similar material must be used for the wavemeter panel.

soldered permanently, or the connections being made by plug and socket connectors, whichever method is preferred. The panel should be wired up with 16 swg tinned copper wire and sleeving.

The rear view photograph shows clearly the layout of the components in the transmitter itself. It will be noted that the valves and their associated components are mounted on a small panel which is fixed to the main chassis by small brackets. The tuning condenser is mounted on a polystyrene panel, which should be as close as possible to the tuning coil. Construct the tuning coil along



Constructional Details

The layout of the top panel is pretty obvious, but it is a good idea to construct it as one unit, with all its connections taken to one tag board fitted on to the panel. From this the correct connections are made to their respective positions via flexible coloured cable, the cable either being

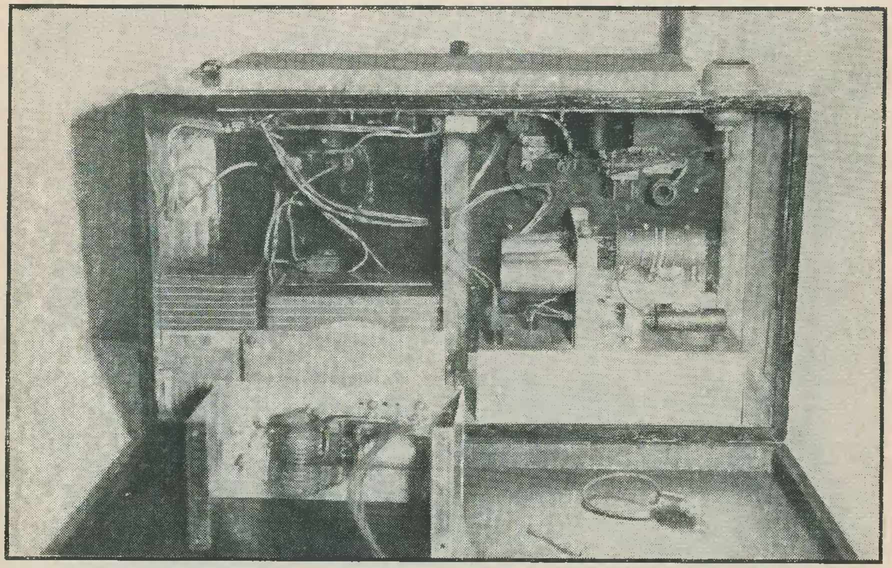
the lines indicated in a previous article. In the writer's case, the former used was of polystyrene, but other similar material can be used. It should be 1in. diameter by 2½in. long, and eight turns of 16 swg tinned copper wire should be put on, the completed winding being 1½in. long. A tap must be made at the centre of the coil. The aerial should be coupled by a two-turn link of insulated wire wound round the centre of the coil, one end being connected to the chassis, the other to the aerial. The correct position of this link is a matter of experimenting. It will be found that if it is placed slightly to either end of the coil the signal strength may be greater. Similarly, some experimenting with the total number of turns on the anode coil itself may be worthwhile, an increase in signal strength thereby being obtained. The writer found, for instance, that seven turns, rather than the eight suggested above, gave better results in one case. It is a good plan to make the coils up with plug and socket holders, so that they can be changed easily.

Once all the components are mounted on the chassis, wire up with 16 or 22 swg tinned copper wire, sleeve with coloured sleeving, keep all wires short and rigid, take all earth wires to the same solder tag and twist together all flexible leads wherever possible.

controlled models frequency which, for the gear described in this series of articles, is 27Mc/s. As previously stated, the help of a local radio amateur or a sympathetic radio dealer can be sought to aid one in this matter. Alternatively, if one has an accurately calibrated receiver covering this band, it can be set to 27 Mc/s and the transmitter tuned until its signal is heard in the receiver. The question of wavemeters will be dealt with in a later instalment and those who have had little experience of this aspect of frequency measurement are advised to proceed as above until they have gained more experience.

Aerials

Much can be written on the subject of aerials, and it must be emphasised that experimenting is necessary to get the best results. In the writer's case, an 8ft. 6in. length of copper-coated thin steel tube is used, being mounted as suggested in a



This photo shows clearly the chassis and method of mounting components Note coil and mounting, also aerial. Built-in wavemeter unit can be seen in the background

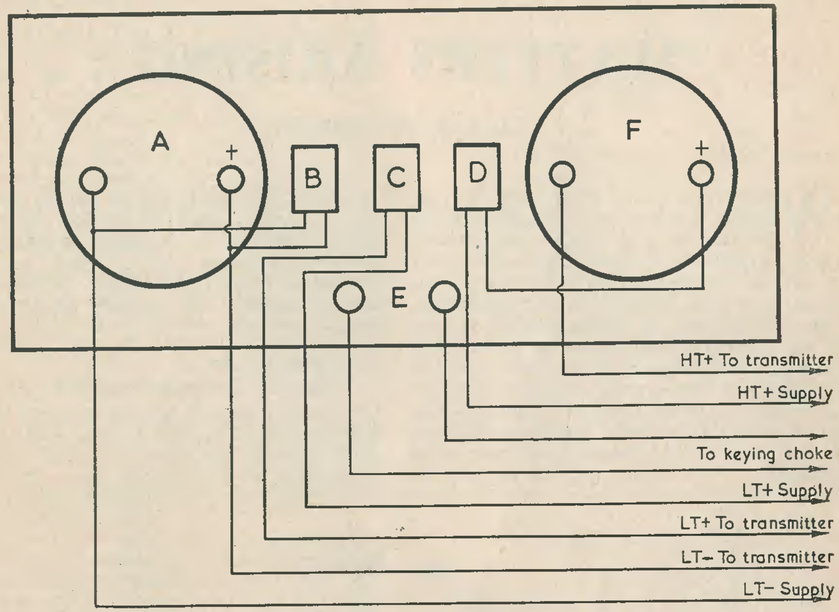
Batteries and method of holding are clearly seen. Small chassis in front is a one-valve transmitter; at the time of taking this was not completed. Note frequency testing loop on right

