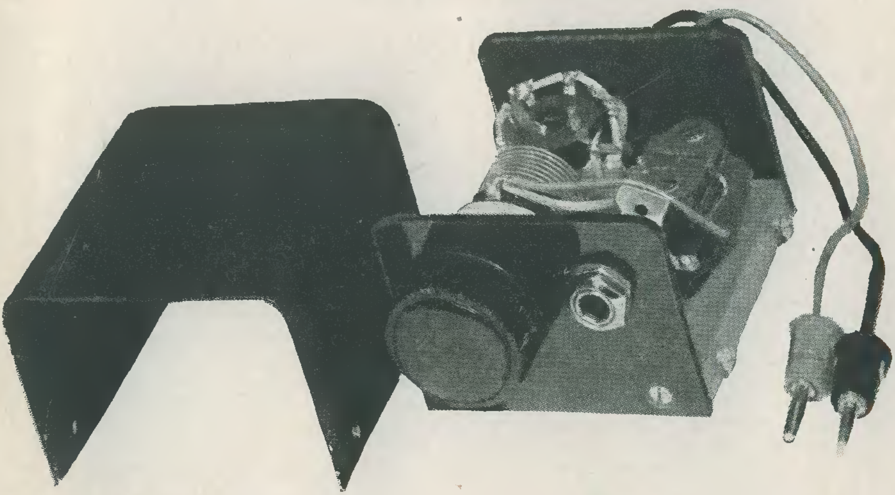
The RADIO CONSTRUCTOR

for the Radio and Television Enthusiast

Volume 8
Number 7
FEBRUARY
1955

A TRANSISTOR



"ONE - VALVER"

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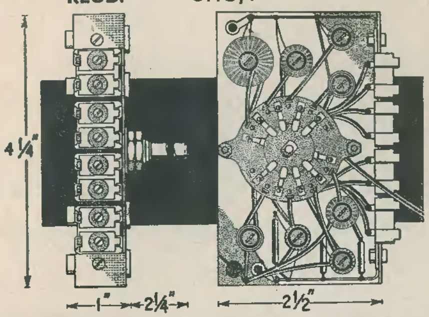

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The Radio Constructor

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

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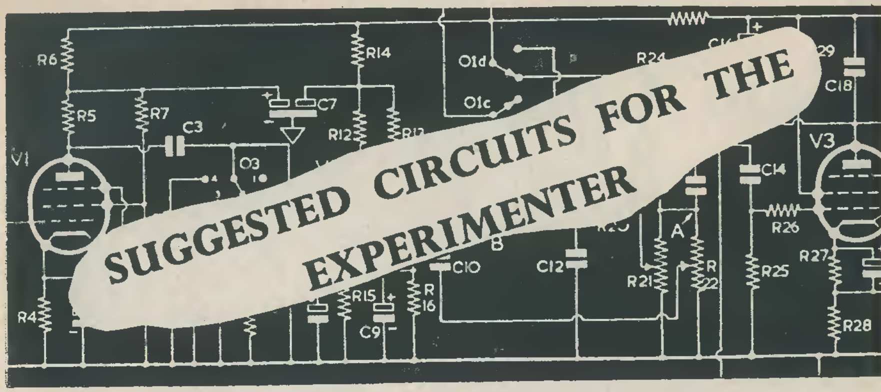


The circuits presented in this series have been designed by G. A. FRENCH, *specially for the enthusiast who needs only the circuit and essential relevent data*

No. 51. A SYNCHRODYNE LOCAL STATION RECEIVER

An entirely new system of receiving and detecting amplitude-modulated signals was introduced in 1947 under the name of the "Synchrodyne." This was developed by Dr. D. G. Tucker who was, at that time, with the British G.P.O. When details of the new system were first published[1] considerable interest was aroused in the technical world; this being due to the revolutionary principles involved and the theoretical possibilities made feasible. Especially of interest in the present context is a subsequent article by "Cathode Ray," this illustrating very clearly the fundamental workings of the circuit.[2]

Until recently, little further has apparently been heard of the Synchrodyne receiver. However, the circuit has now come into prominence once more; this time in New Zealand, where a technical magazine has revised the circuit and has also published constructional details of a high-fidelity Synchrodyne tuner which can be made at home by the amateur.[3] This unit is designed to cover the medium-wave broadcast band under the reception conditions existing in New Zealand.

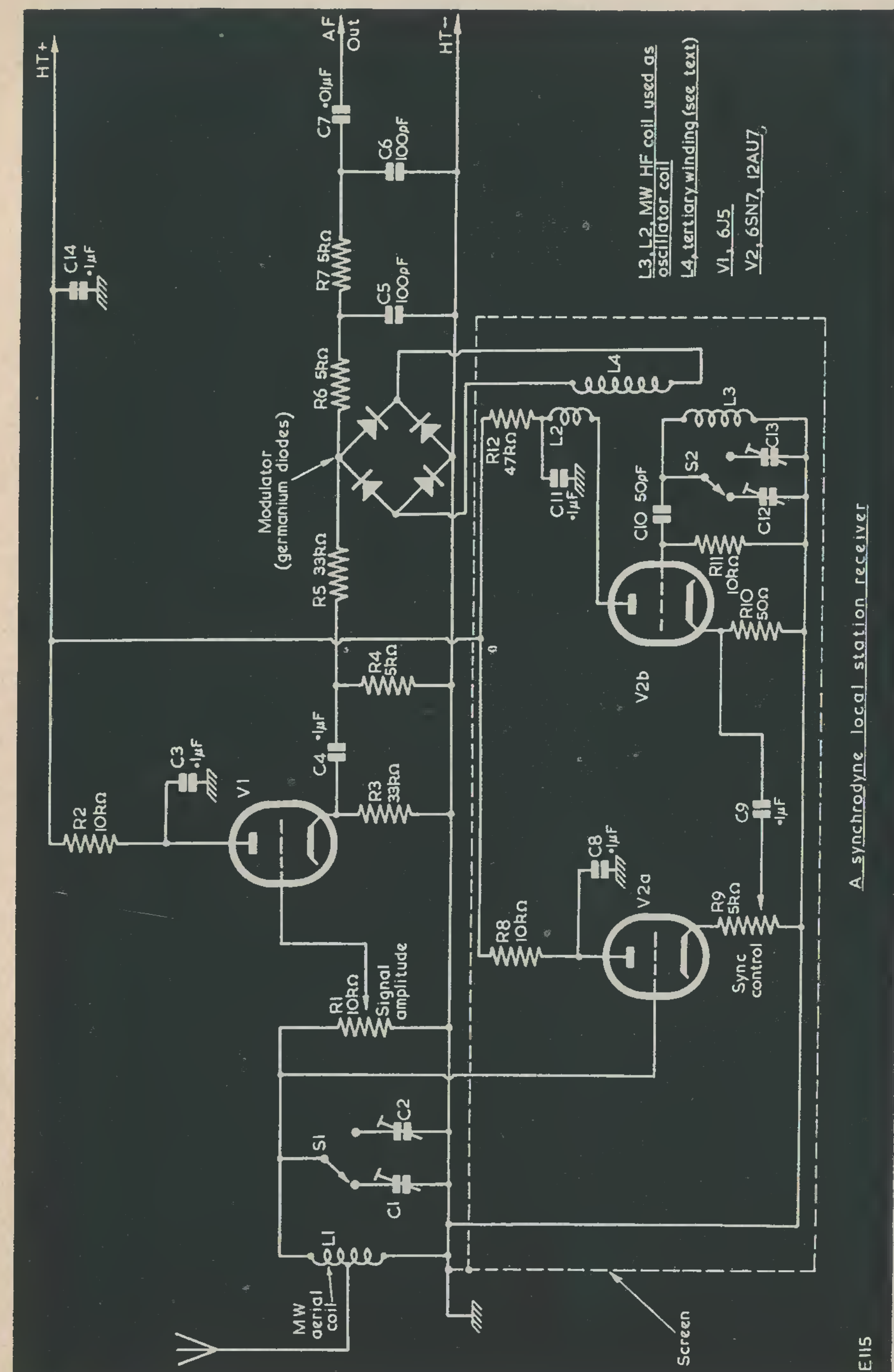
The Synchrodyne

The easiest way of appreciating the working of the Synchrodyne is to consider it from the viewpoint of the conventional superhet. In the superhet, incoming signals are modulated in the frequency-changing stage by a local oscillator, the result of this process being the production of new frequencies. Of these new frequencies, the most important (so far as the conventional superhet is concerned) is that which is equal to the difference between the frequency of the local oscillator and the frequency of the incoming signal. This "difference frequency" is known as the intermediate frequency and is selected, subsequent to the frequency-changer, by the pre-tuned IF stages in the receiver. Thus, an incoming signal at 2,500 kc/s, if modulated by a local oscillator at 2,000 kc/s, produces an IF at 500 kc/s.

It is obvious that the closer the local oscillator approaches the required signal in frequency, the lower does the "difference frequency" become. If the process is carried to its logical conclusion, at which stage the local oscillator is *exactly* equal to the incoming signal, the resultant "difference frequency" becomes zero.

This is precisely what is done in the Synchrodyne. In this receiver a local oscillator is locked to the carrier of the incoming signal, the two equal frequencies being then fed to a balanced modulator. The resultant output then includes the "difference frequency" (which is zero and is, in consequence, a DC voltage) and the frequency differences between the local oscillator and the sidebands of the carrier, which frequencies are an exact replica of the original AF modulation applied at the transmitter. These difference frequencies may then be applied, as AF, direct to a subsequent AF amplifier.

It will be apparent that the outstanding advantage of the Synchrodyne lies in the fact



A synchrodyne local station receiver

that no tuned circuits are needed, either before or after the frequency-changing stage, to contribute towards the selectivity of the receiver. Indeed, the only selective device is the subsequent AF amplifier itself, whose frequency response governs what side-bands will eventually actuate the loudspeaker. Thus, "sharp selectivity" may be obtained when desired entirely by operation of the amplifier tone controls!

In consequence of these points, the Synchrodyne offers itself as a unique receiver capable of selecting a carrier pass-band whose width can be controlled simply and accurately by AF filters. As such, it may be employed for conditions which require a high degree of selectivity, or which require a high degree of fidelity of reproduction. It appears that the latter is, at present, the most popular application.

(The above description of the Synchrodyne is somewhat simplified and touches only on the major points of its operation. Readers who require more detailed information may care to study the references given at the end of the article.)

The Circuit

This month's circuit illustrates an experimental high-fidelity Synchrodyne tuner which should give useful results on medium waves under the conditions to be expected in many parts of the U.K. It is intended for local station reception only, in areas where signal strength is high. It will require a good outside aerial to ensure sufficient signal pick-up. The writer wishes to emphasise that this is an experimental circuit only, and that resultant performance can in no way be guaranteed.