Lining up the Transmitter on 27Mc/s

Great care must be taken to see that the transmitter is operating within the radio previous article. Any good quality insulating material can be used such as Tufnol, Polythene or Paxolin. Porcelain stand-off

insulators can be purchased from most radio shops, and these are ideal for mounting the aerial. Again, details can be varied to suit individual tastes.

will be seen to be glowing if all is correct. Connect in the HT positive lead a 0–50mA meter. Switch on HT, when the meter should show a reading of about 18mA when



Wiring diagram of top panel of two-four transmitter

A. LT mA meter
B. LT meter switch
C. LT Positive supply switch
D. HT positive supply switch
E. Keying sockets
F. HT mA meter

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Testing

First check all wiring, giving those wires carrying HT and LT particular attention. Connect and switch on the LT. The valves two valves only are used and half the aerial connected. Connecting up the full aerial should increase the current to about 30mA with two valves, and 40mA with all four valves in circuit.

PERMANENT SOLDERING BIT

LIGHT SOLDERING DEVELOPMENTS LTD., 106 George Street, Croydon, Surrey

After considerable research and tests this company have now evolved a permanent bit for soldering irons which is now registered under the name "Permabit." This bit will last indefinitely, does not become pitted, or lose its face, and requires no reshaping, filing or maintenance. These "Permabit" units are available in a fixed bit range of instruments and also as bits for replaceable types in all sizes. The "Permabit" completely eliminates the need for constantly replacing the normal copper bit and therefore considerably reduces the problems of soldering instrument users. As replaceable bits the prices range from 2s. 10d. for an ⅛in diameter to 4s. 10d. for a ⅜in diameter bit.

Let's Get Started 22:

MATTERS ARISING . . . .

by **A. P. BLACKBURN**

When this series first appeared in *Radio Constructor*, it was pointed out that its main object was to present the principles of radio theory to the beginner in a form more palatable and easily assimilated than that offered by the textbooks. The disadvantage of such a method is that, if the subject under review is to be dealt with in one fell swoop in one issue, and not dragged out over several numbers, complete coverage cannot be provided. The treatment must necessarily be short, and many subtleties and apparent contradictions will have to be ignored.

However, the major factors likely to affect the radio enthusiast having been explained in the past articles, it now seems an excellent opportunity to discuss some of the questions raised by readers on points which could not be explained in detail on a previous occasion. It is hoped that they will have a general interest, in clarifying and expanding any obscure details which have arisen.

Matching—Again

There is a very thorny problem here, and few radio engineers see the solution clearly for the first time, for the very good reason that, without an exhaustive and complex mathematical explanation, very few books indeed give it an easily understandable treatment. The major trouble lies, without doubt, in the confusion which appears to shroud the expression giving the maximum power output of a valve.

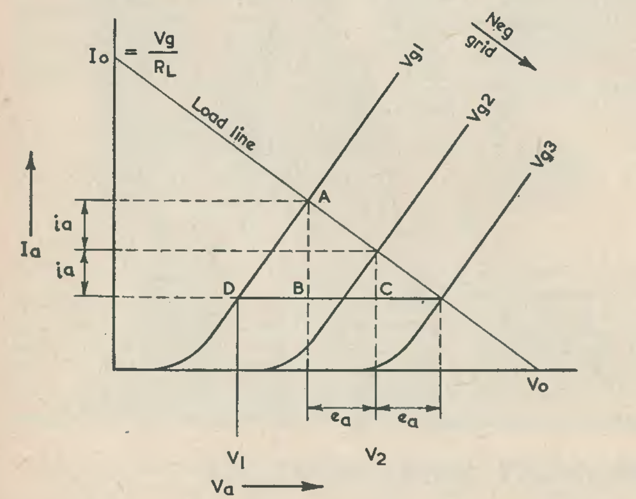


FIG.1. CONSTRUCTION FOR MAX UNDISTORTED POWER OUTPUT

G134

Some books give the expression as: "A valve will produce maximum power output when $R_a = R_L$. That is, when the anode impedance of the valve is numerically equal to the load impedance." However, others again state "A valve will produce maximum undistorted power output when $R_L = 2R_a$, etc." How may these two apparently conflicting statements be reconciled?