Considering the circuit itself, it appears to be customary in Synchrodyne receivers to employ one or two stages of RF amplification before the modulator in order to ensure that sufficient RF energy is available for this part of the circuit. Unfortunately, it is essential that such RF stages be perfectly linear in performance, or intermodulation between the required and other signals is likely to take place, with consequent distortion. Because of this, such RF stages as are fitted to Synchrodyne receivers have to be provided with heavy negative feedback loops. As, also, Synchrodyne RF stages are usually required to pass a very wide band of frequencies, the gain provided is not large. In the U.K., where many areas are served at high signal strength, it appears doubtful whether RF stages are worth the added complications, No RF amplification is used in the circuit shown here.

The incoming aerial signal is fed to the tuned circuit L1, C1 (or C2). This tuned circuit is very heavily damped by the potentiometer R1 and, in consequence, passes a very wide band of frequencies around that required. The proportion of the aerial signal which is tapped off by the slider of R1 is then applied to the grid of the cathode-follower V1, and, thence, to R3 and R4 (effectively in parallel). The voltage across R4 is next applied, *via* R5, to two arms of the modulator.

At the same time, the voltage appearing across R1 is applied to the grid of a second cathode-follower, V2 (a). A proportion of the output of this valve is then tapped off by R9 and passed to the oscillator V2 (b).

V2 (b) functions as a conventional tuned grid oscillator, the circuit constants of which result in somewhat unstable frequency control. It is, in consequence, easily capable of being synchronised by the voltage injected into its cathode circuit from R9. A tertiary winding on the oscillator coil feeds the oscillator frequency to the two unused arms of the modulator. The oscillatory voltage across the tertiary winding should be approximately 1 volt. The AF output from the modulator is then passed to the RF decoupling circuit R6, R7, C5, C6 and, thence, to the subsequent AF amplifier.

Operation

The operation of the receiver is somewhat complex. For this reason it is recommended that continuously variable tuning be dispensed with; spot frequencies being selected by the switches S1 and S2.

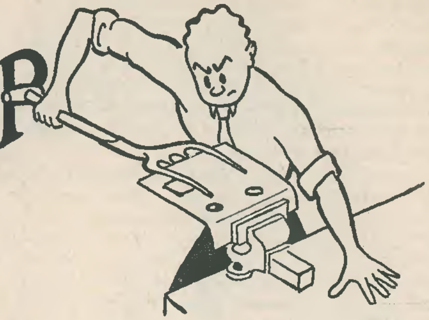
To commence with, the tuning condenser (or trimmer) switched in by S1 should be set approximately to the position required for the station it is desired to receive. R1 should then be set to its maximum and R9 to its minimum position. R10 should next be temporarily short-circuited and the tuning condenser (or trimmer) selected by S2 adjusted until a heterodyne beat note with the required signal is heard. The short-circuit across R10 should then be removed and the sync control R9 advanced until the oscillator locks with the incoming carrier. The final adjustment is that at which the oscillator is *just* synchronised by R9. All that remains is to finally adjust R1 and the aerial tuning condenser (switched in by S1) for best results. The receiver is then tuned in.

It is possible that, due to the presence of R10, the oscillator will not function in the absence of a synchronising signal, but this need not be essentially a disadvantage. In cases where the optimum sync control position is at the lower end of its travel, a fixed resistor (value between 50 and 500Ω) should be inserted between its slider and C9.

References:

1. *Electronic Engineering*, March 1947.
2. *Wireless World*, August 1948.
3. *Radio and Electrical Review*, September, October, 1954 (P.O. Box 8022, Wellington, N.Z.).

IN YOUR WORKSHOP



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

Readers of my contribution to last month's issue of the *The Radio Constructor* may remember that, in this, I waxed eloquent on the subject of aerial coupling coils and circuitry. Unfortunately, the space available did not allow me to complete the discussion by carrying on to short-wave aerial coupling coils, and so this subject had to be left over until this month.

Serious or Sales-Point?

As most readers will be aware, the short-wave aerial coil systems fitted these days to the average domestic receiver are, to put it mildly, by no means as efficient as they could be. In quite a few cases, indeed, short-wave coil systems are included merely to provide an additional sales-point. Whilst they are obviously bound to work in some sort of fashion, such coil systems offer little attraction to anyone who is interested in serious short-wave listening.

The trouble behind this situation is, of course, the old story of consumer-resistance. In just the same way as many set-owners do not feel that they have had real value for their money unless the output from their receivers contains plenty of over-accentuated bass and "woomph," so also does the average listener consider that no sound receiver (apart from a midget) is worth-while unless it is "all-wave."

Because of this universally held opinion, the manufacturer of a sound receiver is practically compelled to include a short-wave band if he hopes to sell the set at all. At the same time he fully realizes that the set, if used in the United Kingdom, will probably never be switched to the short-wave band from one year's end to the other. He overcomes this problem, on his more inexpensive models at any rate, by fitting the cheapest short-wave circuits and components he can reasonably expect to get away with; usually settling for an arrangement which provides a high transference of signal power from the aerial system to the grid of the first valve in the receiver, appreciable damping of the aerial tuned circuit, and lack of selectivity with consequently heavy second-channel interference. It is true enough that one can tune in a fair number of distant stations on a receiver fitted with a short-wave range of this type, but one is lucky if the majority of these stations do not suffer from heavy second-channel whistles.

Of course, the above remarks by no means apply to all manufacturers. Some manufacturers, indeed, are particularly well-known for the fact that the short-wave ranges fitted to their sets (including the lowest-priced models) give excellent results; sufficient care having been taken in initial design to ensure that this point is met.

Q and Second-Channel

As occurs on medium and long-waves, one of the greatest difficulties in short-wave aerial coil design consists of reconciling the two opposing requirements of high selectivity and high signal transfer from the aerial system. If the receiver has one or more RF stages the difficulty is reduced considerably, since the more selective circuits may then be those fed by the RF anodes. However, if the receiver has no RF stage at all, as occurs with the conventional superhet, some considerable care in design has to be exercised if good results are to be expected.

In such an instance, probably the best solution consists of incorporating a fairly loose coupling between the aerial and the aerial coil. This course does not essentially allow the reception of a large number of stations with a picture-rail aerial, but it does enable the more serious listener who is prepared to fit an efficient aerial to take advantage of a signal tuned circuit which is not, in consequence, heavily damped. If made carefully, such a tuned circuit may then have quite a high value of Q and give good second-channel rejection.

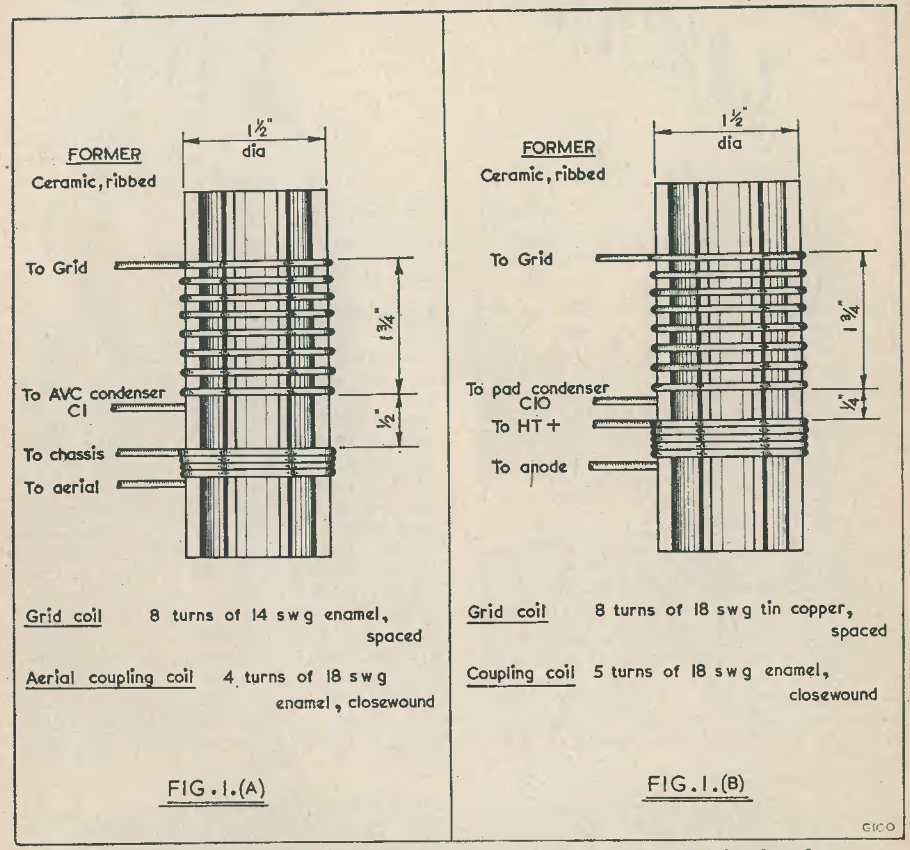


Fig. 1 (a) *Short-wave aerial coil designed for high selectivity and freedom from second-channel interference.*
(b) *An oscillator coil suitable for use with the aerial coil.*

It is possible to obtain a reasonable idea of the Q values needed for good second-channel rejection by considering one of the fundamental expressions involving selectivity.[1] This is

$$\frac{A_o}{A} = \sqrt{1 + Q^2\left(\frac{f}{f_o} - \frac{f_o}{f}\right)^2}$$

where Ao is the voltage gain at the resonant frequency fo, and A the gain at frequency f.

We can use this formula to advantage here in the typical case of a superhet employing 465 kc/s IF's; and with which we wish to receive a desired signal at, say, 10 Mc/s (more or less in the middle of the conventional short-wave band) and prevent second-channel interference from a signal on 10.93 Mc/s (twice the IF above). The table accompanying this article gives the voltage ratios obtainable under this set of circumstances for different values of tuned circuit Q.

The figures given in the table are of interest because they give a good guide to what one can expect from one's own home-constructed coils. As is to be expected from the expression, the voltage ratio between required and second-channel signal is nearly proportional to the Q of the tuned circuit. Thus, if we double Q we very nearly double the voltage ratio between the wanted and unwanted signals.

I should imagine that, at this point, one or two readers might be deciding that it is all very well to juggle around with a few figures and show what marvellous results one can get from theoretical examples, but where does all this lead to in practice? Where, for instance, can the home-constructor dig out a short-wave aerial coil whose Q factor is as high as 250, or even 300?

The answer to that question is given in the article which started this coil discussion rolling.[2] In that article I made a simple coil with 10 turns of 18 swg enamelled wire (diameter 1¾ inches, length 1¼ inches), and checked it on a Q-meter. The Q at 400 pF tuning capacity was 235; and at 100 pF, 240. If I had used thicker wire, say 14 swg, I feel certain that I could have brought the Q factor well over the 250 mark. So a high-Q short-wave coil is not so difficult to obtain as may at first sight appear.

Looking at the reverse side of the picture, I also at that time checked a short-wave aerial coil typical of those used in some commercial receivers. Its Q factor never rose above 70 over the entire tuning range!

It is also of interest to check the figures given in the table against those specified in the performance data for commercial communications receivers. One typical well-known American receiver, for instance, has an image rejection ratio that is better than 30 db at all points in its coverage. So if we can possibly get as good an image rejection as this with a single aerial coil we wouldn't be doing too badly at all!