The significant word here is "undistorted," in the second statement. In a previous article* it was shown that a generator, of internal resistance R, would produce maximum power when the load it was feeding had a resistance of value R also. The valve was then represented by a generator, of internal impedance R_a, and it was suggested that maximum power would be developed in the load when the load resistance was numerically equal to R_a.

* Matching—A. Blackburn, pp, 114-117, Sept. '54 R.C.

Theoretically, this is all quite true, but in practice it takes no account of the conditions under which the valve is operating. Merely to represent the valve as an AC generator will tell us nothing about the grid conditions, or, therefore, about the possibility of distortion. The analogy of the generator is very useful for many applications involving calculations on valve circuits, and in this case it has helped to justify in simple terms the statement '$R_a = R_L$'.

The second statement is not so easy to justify. Very early in this series the "load line" method of estimating valve performance was examined, and we shall have to resort to this method in order to prove that $2R_a = R_L$ for maximum *undistorted* power.

Fig. 1 shows a typical family of triode anode characteristics. Each curve represents the effect upon the anode current I_a, as the anode voltage V_a is changed, the grid voltage V_g being held constant for each curve.

The load line is drawn by marking the HT voltage V_o on the appropriate axis. This is the voltage which would exist at the anode of the valve if no current were flowing, i.e., the valve is cut off. The other extreme condition is that the valve is drawing current so heavily that no voltage exists between its anode and cathode, the total HT being developed across its anode load. This point is I_o on the vertical axis, where

$$I_o = \frac{V_o}{R_L}$$

By joining these two points, the load line as shown in the figure is produced. A signal swinging from V_g1 to V_g3 will, therefore, produce a corresponding anode swing of $e_a + e_a$ and a current swing of $i_a + i_a$.

Before we can start on the proof, we must assume that each I_a/V_a graph is a straight line, and that they are spaced equidistantly from each other. We are interested in swinging the grid as far as possible with grid current flowing, and as far as possible without cutting off the valve, bearing in mind that either of these conditions causes distortion. To find the value of R_L to give maximum power with the largest input signal we must involve ourselves in the following:

From Fig. 1

$$V_1 - V_2 = DB + e_a \qquad \ldots.(1)$$

Now $\dfrac{DB}{AB} = R_a$ (defined as change in anode voltage for a given change in anode current)

$\therefore \quad DB = AB \times R_a$

but $\quad AB = 2i_a$, and $e_a = i_a \times R_L$.

Substituting these results in (1),

$$V_1 - V_2 = 2i_aR_a + i_aR_L$$
$$= i_a(2R_a + R_L) \qquad \ldots.(2)$$

Now, power output
= RMS value of the anode current squared, times R_L.

RMS anode current

$$= \frac{i_a}{\sqrt{2}}$$

$\therefore$ Power output Po

$$= \frac{i_a^2}{2} R_L, \text{ and from (2),}$$

$$i_a = \frac{V_1 - V_2}{2R_a + R_L}$$

Substituting for i_a from (2)

$$P_{out} = \left[\frac{V_1 - V_2}{2R_a + R_L}\right]^2 \frac{R_L}{Z}$$

So far, so good. We have an expression for power output for the extreme condition under which the particular valve may work. You will notice that, if the same current as would be drawn at V_g3 were drawn at the other extreme of grid voltage, V_g1, the anode voltage so obtained would be represented by V_1.

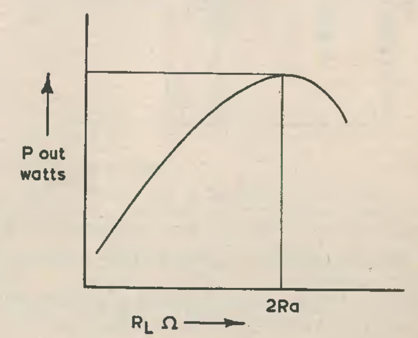


FIG.2.

G135

We now want to find, from our expression for P_{out}, what value of R_L will make P_{out} a maximum. The mathematically minded readers will differentiate the expression with respect to R_L, and equate to zero to get the result, but a more readily understood, although lengthier, method is to plot P_{out} for various values of R_L, as in the article previously mentioned. The graph will be of the type shown in Fig. 2, the maximum value of P_{out} occuring at $R_L=2R_a$. If, therefore, the R_a of the valve were 5kΩ, R_L should, of course, be 10kΩ.

Having digested all this mathematical stuff, we cannot be blamed for sitting back well satisfied. It comes as rather a shock, therefore, to pick up a valve data book and read, under two columns headed 'R_a' and 'Recommended Load', a value of 5kΩ, with a recommended load of 15kΩ! Who is pulling whose leg? Have we spent all this time and thought on incorrect information?

Not really, no. We started off by assuming that the characteristics were *straight and equally spaced*, and for the purposes of proving the point, this seems a fair restriction to make. Examination of the curves of any particular valve, however, will show that these assumptions are not strictly accurate. The value of R_L is therefore modified from the value we have found. In actual fact, of course, we have proved that $R_a=R_L$ is the condition for maximum power, but not maximum undistorted power.

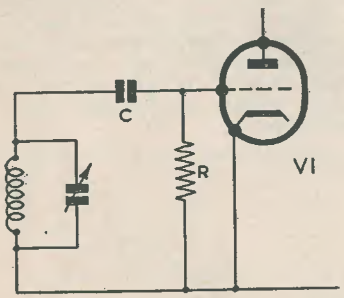


FIG. 3. G136

We have arrived, therefore, at the following conclusions:

(*a*) For a given valve, and for a given small signal grid voltage, maximum power output is achieved if $R_a=R_L$.

(*b*) The actual power output is small in case (*a*), but it is a maximum for that particular value of anode load. However, power valves are normally driven with a large grid signal. Under these conditions, the maximum undistorted power output is obtained when $R_L=2R_a$. This assumes that the valve characteristics are straight and evenly spaced, and that no grid current flows at any part of the signal waveform.

(*c*) The characteristics of practical valves are not straight over their complete length, and they are not equally spaced. Some modification must thus be made to the ideal value of R_L to obtain optimum power. This value also assumes that no grid current flows.

Detectors

After that rather weighty piece of reasoning about power, we shall now turn our attention to the more delicate side of valve circuitry—the grid.

Grid leaks often appear to be arbitrarily chosen, and in some designs this would appear to be true. The choice of this humble component is generally not difficult, because in most applications it is not particularly critical. Most enthusiasts judge the value required by experience, which is undoubtedly the best guide. There are, however, some broad principles which should direct the choice.

In most cases it is not the grid leak alone that we have to consider—we have mostly interested in the grid circuit time constant. Fig. 3 shows the circuit of a leaky grid detector. This is, of course, familiar enough, but the values of C and R cannot be decided arbitrarily.

It will be remembered that the grid and cathode of V_1 are being used as a diode, where the grid represents the anode of the diode. There are two expressions which will give fairly accurate estimates for values of R and C with a minimum of distortion.

They are:

$$RC=\frac{\sqrt{1-d^2}}{\omega d}$$

where R and C are as in Fig. 3, d is modulation depth, and ω is 2 π× highest audio frequency used.

$$R=2\times K\times R_i$$

where Ri is diode input resistance and K is detector efficiency.

Typical values of R_i and K are 0.5 MΩ and 80% respectively. The detector efficiency K is defined as the ratio of the mean voltage across C to the peak value of applied RF voltage.

The following case is typical:

Highest audio frequency, 10kc/s
Modulation depth, 70% (i.e., d=0.7)

$$R\times C=\frac{\sqrt{1-0.49}}{2\,\pi\times 10000\times 0.7}=0.000016$$

$$R=2R_iK$$

Taking R_i as 0.5MΩ and K as 80% (i.e., 0.8)

$$R=2\times 0.5\times 0.8$$
$$=0.8M\Omega$$

From R×C=0.000016 above and R=0.8MΩ

$$C=\frac{1.6\times 10^{-5}}{0.8\times 10^{6}}$$
$$=200pF.$$

Here again the result is not particularly critical. For example, the final network would become 1MΩ and 200pF. The small modification to the calculated values to enable standard value components to be used would have little effect upon the final result.

It is worth remembering that there is no point in calculating circuit values to a very fine accuracy, if ±20% tolerance components are used in the final job. In most radio applications, 10 or 20% components are quite good enough, so an approximate estimate only of the correct value is all that is required.

Oscillators

Before we leave the subject of grid leaks, some readers may find it helpful to have a look at the part they play in oscillators. Most of you will be familiar with the mechanism by which this circuit oscillates. Any small disturbance at the grid is amplified and fed back to the grid in such a way as to assist the original disturbance. This process continues, the frequency of oscillation being determined by the tuned circuit. Initially, there is no bias on the grid, and therefore grid current flows during positive half-cycles.

This grid current flows back to the cathode via the grid leak R, and produces—with respect to the cathode—a negative voltage at the grid. The plates of the grid capacitor C connected to the grid are also charged negatively. As the amplitude of oscillation builds up, this negative bias increases, and the gain of the valve begins to fall. The time eventually comes, therefore, when the bias produced by the oscillation allows the valve just enough gain to maintain oscillation.

Now imagine what would happen if the time constant of C and R were very long, compared to the duration of one cycle of oscillation. The amplitude would build up until the valve were driven into cut-off by the bias produced by the oscillation. Once this has happened, oscillation would cease, not to recommence until the charge on C has leaked away through R. As the charge leaks away, the grid voltage will rise toward the cathode potential, thus allowing current to flow in the valve once again. Oscillation will start once again, and build up until the cut-off bias is reached, when the oscillation will cease. This process will go on indefinitely under these conditions, and is called "squegging."

If the grid RC combination is made too small, the mean grid voltage does not remain constant over each cycle, and the output waveform becomes distorted and harmonics are introduced.

The components must clearly, therefore, be a compromise fulfilling these two requirements. It is not necessary to have a system for their calculation because, once again, their values are not critical. It should be remembered, however, that a CR combination for an oscillator of 1Mc/s would not be as effective at 100Mc/s or at 10c/s.

Typical values in a superhet local oscillator are 100pF and 50–100 kΩ. The wide band over which a three-waveband receiver tunes makes these values a broad compromise.