A Practical Example

In practice, however, a performance of this nature might not be too easy to realize. This is due to the fact that, whilst the coil itself can easily be made to have a high value of Q, there is the necessity of having to fit waveband switching, with consequently long leads and switch contact losses. Nevertheless, by using a good-quality switch and employing a careful layout, it should be possible to keep losses reasonably low. The tuning condenser, if of good manufacture, should introduce few losses.

Fig. 1 (a) gives details of a very simple high-Q short-wave aerial coil suitable for covering 5 to 15 Mc/s with a 500 pF tuning condenser. This is a practicable coil and I can vouch for its efficiency, It is, in fact, a coil I used in a superhet I knocked up during the war and which gave me excellent short-wave reception.

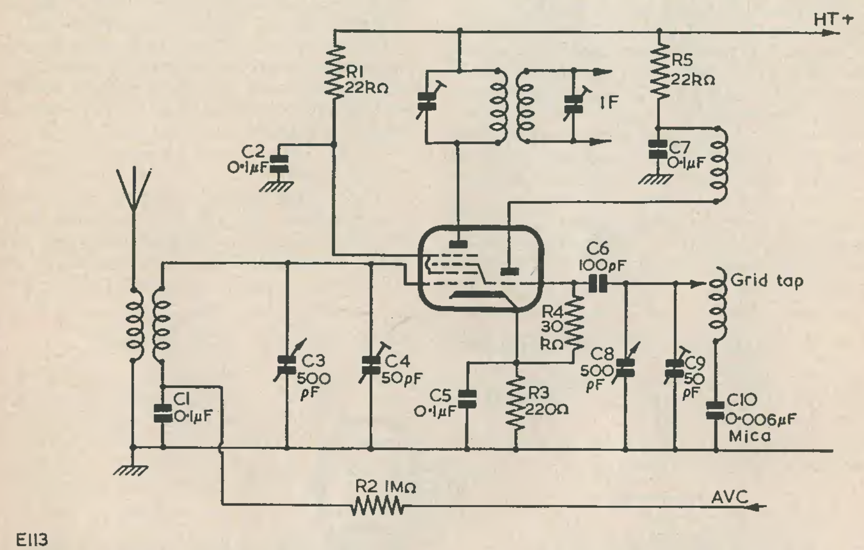


Fig. 2. The circuit in which the two coils were used by J.R.D. The frequency-changer was a 6K8, but this may be replaced by a more modern type, if desired

Table showing image rejection ratios against Q of a single aerial tuned circuit at 10 Mc/s (IF=465 kc/s).

Ω	*Voltage Ratio*	*db Difference*
50	8.93	19
100	17.8	25
150	26.6	28.5
200	35.5	31
250	44.4	33
300	53.3	34.5

The requisite oscillator coil is illustrated in Fig. 1 (b). This is very similar to the aerial coil, with the exception that the grid coil is wound with thinner, tinned copper, wire. The reason for this choice of wire is that a very high value of Q is not quite so essential for the oscillator coil, and the use of tinned wire enables a tap to be made into it for accurate tracking.

In the particular superhet in which these coils were used, the aerial coil was mounted vertically above the chassis and the oscillator coil horizontally below. There was no switching, the coils being connected directly to the tuning condenser. The circuit of the frequency-changer was quite conventional and is given in Fig. 2.

However, the aerial coil was so selective that, to ensure really perfect tracking, final adjustments had to be made to the tuning condenser end-vanes. This process was carried out by primarily setting the trimmers at the high frequency end of the band to optimum capacity. The tuning condenser was then advanced until the first split section of the end-vanes engaged with the fixed vanes. Working from the indications given by the trimmers, either the signal or the oscillator end-vane was then bent out until the resultant trimmer positions were the same as those required at minimum tuning capacity. The condenser was then advanced until the second end-vane was engaged whereupon the process was repeated. None of the end-vanes needed to be bent through more than a sixteenth of an inch, so the whole procedure was not really as fiddling as it may sound.

The result was a short-wave receiver which was almost entirely free from second-channel interference, and which certainly knocked spots off any commercial four-plus-one in the neighbourhood!

Little Horror

One of the horrors that is occasionally perpetrated in the name of radio came into my workshop the other day for repair. This was a midget superhet in which every conceivable component that could be dispensed

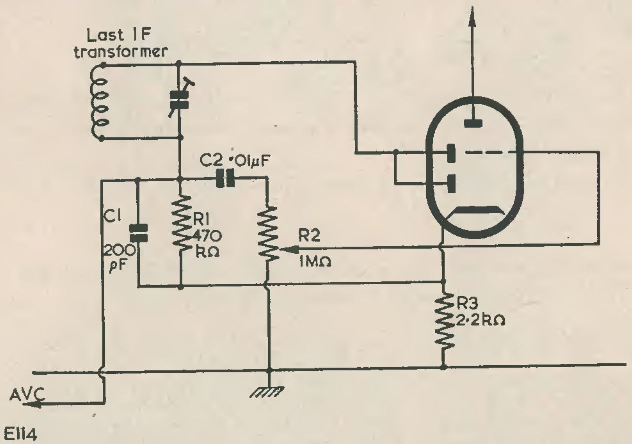


Fig. 3. A commercial second detector stage whose shortcomings are discussed in the text.

Getting the coils lined up was not too difficult, although a signal generator was necessary. The first step consisted of obtaining the correct tap into the oscillator coil for good tracking. The best position was found by trial and error, the optimum spot being that at which both trimmers were set for half-capacity near the low frequency end of the band. The coils then tracked excellently.

with had been omitted by the manufacturer; and which generated a comfortable 75 watts of heat (dropper, heaters, HT current, *et al*) inside a plastic case that fitted without half-an-inch to spare. Three "live" chassis-mounting bolt heads, "insulated" optimistically by rubber recessed washers and projecting from the underside of the cabinet, completed the picture.

The faults were the sort of thing to be expected from a receiver of this nature after it has been in use for some four or five years: intermittent crackles and instability, hum, and distortion. A further interesting point was given by the fact that it was impossible to turn the volume down completely. At minimum volume settings the output, when the set was tuned to a local station, was still sufficient to be annoyingly loud in a quiet room.

The first few faults were routine. In the miniature oven represented by the receiver the loudspeaker cone material had become hard and brittle, and it was impossible to centre the voice coil accurately. The only cure was a new loudspeaker. The hum was, of course, caused by absence of capacity in the HT electrolytics, these having almost literally been boiled dry! The intermittent crackles and instability were the result of bad design; since the earthing solder tags in the receiver were eyeletted to the chassis, which was made of soft aluminium. It is impossible to ensure a good continual contact when eyeletting to aluminium, owing to the softness of the metal and its readiness to oxidise. The cure for this snag consisted of mounting new solder tags close to the eyeletted tags and bonding them together. The new tags were held by 6-BA nuts and bolts, using shakeproof washers.

All that remained was the fault given by the impossibility of reducing volume to a minimum. However, a little prodding with one of my favourite items of service gear (an 8 μF, 500 WV, paper condenser fitted with test leads) soon brought the trouble to light.

Fig. 3 shows the circuit employed at the double-diode-triode. This is conventional enough, save that the resistor R1 would have been better at half its value. The fault was caused by the un-bypassed resistor R3; and a 12 μF 12 WV electrolytic condenser connected across this component soon cleared the trouble. (The bypass condenser had been omitted by the makers). The reason for the trouble was probably due to the fact that, on strong signals, sufficient IF voltage appeared across R3 to overcome the effective delay voltage between grid and cathode, whereupon these two electrodes functioned as a diode and detected the signal. However, I wouldn't like to be too positive about this, since the receiver was so squashed-up on its chassis that stray IF linkages could have occurred at any point around the double-diode-triode. Perhaps one or two readers may have an alternative theory.

References:

1. F. Langford-Smith, Radio Designer's Handbook, 4th edition, p. 412.
2. "In Your Workshop," October 1954.

BAND III TEST TRANSMISSIONS IN APRIL

Belling and Lee Limited working in close co-operation with the industry and the I.T.A., are to be given permission by the G.P.O. to radiate a 1kW, Band III, Channel 9, vertically-polorised vision signal such as a test pattern.

The signal which is designed to be of assistance to manufacturers and the industry, will be radiated on approx. 194·75 Mc/s from a temporary mast on the I.T.A. site near Croydon. It is expected that transmissions will start about 1st April.

World Radio Handbook, 1955

We apologise to those readers who have ordered copies of this publication from us for the delay in delivery.

This book, which is published in Denmark, was held up in the Customs since before Christmas. Supplies are now available, and all outstanding orders have been despatched.

Radio Amateur Operator's Handbook

We are out of stock of this publication at the moment. The contents are now being completely revised and brought up to date, and printing will commence as soon as this has been completed. An announcement will be made in these pages as soon as supplies are available.

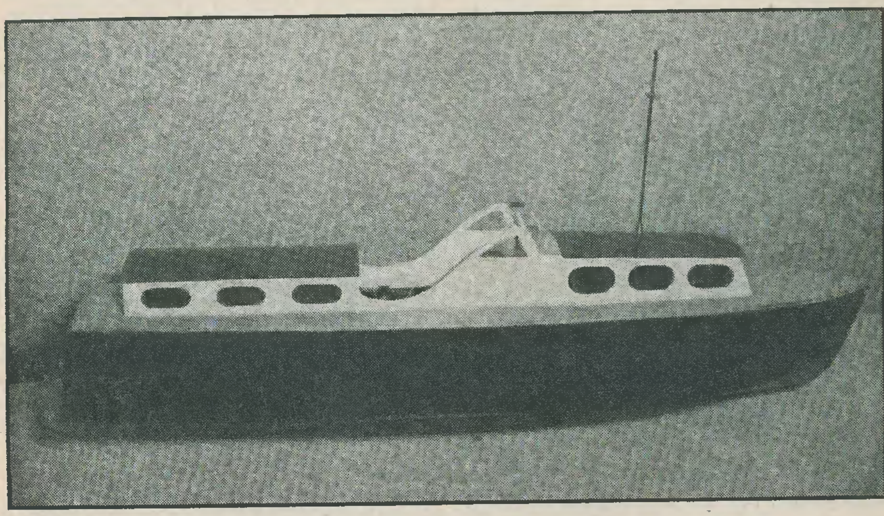
RADIO AMATEUR HONOURED

It is with great pleasure that we record that Ald. John Clarricoats, G6CL, has been appointed an Officer of the Order of the British Empire.

Mr. Clarricoats has recently completed 25 years' service with the Radio Society of Great Britain, of which he is the General Secretary. In this connection, the retiring President, Mr. A. O. Milne, G2MI, presented him with a cheque which had been subscribed to by members of the Society.

A further honour recently bestowed on Mr. Clarricoats was the award of the Society's "Calcutta Key" Trophy for 1954 for outstanding service to the cause of International Friendship through the medium of Amateur Radio.