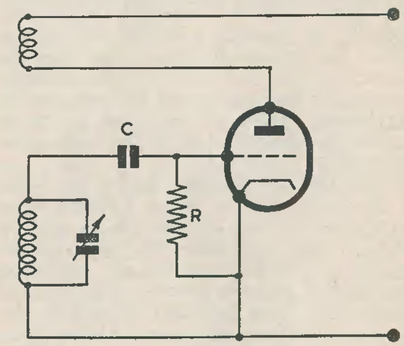


FIG. 4. G137

Audio Frequencies

The choice of grid leak at audio frequencies is, as in the previous cases, dependent to some extent upon the coupling capacitor. The RC combination is dependent upon the low frequency response required. The response of a single stage is 3db down when the frequency is equal to

$$\frac{1}{2\,\pi CR}.$$

For example, the response of a stage would be 3db down at 16c/s approximately, if C were 0.1μF and R were 100kΩ.

The Prevention of Accidents

by C. H. L. EDWARDS, G8TL

CARELESSNESS IN THE WORKSHOP CAN very often lead to serious accident and even loss of life. One moment you may be fit and active and in a split second you can be severely maimed. It's no use saying "If only I had . . ." because then it's too late. Here are a few wrinkles for the newcomer to the hobby, and possibly a reminder to some of the older hands.

Firstly always keep the workshop and benches clean and tidy. When the day's work is finished sweep the bench and floor, and clean and put away the tools in the racks. Pieces of metal on the floor may pierce the soles of the shoes or may twist the ankle, and sharp pieces of metal lying around on the bench can give a nasty cut when fishing around for tools.

Never use a file with a split handle, as the tang can run deeply into the palm of the hand when it is faced on to it as is done when filing work. See that spanners fit the nuts properly, or barked knuckles will result. Do not use a piece of pipe to lengthen the spanner, as the additional tension is likely to sheer the bolt and cause the operator to overbalance. Also, do not use shims; if the nut is an odd size use an adjustable spanner.

Watch that the hammer head is not loose on the shaft split; a flying hammer head can do quite a lot of damage to all and sundry. Also see that the face has not become rounded or damaged, otherwise when driving nails the thumb is likely to take the impact. Note the heads of chisels and see they aren't mushroomed; pieces flying off may lodge in the eye with serious results. Don't try and remove obstinate screws with the work resting on the hand or across the thigh, as the driver is likely to slip and penetrate the flesh. Keep out of line with the edge of the grinding wheel, or if the work has to be done closely use a pair of goggles—it's worth it.

When using a knife always cut wood away from and not towards you, and when a drill brace is used do not support the work behind with the hand, nor drill thin metal chassis across the knees. If the drill is portable and electrically driven see that the frame is earthed back to the plug, because, when standing on concrete, should the drill become "live" the operator is on the earth return.

If a broken neck is not desirable, when using an electric drill see that the tie is not hanging over the work, as the spinning drill will quickly pick up the end if contact is made with it. This also applies to the grinder. Also refrain from holding work which is being drilled with rag, as the fingers are likely to become entangled in it if the drill should pick up a loose end.

Purchase or make a "V" iron rest for the soldering iron and place it towards the rear of the bench, so that visitors do not unwittingly place their hand upon it, or burn holes in their clothes when leaning against the bench.

Arrange all of the AC supplies to the transmitters, receivers, instrument and tool plugs to be fed from a double pole iron-clad switch and fuse, and mount this adjacent to the door of the workshop. Connect a neon bulb across it which will flicker when the lights have been switched off, thus reminding the operator to draw the switch before locking up for the night.

Don't forget to insure the workshop and its contents. A fire can quite easily start through poor electrical wiring, and for the very reasonable premiums it is worth the cost. Have the masts included in the policy under third party risk; a gale can easily wreck a mast or tower with disastrous damage to a neighbour's roof.

Having taken all reasonable precautions, it is as well to have handy in the workshop a few one-inch bandages, cotton wool, lint, Elastoplast patches, a small bottle of iodine and a pair of tweezers to render first aid immediately to any cuts or wounds, which are bound to occur sometime in the course of work.

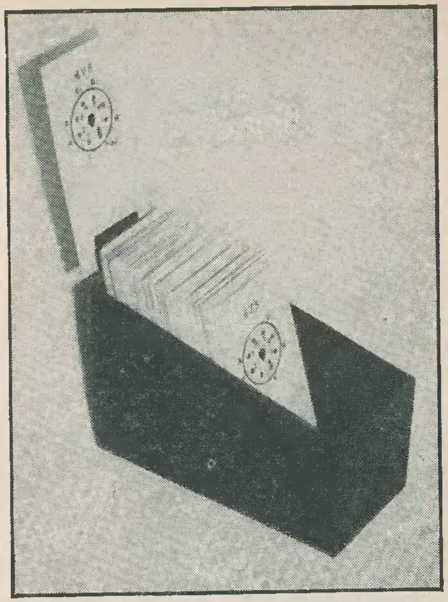
Always remove splinters right away and dab iodine into the wound after they have been extracted. The danger of poisoning is just as great in a small cut as in a large one; in fact more so, if neglected. The irritation produced in movement by working and the dirt aggravating the skin can soon inflame a small cut, so take heed and give it due attention.

If you are unlucky enough to get some grit in an eye pull the top lid over the bottom; this invariably works it out. If painful, wash the eye with boracic in an eye bath.

And lastly, from the psychological aspect, don't attempt to carry on with the work if one is getting tired and irritable. Leave it alone and pack up for the day. A good night's sleep can work wonders, and next day the job which was beginning to get irksome becomes dead easy as one looks at it from an entirely different viewpoint, when the mind is clear and the body refreshed.

A SIMPLE WORKBENCH ACCESSORY

by L. E. PROFAZE



WE ARE UNFORTUNATELY FACED WITH the problem of numerous valve base arrangements, and every experimenter becomes personally involved with perhaps as much as a dozen types, if not more. Searching the various makers' data books, with their individual methods of listing information, can be tedious. The use of a small workbench filing system can, therefore, be of inestimable value.

A small wooden box should be provided and a number of fairly stout cards cut to fit, allowing about a half an inch to project above the upper edge of the box to facilitate selection. The cards need to be reasonably thick as they will be subject to hard work during their lifetime.

The valve type should be printed in one upper corner and below this a circle about the size of a penny (in fact, the use of a coin as a drawing guide makes a readily available "compass" of uniform diameter) into which is sketched the pins together with their number and respective electrodes, employing a code of symbols to which you are accustomed. Below this could be a schematic plan of the valve to complete the picture. The reverse side is useful for data relating to the particular valve and any special information collected in the course of experiments.

At the rear of the box should be fitted a clip—a small bulldog or crocodile clip will serve—and into this is slipped the card required so that the information is readily available and easily viewed while work progresses.

The information contained in such a system need not, of course, be entirely confined to valve bases, but can be extended to cover component colour codes, special circuits, or data, etc., being limited purely to suit the individual.

Although this may seem a very simple and obvious idea and takes but a short time to construct, it will prove itself a great time saver and prevents the bench from becoming unduly littered with books which invariably become tattered and torn or covered with soldering flux. (A limited number of stoved green steel trays suitable for this purpose, comfortably holding 500 cards, can be obtained from us, price 3s. 6d. Suitable cards can be supplied at 3s. 6d. per hundred whilst stocks last. Postage on each item is 3d. —EDITOR.)

Are You Insured Against Accidents?

(*See article on facing page*)

If not, it will pay you to complete and send in the proposal application form on page II of cover (Scottish Insurance Corporation Ltd.)

DAYLIGHT ON CAPACITORS

By T. H. ROBINSON, B.Sc.

TWO CONDUCTORS SEPARATED BY AN insulator constitute a capacitor. Various types are available, and this article is intended as a refresher on their advantages and faults.

IMPORTANCE OF POWER FACTOR

The Power Factor of a device is defined as the Real Power divided by the Apparent Power. In an ideal capacitor the Real Power consumed would be nil, and the PF therefore zero. Unfortunately, the energy released by a capacitor on discharge is never quite equal to that expended in its original charge, and a small PF exists.

In an ideal capacitor, the current and voltage are 90° out of phase; but in reality this is never reached, and the phase angle fails to be a right angle by a complementary angle, which, if expressed in radians, equals the Power Factor.

CAPACITOR LOSSES

The power that is dissipated in a capacitor is lost in several ways, the most important being dielectric hysteresis, or molecular friction in the dielectric, causing heat. The second most important loss is leakage current due to poor insulation properties of the dielectric, and this also causes heat. Small losses also occur due to resistance in the conductor plates; and occasionally, in high voltage work, to corona discharge between them.

Leakage currents are proportional to frequency, and the allowable voltage on a capacitor is therefore inversely proportional to the frequency (square root of frequency at very high frequencies). Many capacitor failures are due to disregard of this fact. Professor F. E. Terman quotes the case of a 0.001μF mica capacitor which has the following ratings:—

DC..	10,000 volts
1,000 kc/s,.. ..	1,780 volts
10,000 kc/s, ..	178 volts

Care must therefore be taken in the selection of capacitors for high frequency conditions, and it should be noted that the highest voltage rating is on DC which is generally the one quoted on the component.

The Power Factor of a capacitor is almost independent of capacity, voltage or frequency (assuming that the insulation of the dielectric is sufficiently high to prevent leakage), but increases as the temperature rises or if dampness gains access. In fact, the two main enemies of capacitors are temperature and dampness, both leading to increased losses, bad Power Factors and eventually failure.

Capacitors should therefore be kept as cool as possible; not close to rectifier valves for instance, and they should not be stored in damp places. Canned components, as opposed to those in cardboard tubes, are less likely to be penetrated by moisture.

NON-INDUCTIVE CAPACITORS

Not infrequently non-inductive components are specified, though very rarely is such a qualification necessary. Except in very high RF work, inductance can be ignored: there is generally more in the wiring than in the component itself. It is true that a type of tubular capacitor, consisting of a long rolled strip with the contacts at the end, may have had an appreciable inductance; but this is not likely to be present to any great extent in the modern types where contact is made along the entire length of the conducting foil.

TYPES OF CAPACITOR

There are three types classed according to the dielectric: Solid, Electrolytic Film, or Air. The solid group will be mentioned first.

CERAMIC

Here, a very thin film of metal is deposited on a ceramic dielectric. These capacitors are exceedingly stable and reliable, and have very low losses. They are consequently used for high RF work. They are obtainable from very low values up to about 10,000pF.