NOTES ON RADIO CONTROL



4: INSTALLATION IN THE MODEL

By **QUENCH COIL**

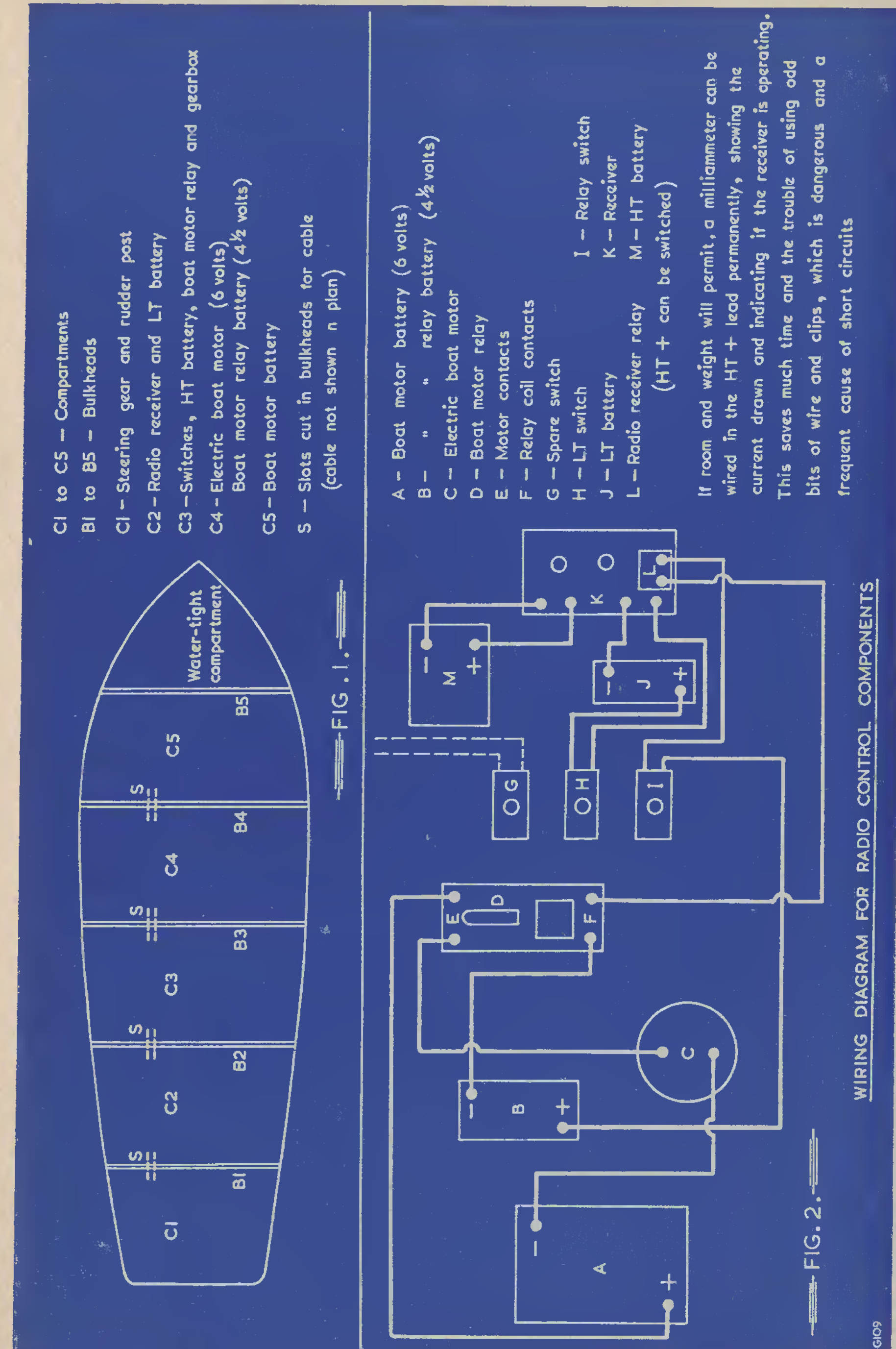
THE INSTALLATION OF THE RADIO CONTROL equipment in the model is one of the most important factors in ensuring a successful model, and a good deal of consideration should be given to it before making a start. Shoddy work will result in poor operation, with the possible loss of the model. No two models are alike, and it will be found that what suits one will not suit another. It is therefore impossible to make hard and fast rules. One can, however, lay down broad principles.

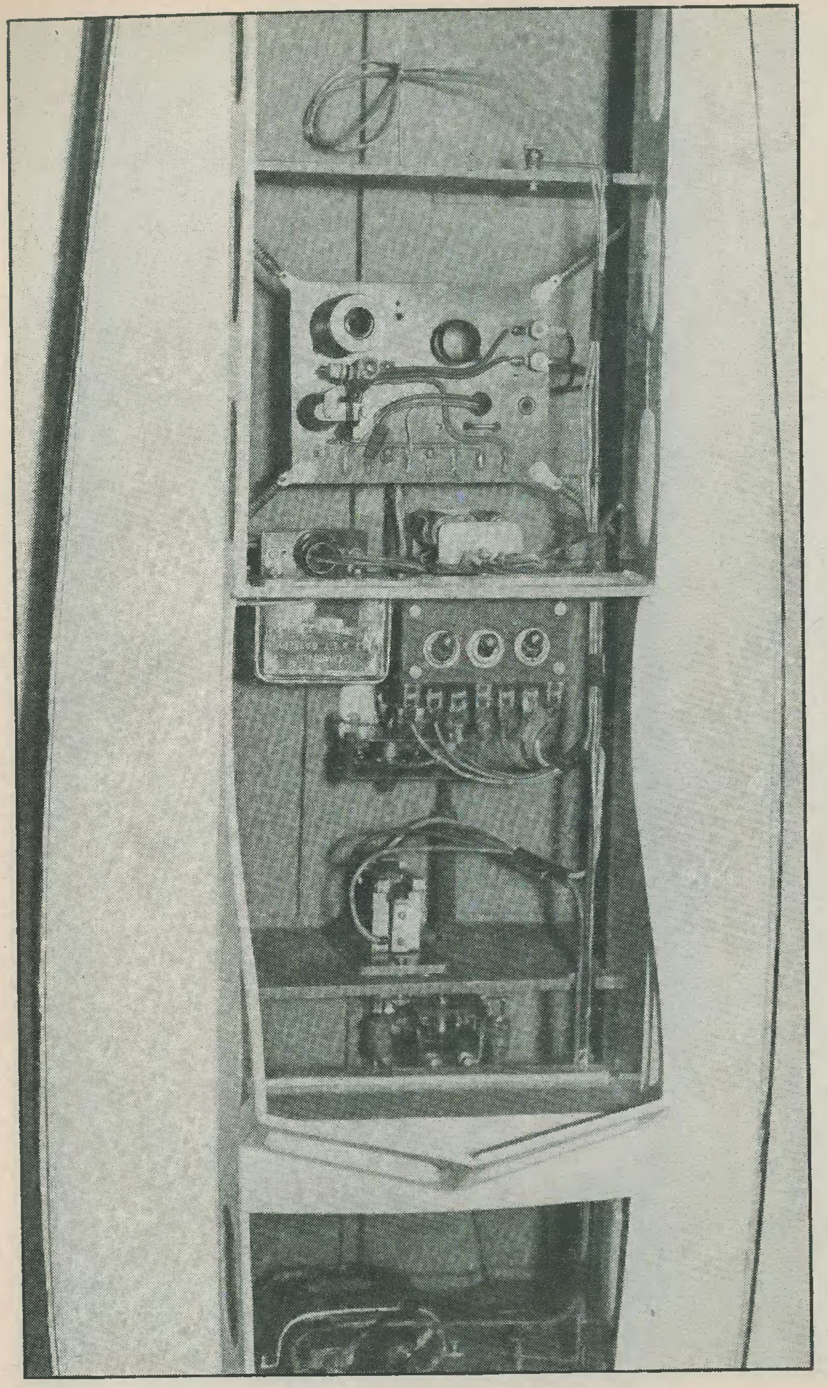
The writer specialises in the construction and operation of radio controlled model ships, and this article will therefore deal mainly with this type of model. All the same, the advice given herein does apply to all types of radio controlled models.

First of all, plan the installation so that every item of equipment can be easily removed for servicing, alterations, etc. The method of fixing should be such as to allow ease of removal—small bolts with terminal tops being used in the writer's case. Connection of leads to the various units should be by plugs and sockets, so that disconnections can be easily made when units have to be removed. The radio receiver itself should be put in such a position that it will not get wet when the model is at speed in rough water. For this reason, in the writer's model the receiver is fitted in the stern compartment of the boat, small springs being used to sling it from suitably placed hooks screwed into the bulkheads. Group all wires together into the form of a cable which can run along the boat as shown in the photograph and in Fig. 1. The latter also shows a suggested division of the boat into compartments. Wire up with coloured wire, making a note of each wire connection on a small card, which should be kept in the model for future reference.

It is a good plan to fix the various units, batteries, etc., in temporarily to start with, and then check the model for balance in the water. Once the best position for the various items has been ascertained, permanent fixing can be effected. Where wires have to be soldered to soldering tags, it is a good plan to slip a length of sleeving over the wire and tag to prevent bending at the point of connection. Batteries should never be soldered direct to the receiver; small

The title illustration shows a cabin cruiser 36" long. This type of model is ideal for radio control.





Layout in boat, showing left to right: Relay battery; electric motor; motor relay, switches, HT battery, gear-box; LT battery, battery plug, receiver (note suspension springs).

two- or four-pin plugs and sockets should be used. This enables the batteries and receiver to be removed with ease for service, etc. At no time should a temporary hook-up of wires be made, particularly when making test runs on the water. The writer has seen many models stranded through this practice.

Earthing

A small brass plate should be fitted to the hull, at a point which is always under water. To this, a wire from the LT negative is connected. The propulsion motor, rudder control gear, prop. shaft, etc., should also be bonded together and connected to the earthing plate. The propulsion motor should be connected to the prop. shaft by some form of insulated coupling. If the shaft is of the pin and crank type, slip a length of sleeving over the pin, to insulate it. This will avoid an erratic earth connection being formed via the propeller. Similarly, rudder control escapements should be insulated from the metal rudder. Alternatively, earth all metal objects such as rudder, rudder escapement, etc., bonding them together and connecting to the earth plate. It may be well to do this in any case, insulating the motor—prop. shaft coupling, and the rudder shaft—control mechanism coupling as well. This should effectively eliminate the trying erratic interference which frequently occurs through faulty earthing via rudder and propeller.

Electrical Interference Suppression

The propulsion motor should be smoothed by a 0.1μF condenser fitted from each brush holder to the frame of the motor. A spark suppressor must be fitted to the radio receiver relay. This should consist of a 0.1μF condenser and a 100 ohm resistor in series, connected across the operating contacts. If a spark ignition engine is used, all wiring for the engine's electrical system must be kept clear of the radio equipment, aerial and battery wires. The ignition battery must not be placed in the same compartment as the radio batteries. If motor-operated servos are used, the motor must be smoothed in the same way as the propulsion motor.