MICA

These have very low losses, and are used also where high voltages require high dielectric insulation. In high RF work, the metal conductors are sometimes silver plated to reduce skin resistance.

Mica capacitors are obtainable from about 10pF to 25,000pF (0.25μF). Unfortunately, they tend to be rather expensive for general use.

PAPER

Range from 500pF to about 12μF in standard types. These are inexpensive and are for general use. Losses are normally fairly high, though they vary considerably with construction.

ELECTROLYTIC

Here, the positive plate is aluminium, and has a thin film deposited on it electrolytically: this film acts as the dielectric. The negative plate (often the can and often aluminium also) is separated from the positive plate by a jelly, liquid or paste electrolyte which forms a conducting path. The capacitor is therefore polarised, and must be connected the correct way round. Should the connections be reversed, current will flow, and the dielectric film will quickly be destroyed. It will, however, withstand a small AC ripple superimposed on DC. Occasionally non-polarised types are encountered, a film having been deposited on both plates.

The great advantage of electrolytic capacitors is their cheapness. Due to the thinness of the dielectric film, very high capacities can be obtained in small volume.

On the adverse side of the balance, they have a high leakage current and Power Factor, deteriorate with age owing to chemical action, and are neither consistent nor constant.

The leakage current should be about 0.5mA per μF, and as this increases with age (when not in use) capacitors that have been stored should be reformed by applying low voltages and gradually increasing until the leakage at full working voltage is about this figure. The dielectric film will then have been remade.

The PF is very high, and contrary to the general rule increases with frequency. At high frequencies it is so great that the capacitor is virtually a resistor. The PF also increases with applied voltage, and varies with temperature.

The safe working voltage depends on the dielectric film. If the voltage is too high, the leakage currents will cause heat which further destroys the film, and finally the capacitor will be short-circuited. The Peak Rating figure marked on the component includes both DC and AC ripple. The Working Voltage is usually about 90% of this figure, and if an AC ripple is to be applied, this should be deducted from the steady DC value.

The main use of electrolytic capacitors is in smoothing and bypass circuits where large but not critical capacity is required, and where relatively high leakage currents and variations in PF are not important.

The great enemy of electrolytics is heat. They should not be overloaded and should be placed in positions as cool as possible, otherwise the capacity, leakage current and working voltage will all be adversely affected.

AIR DIELECTRICS

The main use of this type of capacitor is in variable tuning, the moving vanes being shaped so that the degree of turning bears some definite relationship to the capacity. "Straight line frequency" is often used, i.e. a graph of frequency plotted against degrees of turning would produce a straight line.

The PF losses in air are negligible, by far the greatest occurring in the material holding the fixed vanes. For this reason, in VHF work capacitors with ceramic or low-loss mountings should be used.

Air is not a good insulator at high voltages due to corona discharge, and in certain laboratory type capacitors dry air compressed up to twelve atmospheres is used, when much greater voltages can be applied.

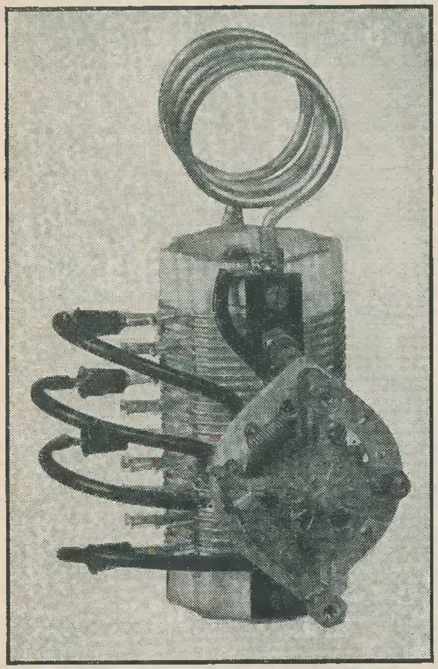
One air-dielectric capacitor which particularly appeals to the writer is the concentric groove trimmer. When temperature increases cause expansion, the dielectric thickness also increases; but any effect on capacity is offset by the increase in plate area, and the capacity remains remarkably steady.

Finally, a capacitor in a class by its own is the high voltage oil-filled one. This is in regular use in television EHT circuits. Special water-free oil is used which resists corona discharge and is self-sealing after minor flashovers. To get good insulation, the dielectric must be thick, and hence the size of the component large.

F.M. TRANSMISSIONS

We understand that the Home Service programme on F M is temporarily being transmitted from 9–11 a.m. from Alexandra Palace, until 7th April, when the Home and Third programmes will be resumed as heretofore. From 2nd May the full Home, Light and Third programmes will be transmitted.

TRADE NEWS



Labgear (Cambridge) Ltd., Willow Place, Cambridge

HIGH POWER SWITCHED PI-NETWORK INDUCTANCE

(for the 80, 40, 20, 15 and 10 metre bands)

The Pi-network anode circuit for R.F. power amplifiers provides undisputed advantages over the more conventional parallel tuned tank circuit. Its use provides a very worth while attenuation of harmonic output with an attendant reduction of T. V. I. problems. Moreover, it affords a remarkably smooth control of impedance matching and loading simply by the adjustment of a standard variable capacitor.