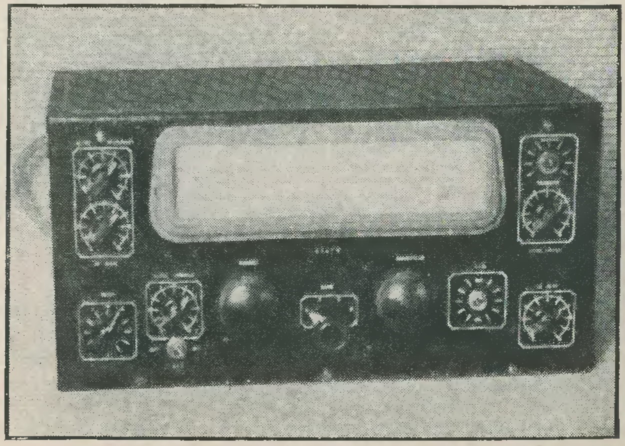
Layout

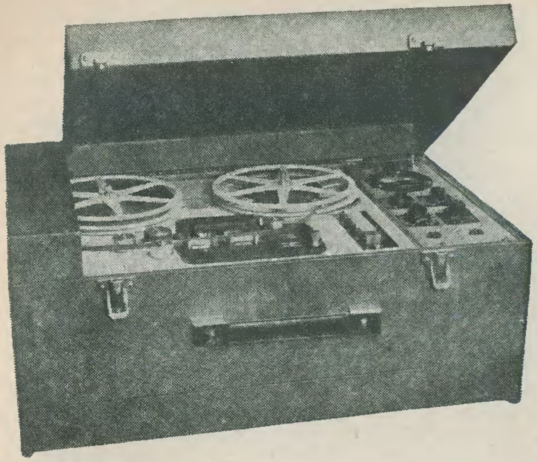
Careful planning and good layout are essential. Many of the types of models advertised have a cabin top and deck which is a fixture when the model is completed, the only access to the interior of the hull being via the cabin roof which is in the form of a lid. It is quite a job to drill holes and fit components after the cabin and deck have been fitted, so all wiring, etc., must be completed before this is done. When planning the layout of the various units, care must be taken to so position them that none of them become inaccessible when the deck and cabin structures are in place. Moreover, they should be so fixed that the balance of the hull is kept right. It is advisable in the first place to make them only a temporary fixture so that adjustments can be made if necessary.

Aerials

Some experimenting will be necessary to obtain the correct aerial length. In the model shown, an aerial 24″ long is used, running between the mast head and the flag staff. The aerial should be of silk covered wire and suspended by small insulators. Remember that final adjustments must be made with a full length of aerial on both the receiver and the transmitter.

The purchase of a National cabinet complete with chassis, coil pack, twin gang bandset and bandspread tuning condensers, dial and drives led to the building of this double superhet communications receiver by G2ATV. Ease of handling, as well as appearance, have been greatly improved by the use of Panel-Signs transfers





THE *Paragon* TAPE RECORDER

PART 2

By J. W. WALKER

Further details of this simple Tape Recorder, which has been designed expressly for the home-constructor

In last month's issue of the *Radio Constructor*, we introduced the Paragon and fully reviewed its circuit. We pass on in this month's article to the constructional details of this simple recorder.

The Cabinet

The prototype recorder was built into a tape recorder cabinet which can be purchased from H. L. Smith & Co. Ltd. of Edgware Road. This cabinet needs some slight modification to enable it to take the Paragon amplifier and Truvox tape-deck, but no high degree of skill in carpentry is needed for the process.

As supplied, the cabinet may be fitted with a panel covering a recess at its left hand side, above the speaker opening. This panel will interfere with the mounting of the Truvox tape-deck, and should be removed.

Running along the inside edge of the front and back of the cabinet are two battens. These battens will comfortably support the weight of the tape-deck motor-board, allowing it to take up a snug fit with its top surface lying flush with the top of the opened cabinet. The motor-board should be positioned such that its left hand edge bears against the left hand inside surface of the cabinet. As a result of this method of mounting, a small part of the motor-board lies below the built-up portion. The photograph above will assist in showing this point.

The two battens taking the weight of the tape-deck do not project sufficiently far into the cabinet to coincide with the four mounting holes drilled by the manufacturer in the motor-board. The motor-board may, therefore, be drilled in several places along its edge, enabling woodscrews to fix it to the battens. Alternatively, four small angle brackets may be fitted inside the cabinet to locate with the existing motor-board holes.

It is possible, with some cabinets, that the two supporting battens do not run to the extreme inside left hand wall. If this is the case, additional battens should be fitted, slightly lower than the existing ones. The reason for this is that, when finished, access to the underside of the motor-board will be obtained by tilting it up by its right hand edge. If there is then no support for the left hand edge the motor-board may slip too far and cause damage.

The speaker is mounted, on a baffle, at the left hand edge of the cabinet also; the baffle

Fig. 3. Details of the baffle board for the loudspeaker

Fig. 4. View of the back of the cabinet, showing the position of the on-off switch and the mains socket. Both are recessed

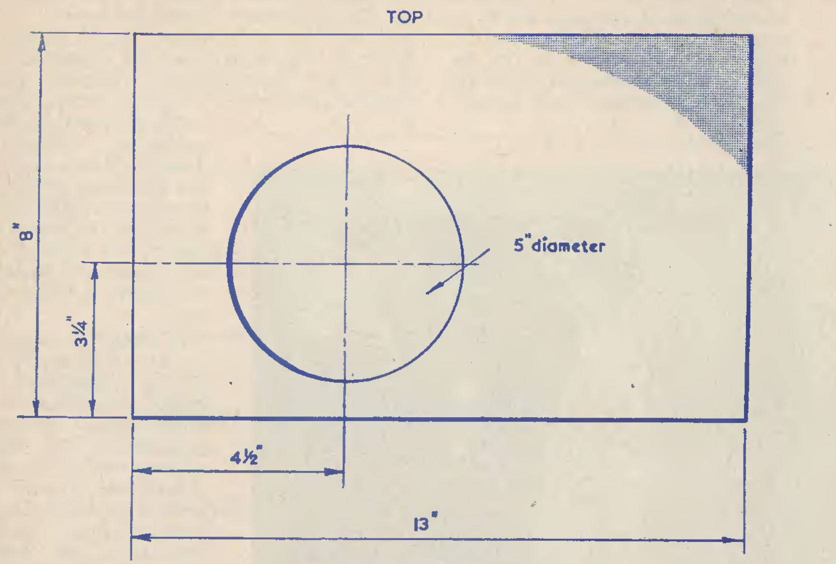


FIG. 3.

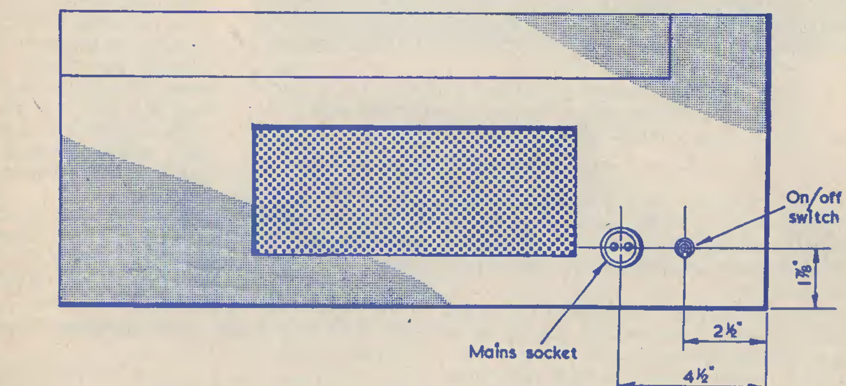
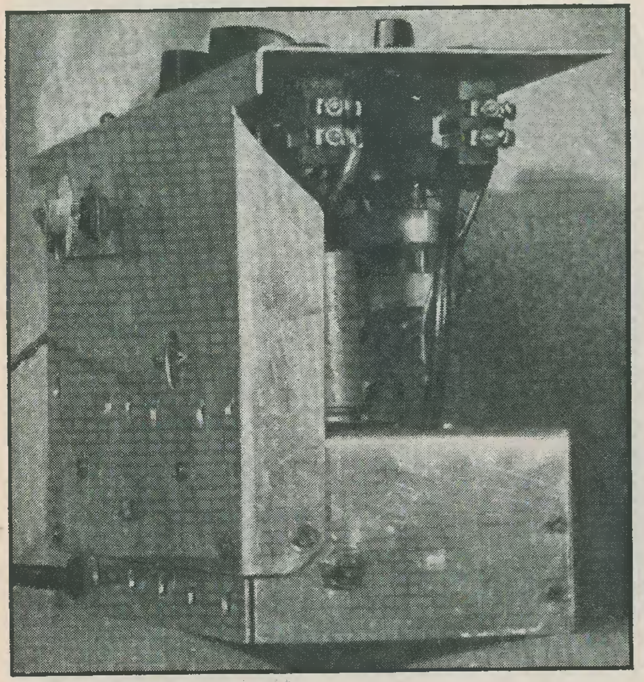


FIG. 4.

G101

being screwed to the inside of the speaker opening. The baffle may be made of three-ply, hardwood, or any similar material, and it should be cut to the dimensions shown in Fig. 3. As may be seen from this diagram, the speaker is off-set towards the front of the cabinet. This position is necessary in order to prevent its fouling the tape-deck motors.



Three-quarter view of finished Chassis.
Note ventilation holes along rear edge, and on side wall level with valve bases

It is recommended that a 6-inch Truvox "Wafer" speaker be used in this position, as the small back projection of this loudspeaker allows adequate clearance from the motors to be obtained.

Before the speaker is mounted, a check should be made to ensure that the top of its frame will clear the underside of the motor-board. To make certain that such a clearance occurs, the bottom of the speaker frame should bear against the inside bottom of the cabinet. Unfortunately, with some cabinets this may still not provide sufficient clearance, and it then becomes necessary to remove a small portion from the motor-board itself to allow for the top of the speaker frame.

The power pack is mounted on a small chassis fitted to the bottom of the cabinet. The position and dimensions of this chassis are discussed later in these articles.

At the back of the cabinet, in the position shown in Fig, 4, is fitted the mains on-off switch, S4. This should be mounted on a recessed sub-panel. Also fitted at this point is a Bulgin female mains connector. Neither of these items should project more than approximately one eighth of an inch from the rear surface of the cabinet, as they are otherwise liable to suffer damage in use.

It should be pointed out at this stage that it is not necessary to mount the switch and mains socket at this position if the constructor wishes to save himself the trouble of drilling the rather large holes required. As an alternative, the on-off switch can be mounted on the amplifier panel; the mains lead being taken out through a grommeted hole at its side, thereby allowing it to be coiled up inside the lid when the recorder is not in use. This second method has the disadvantages, however, of adding a further switch to a panel which already has plenty of controls; of introducing mains leads, and possible hum, to the amplifier; and of complicating the wiring between individual parts of the recorder.

The amplifier chassis is mounted to the right of the tape-deck motor-board. There are two raised runners on the inside of the cabinet which may then be used to support

Fig 5. The first part of the amplifier chassis before bending.

Fig. 6. How the first part of the chassis appears after bending.

Fig. 7. The second part of the chassis before bending.

Fig. 8. The second part after bending.

Fig. 9. How the two parts of the chassis fit together.

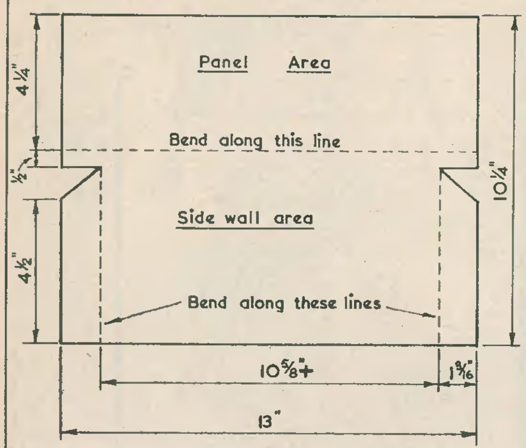


FIG.5.

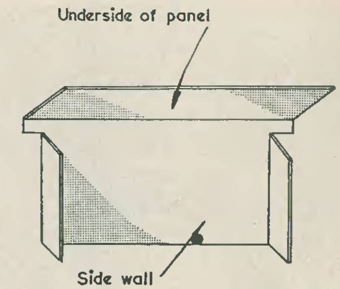


FIG.6.

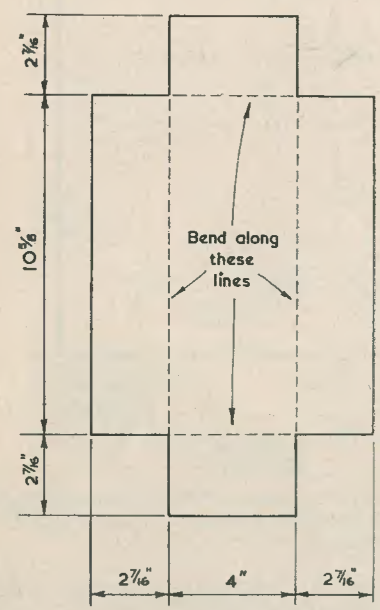


FIG.7.

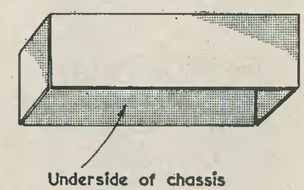
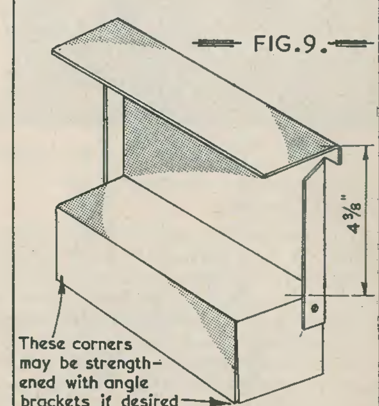


FIG.8.

FIG.9.



G102

the two ends of the amplifier panel. When positioned in this manner, the top surface of the panel will lie flush with that of the tape-deck motor-board.

Although this hum pick-up is very low, the possibility of its presence represents a potential annoyance. It may be cleared very simply by lining the inside of the cabinet at the

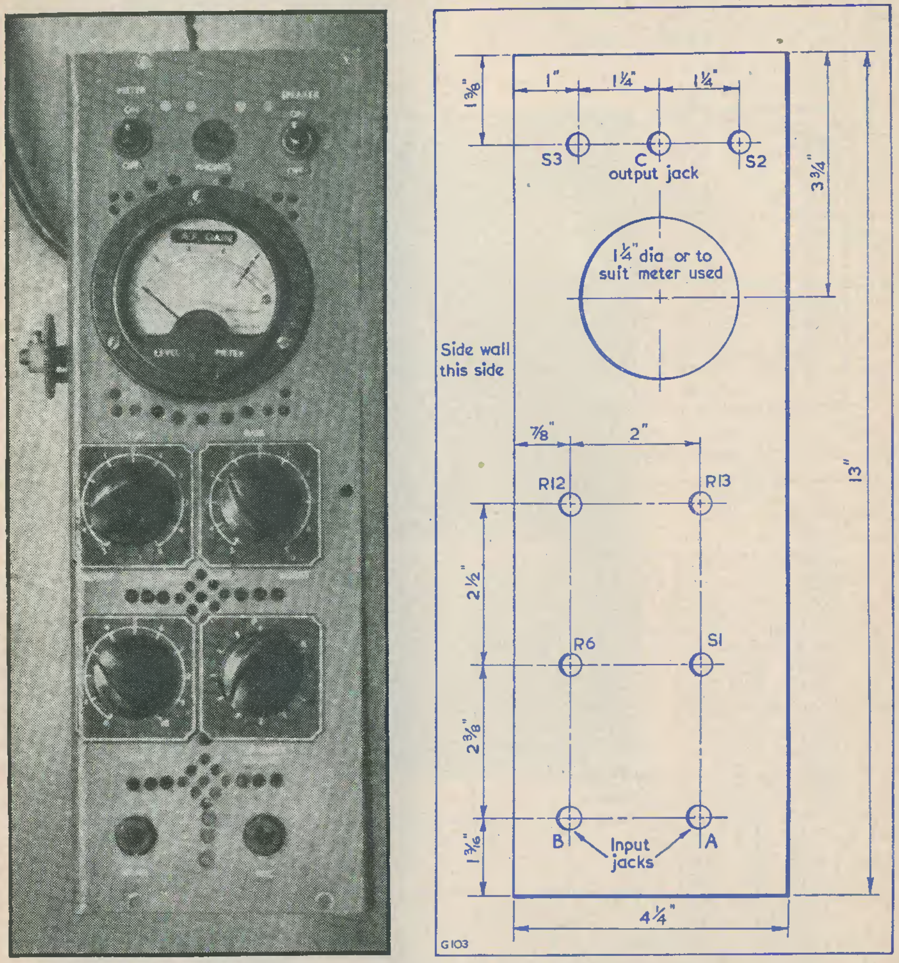


Fig. 10. The positions of the various panel controls.

Cabinet Screening

It is worth-while mentioning at this point that if the recorder is to be used in localities where there is a high ambient level of hum (viz. in rooms or houses where mains wiring is unscreened) it would be of advantage to fit additional screening to the inside of the cabinet at the amplifier end. If this is not done it is possible for a slight amount of hum to be picked up if the operator's hand closely approaches the right hand side of the cabinet.

Fig. 11. Showing the position of the various components mounted on the side-wall of the chassis.

Fig. 12. Drilling centres and layout of the more important components of the lower chassis.

Fig. 13. Under-chassis layout. The holes in the chassis for the passage of leads should be fitted with grommets.

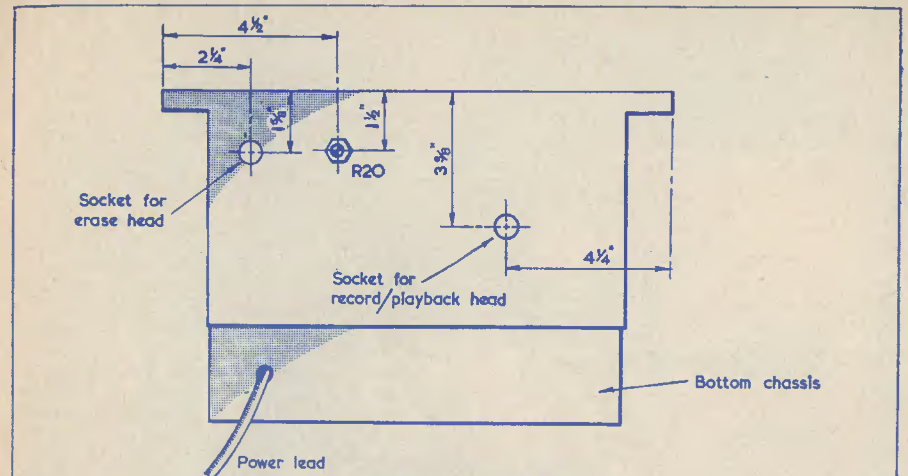


FIG. 11.

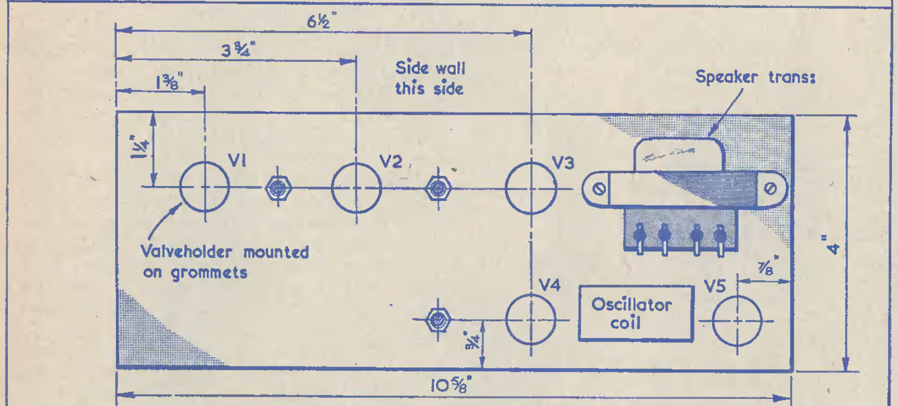


FIG. 12.

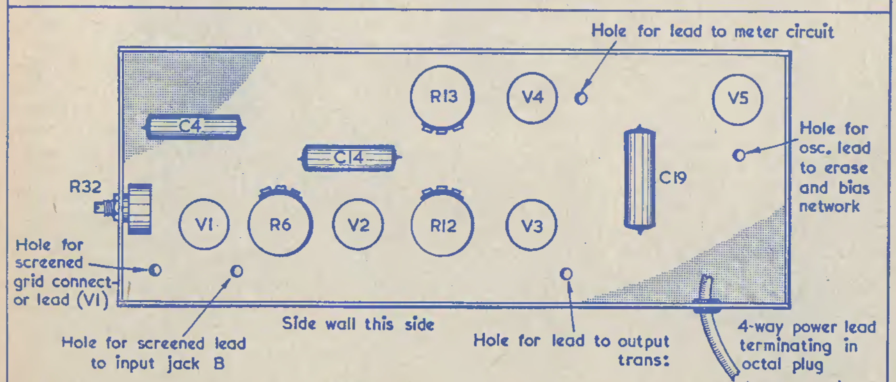


FIG. 13.

amplifier end with metal foil, the foil being connected to the amplifier chassis at any point. An alternative to the foil would be given by close wire mesh or even by several coats of conductive aluminium paint. If the latter is used, an earth contact should be made to it at several points.

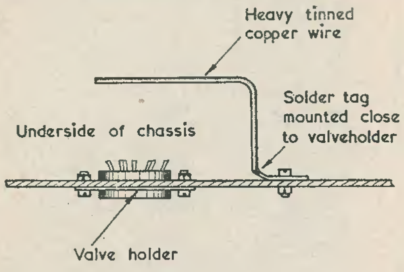


FIG.14. G105

Fig. 14. *A suitable method of fitting individual earthing bus-bars for each valveholder.*

The Amplifier

As may be imagined, the building of the amplifier represents the major part of the constructional work involved in the recorder.