In the Labgear unit, a small "hold-off" inductance has been added at the "hot" end of the main tapped coil which will resonate in the 28Mc/s band. This greatly increases the efficiency on the higher frequency bands and the overall performance is comparable with that obtained using inductances individually designed for each band. The main coil is wound on a ceramic former and is provided with sockets at every turn so as to provide complete flexibility and to cover a wide range of input and output impedances. The heavy duty ceramic band-switch is connected to the inductance via stout leads and plugs which will safely carry the high R.F. circulating currents.

When using an 813 P.A. valve, the input (anode) tuning condenser should have a maximum capacitance of 100pF and a spacing of about 0.1in/KVof DC supply voltage. Parallel 807's require a larger capacity tuning condenser but a quite close spaced model will suffice owing to the low HT required by these valves. It should be isolated from the high voltage DC by a first class .002μF mica dielectric capacitor. It is essential to feed the HT to the anode of the P.A. via a special type of R.F. choke and a Labgear model E.5032 is recommended.

The output (loading) condenser may be a 2-gang broadcast receiver type, both sections being paralleled to give approximately 1000pF maximum capacitance. This condenser should have an air gap of about .017in or greater. It may flash over if operated without load, but there is no danger when working into a standard 52 ohm or 75 ohm co-axial feeder. The unit will also operate satisfactorily into impedances of up to 600 ohms but the majority of users will prefer to match into a standard co-axial line feeding either the antenna directly or an antenna coupler.

The unit is suitable for panel mounting so as to allow a lay-out yielding very short leads. When setting up for the first time, turn the loading capacitor to maximum and select a tap which allows resonance to be achieved with the anode tuning condenser at a value likely to result in a reasonable circuit "Q". Initially operate the P.A. at reduced anode voltage, then with the load applied gradually decrease the capacitance of the loading condenser until the correct P.A. anode voltage to current ratio exists. During this process the anode tuning condenser should be progressively re-resonated. The HT may then be increased to the standard working value.

The Labgear switched Pi-network is very suitable for 150 watt transmitters and indeed may be incorporated in P.A. stages operating up to about 250–300 watts. It is most important to avoid turning the band-switch when the anode volts are applied as in this event serious contact arcing will result.

Nominal overall inductance	21 microhenries
Maximum height	8 inches
Overall width	5 inches
Depth behind panel	6¼ inches
Height of spindle above base of coil	2¼ inches
Catalogue No.	E.5033

TAPPED AERIAL INDUCTANCE

This unit is ideal for the construction of aerial matching units. The majority of well designed transmitters provide a 52 or 75 ohm co-axial outlet enabling a standard low-pass filter to be incorporated between the transmitter and the load to minimise harmonic interference. Unless the aerial installation embodies a co-axial feed system it is usually necessary to employ a matching unit which incidentally provides additional discrimination against unwanted radiations.

Great flexibility of the aerial matching unit is essential and to this end the main tapped inductance of the Pi-network unit E.5033 illustrated above is made available as a separate product. Every turn is tapped and to facilitate rapid change of connections, sockets are provided which accept standard wander-plugs.

Balanced or unbalanced aerial feed systems may be accommodated and series or parallel tuning employed according to the aerial feeder impedance. The use of two 100pF variable condensers in series or parallel connection allows all amateur bands to be covered from 10–80 metres. The low-impedance feed from the transmitter may be fed across two or three turns of the coil in auto-transformer fashion.

If a low-pass filter is used it is desirable to ensure accurate matching by the use of a standing wave ratio meter such as Labgear model E.5029. Catalogue No. E.5022.

G2AK THIS MONTH'S BARGAINS G2AK

Talking *of* TABLE TOPPERS

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

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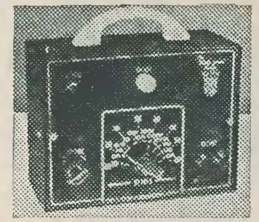

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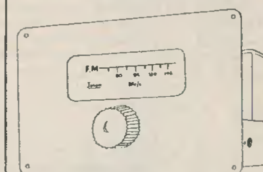

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[continued on page 575

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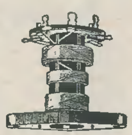

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continued from page 573]

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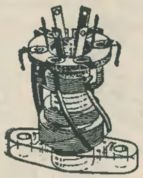

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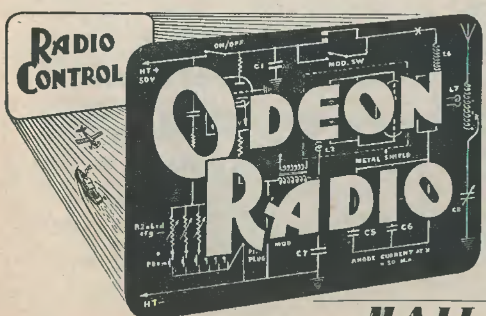

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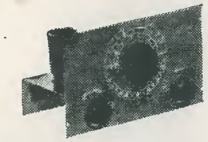

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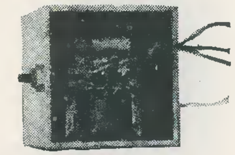

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