The amplifier chassis is made up in two parts. The dimensions of one section, constituting the panel and side-wall of the amplifier, are shown, before bending and drilling, in Fig. 5. After bending, this section takes up the shape illustrated in Fig. 6. The other part of the amplifier chassis is that on which the main components and valves are mounted. Before bending and drilling, this has the dimensions shown in Fig. 7. After bending it takes up the shape of Fig. 8.

The two parts of the chassis then fit together as illustrated in Fig. 9. To ensure that the whole amplifier assembly is rigid, two bolts are needed at either end (one is shown in Fig. 9). Four more bolts, equally-spaced (not shown in Fig. 9), then secure the side-wall to the longer edge of the bottom chassis. Small angle brackets may be screwed to the insides of the two chassis corners designated in the diagram to provide additional strength, if desired; but they are not essential. The distance between the underside of the panel and the top surface of the bottom chassis should be $4\frac{3}{8}$ inches.

The whole assembly should be made from fairly heavy aluminium sheet; 14 swg would be quite adequate.

The Panel

After cutting out the two sections of the amplifier chassis, the next step consists of drilling out the panel. Some constructors may, of course, prefer to carry out this operation before bending.

The mounting centres for the various panel controls and jacks are illustrated in Fig. 10. It should be pointed out that the three potentiometers controlled from the front panel are not, themselves, fitted to this part of the assembly but to the chassis underneath. Their spindles, extended, then pass through the panel. To prevent side-play, it is worth while fitted $\frac{1}{4}$-inch bushes to the holes in the panel through which these extended spindles pass. Suitable bushes may be purchased for this purpose. They may also be available in most workshops by removal from discarded volume controls, etc.

A panel hole for the volume level indicator meter is also shown in Fig. 10. The meter used in the prototype is a standard surplus item which is available from many sources. Nevertheless, the constructor should check for certain that the meter he obtains will fit the panel hole correctly before finally cutting out the hole.

In the prototype, a number of $\frac{1}{4}$-inch holes were drilled in the panel to allow air circulation to the chassis underneath. These holes are really essential to allow adequate ventilation, since there is otherwise no escape for the considerable heat generated by the valves mounted underneath.

The holes needed for the woodscrews which mount the panel to the battens in the cabinet are not shown in Fig. 10, as the battens may not be standard for different cabinets. Two small holes at either end of the panel (four holes in all), drilled to coincide with the battens, will be adequate for the purposes required here.

Two sockets and a pre-set potentiometer (R 20) are mounted on the side-wall of the top section of the chassis. Their centres are shown in Fig. 11. The sockets are intended for the screened leads from the two tape-deck heads. Miniature screened plugs and sockets were used in the prototype.

The second part of the amplifier chassis holds the valves, speaker transformer, and oscillator coil. Valveholder centres are shown in Fig. 12, together with outlines of the speaker transformer and the can of the oscillator coil. Dimensioned centres for the three potentiometers controlled through the top panel are not shown as, to ensure accuracy, it is simpler to mark these out by using the top panel as a template.

It should be noted at this point that the valveholder for V1 is mounted on grommets

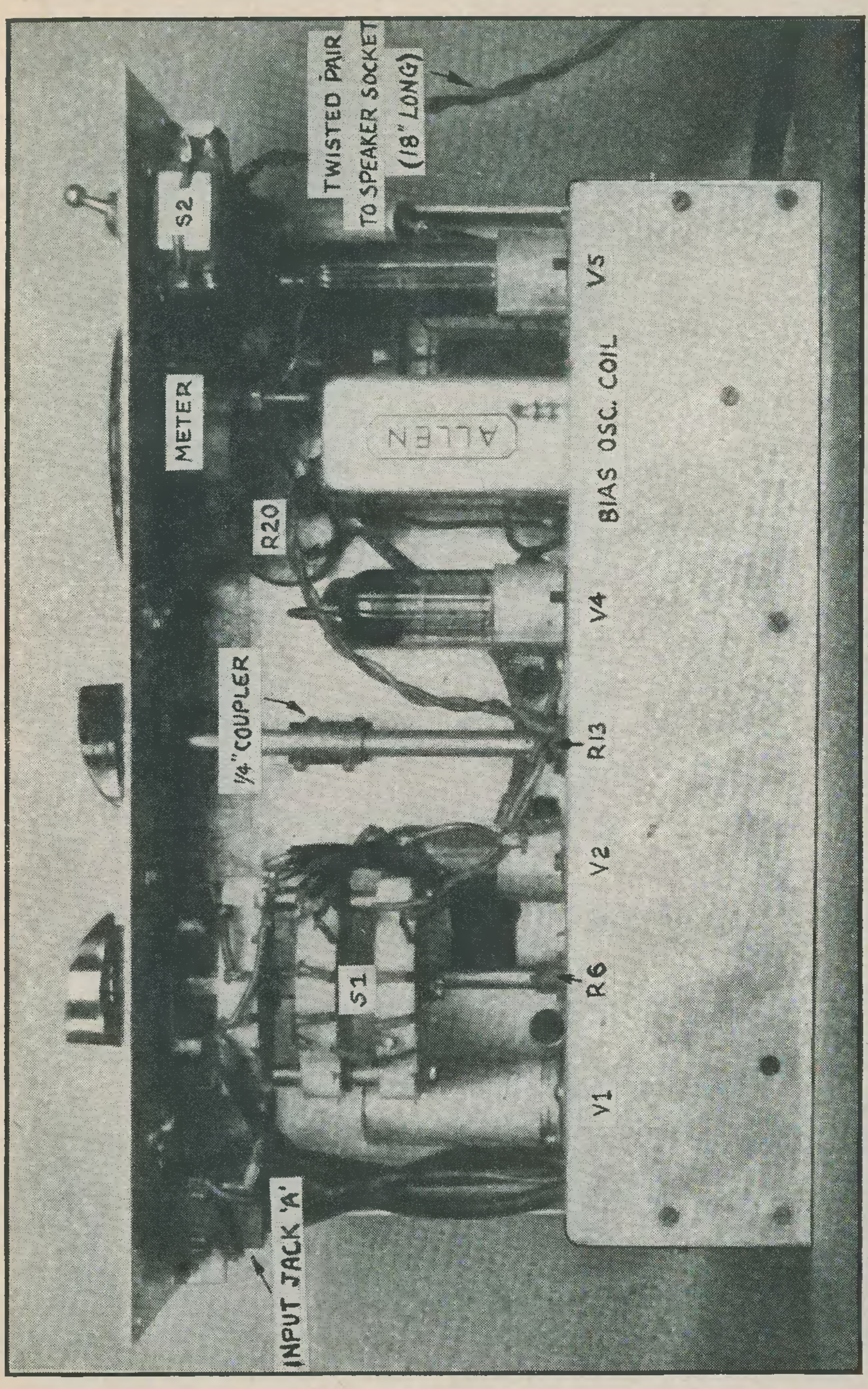


Fig. 15. *Side-view showing principal components between the panel and the lower chassis.* V3 (*behind* V4), *and the spindle of* R12 (*behind that of* R13) *are not shown.*

to prevent microphony. Since V1 is fitted with a screening can, it is necessary for the metal-work of this valveholder to be connected to chassis *via* a flexible connecting lead.

Wiring

A complete under-chassis wiring diagram is not practicable in a series of articles of this type. Nor is it really essential, since wiring is quite straightforward and the normal common-sense rules apply. However, it is considered that a layout of the principal under-chassis components would be of assistance, and this is given in Fig. 13. Fig. 13 shows, also, the 4-way power lead which connects to the power pack fitted in the cabinet. This lead is terminated at the power pack by an octal-type plug.

As the chassis is rather deep, and as single-point earth connections are advisable, it is a good plan to provide individual earthing bus-bars at the valveholders of V1, V2 and V5. A simple method of fitting such bus-bars is shown in Fig. 14. The bus-bars should be connected to chassis at one end only, since otherwise, they could form a loop and introduce induced hum into the amplifier.

Fig. 15 shows the main components which appear between the panel and the lower part of the chassis. It should be noted that a twin flexible lead is connected to the contacts of Output Jack C. This flexible lead connects to the loudspeaker and terminates in a plug. The appropriate socket is mounted in the cabinet.

Volume Level Indicator

Since the first issue of the Paragon Tape Recorder went to press, the writer has been informed by component suppliers that 0–1 mA meters for the volume level indicator circuit are becoming rather difficult to obtain.

As readers may be aware, the instrument specified is an ex-Government item and is consequently available at a considerably cheaper price than would be that quoted for a component manufactured directly for sale in the retail market. Fortunately, it is possible to employ a 0–5 mA instrument in place of that originally specified, an arbitrary marking being made, in this case, at the 2.5 mA level. To obtain the increased current through the meter, it will be necessary to reduce R27 to 22 kΩ. If difficulty is experienced in obtaining adequate deflection of the meter, R30 should be reduced also, the new value being 15 kΩ.

The writer trusts that constructors will appreciate that this modification is intended purely to obviate the high cost of a 0–1 mA meter should this be supplied other than from ex-Government sources. The 0–5 mA meter will, of course, be a relatively inexpensive ex-Government component.

Next Month

In next month's article, further constructional details will be given, together with the procedure needed for setting up the completed recorder.

Can Anyone Help?

DEAR SIR,—I have recently acquired a pre-war American "National" short wave receiver which is a three valve job, with separate power pack and eight coils.

Can anyone supply me with the circuit of this model, or any information about it? I am also in need of the circuit of the Radiovision "Expander" unit.

I would be grateful for any information, and will re-imburse anyone for help given. W. Topham, 200 Longfellow Road, Stoke, Coventry.

DEAR SIR,—Have any of your readers any information (data or circuit) on the Air Ministry Channel Checking Receiver type 6A? R. F. Burns, 50 Bickford Road, Fallings Park, Wolverhampton.

DEAR SIR,—I would be grateful for any information on the 22 Set which readers may be able to provide. Alan W. Whitehead, G3EOL, 59 Longroyd Road, Earby, via Colne, Lancs.

DEAR SIR,—I should, once again, like to take advantage of your excellent service. I wonder if anyone has a copy of the circuit of the TR9H, or failing this, a circuit of any of the TR9's? W. A. T. White, Ermine Lodge, Stilton, nr. Peterborough, Northants.

DEAR SIR,—Can anyone help me with circuit details of the Admiralty Responsor Unit type W4790, model A? R. G. Williams, 30 Prospect Park, Exeter, Devon.

METHODS OF ACHIEVING AGC OF THE VISION CHANNEL

By **GORDON J. KING**, A.M.I.P.R.E.

THE GENERAL AIM IN THE DESIGN OF TELEVISION receivers these days would appear to be towards a versatile instrument capable of working successfully in service and fringe areas, possessing facilities for dual-band operation, and embodying refinements that minimise, or eliminate completely, those disturbing trips from the armchair to the receiver contrast control and back again, during the course of a programme.

A recent feature in this respect, and one which has no doubt been stimulated into current receiver design by the prospect of an alternative television programme looming on the horizon, is that of automatic gain control of the vision channel (AGC).

Apart from contesting picture fading and reducing certain effects associated with passing aircraft, this feature will prove of additional value when an alternative television programme is at hand, for never let it be expected that the received signals from the two stations (or more!) will be of equal strength, while the viewer will, of course, desire to change programme by the simple operation of flicking a switch—without the bother of modifying the gain of the receiver to suit.

Here the problem lies in obtaining a negative AGC potential of magnitude that varies in sympathy with the strength of the received signal, and which can be conveyed back to the vision RF and/or IF stages to stabilise automatically the vision signal applied to the picture-tube.

It is well known that an AVC potential for sound receivers is readily derived by extracting part of the RF carrier through a diode to provide a DC bias—dependent on signal strength—for controlling the gain of the RF and IF valves.

Such practice is not possible with the vision carrier, for it must be remembered that this varies with brightness of the scene being transmitted, and its employment would, therefore, tend to reduce the overall gain of the vision channel with increases in white picture content—a mode of working that would provoke deterioration of the picture contrast and black level, and initiate an undesirable form of white level clamping.

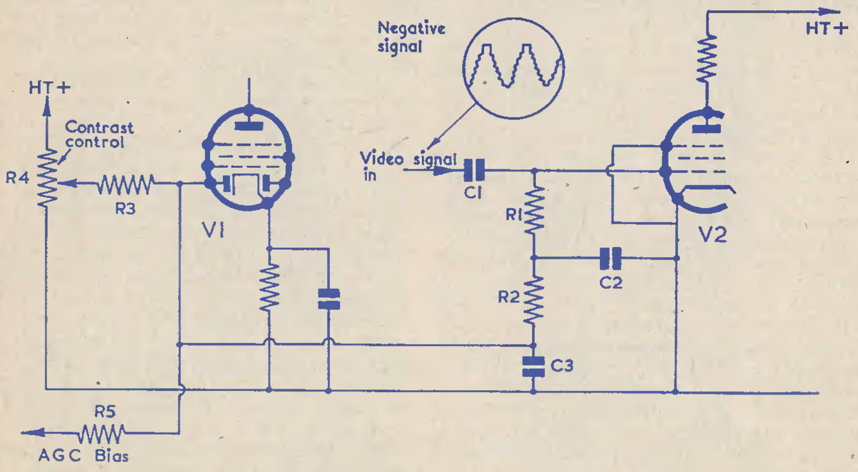


FIG. 1. THE FERGUSON METHOD OF AGC OF THE VISION CHANNEL

Using the Sync Pulses

One part of the vision signal that remains reasonably constant, irrespective of picture signal content, is the sync pulse. In this respect let us consider for a moment a conventional pentode sync separator circuit, such as that formed by V2 in Fig. 1.

From this it will be seen that a negative-going picture signal from the video amplifier is applied to the control grid of V2 through C1. The signal is, therefore, positive-going on the sync pulses and of sufficient amplitude to draw appreciable grid current.

As a result of this the plate of C1 connected to the control grid becomes negatively charged to a value dependent on the size of the received sync pulses, which in turn is dependent on the strength of the received signal.

As is normal practice, the sync separator pentode is arranged in such a manner that the vision content of the signal is beyond cut-off of the valve, whilst only the tips of the sync pulses drive the valve into grid current. A grid cathode path for the valve—the path necessary for the flow of grid current—is provided through R1, R2, R3, and R4.

We can clearly realise now, then, that a source of AGC potential is readily available from the circuit that draws its energy from the sync pulses, and which is probably more well known as the section that puts the DC component back into the signal.

The circuit at Fig. 1 shows the AGC arrangement used in the current range of Ferguson receivers. As we have already seen, the negative potential due to the sync pulses is developed in the control grid circuit of V2; this is filtered by C2, R2, and C3, and carried through R5 to the control grid of the first vision IF amplifier valve.

It will be observed, however, that the AGC potential is also in connection with the diode anode of V1. This diode simply produces a delay voltage, which is controlled by the contrast control R4. Since R4 constitutes a variable potentiometer across the HT line, a positive potential is thus applied to the diode anode by reason of R3.

This renders the diode conductive, clamping the AGC line to V1 cathode, until the AGC potential over-rides the positive potential at the diode anode, when a negative control bias depending upon the strength of the incoming signal is fed into the AGC line.

Using the Blank Lines which Follow the Framing Signal

Another portion of the vision signal that provides a true indication of received signal strength is the set of blank lines that follow the framing signal. It will be remembered that this no vision signal period (10 to 14 lines) is necessary to allow the frame flyback to take place and to get the scanning spot into the right position for interlacing before it starts its line scan of the next frame. During this period the vision carrier level falls to black or 30 per cent modulation.

Murphy, Ltd., have made use of this period of the signal for producing an AGC bias accurately dependent on the instantaneous amplitude of the black signal.

How this is performed can be quickly realised by studying the block diagram of Fig. 2. The main problem involved is to connect a reference signal corresponding only to the blank line period from the video amplifier to the AGC rectifier, and ensure that the connection is properly broken during the synchronising and picture period of the signal.

This is done very deftly by interposing a valve in the form of an electronic switch between the video signal and AGC rectifier, and arranging the switch to close only during the blank line period, and remain open during the rest of the vision signal.

The switch is actuated by a pulse derived from the frame flyback, but since this occurs before the blank line period, delaying facilities are provided to ensure that it arrives at the electronic switch at the precise instant of the blank line period.

Referring now to the circuit of this system at Fig. 3, it will be observed that the pulse from the frame timebase is conveyed to V2 through a cascade differentiator comprising C1–R1, and C2–R2. This network has the effect of modifying the form of the pulse so that it represents a distorted sine-wave.

The positive half-cycle of this waveform—that which is initiated by the frame pulse—drives the triode V2 into grid current, which effectively suppresses the corresponding negative pulse reflected into the anode circuit.

The negative half of the waveform at V2 grid—that which occurs *after* the frame pulse—gives rise to a positive flat-topped pulse in the anode circuit of amplitude depending upon the length of the valve's grid base.

This positive square-wave pulse, thus being effectively delayed, appears across R3 precisely at the instant of the blank line period of the vision signal, and is the pulse employed for actuating the electronic switch.

The negative-going picture signal is taken from the video amplifier, through C3, to the grid of triode V1 (a) which is connected as a cathode follower. Since this valve is unbiased, grid current flows through R4 on the positive-going sync pulses, and successfully provides DC restoration.

The picture signal appearing across the cathode load resistor R5 is in direct connection with the cathode of VI (b), which is also wired as a triode (the anode and screen being strapped). A minimum volts drop

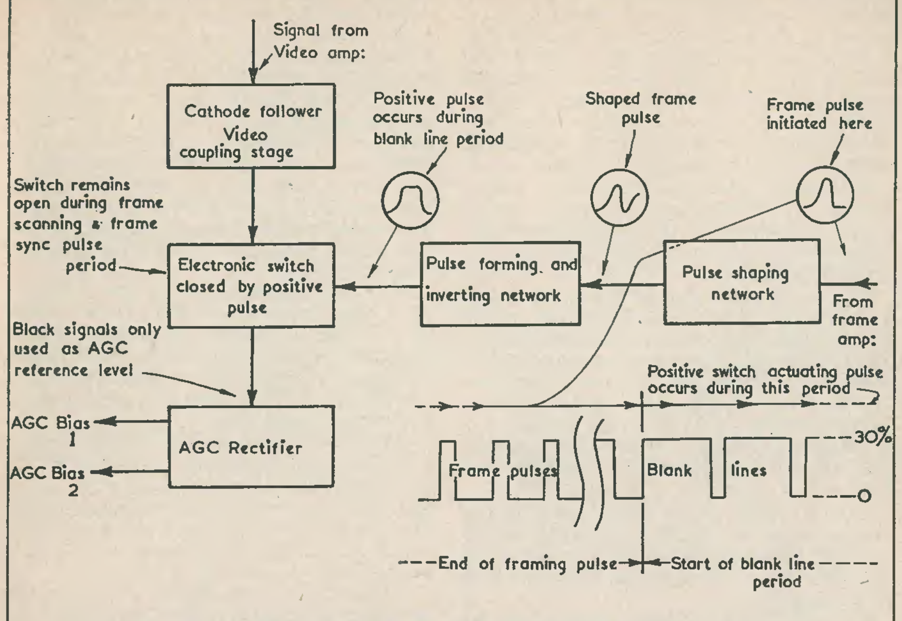


FIG. 2. A BLOCK DIAGRAM ILLUSTRATING THE MURPHY METHOD OF AGC

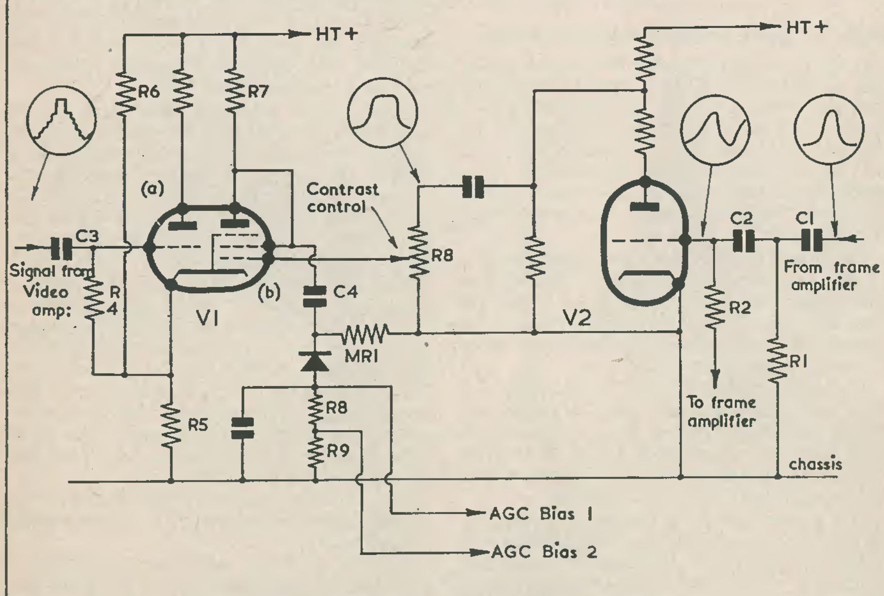


FIG. 3. THE CIRCUIT OF THE MURPHY SYSTEM

GBB

across R5 is maintained by the HT connection through R6, so that even when the grid of V1 (a) is driven heavily negative due to peak-white picture content, V1 (b) is still held at cut-off. This minimum potential across R5 is best considered as a negative bias reflected—as is the video signal across R5—into V1 (b) grid circuit by reason of the grid being returned to chassis through R3.

Judiciously chosen component values provide a predetermined potential swing across R5, whilst V1 (b) is held quiescent, irrespective of picture signal content, as we have already seen.

During the blank line period of the vision signal the positive pulse arrives at the grid of V1 (b)—this valve can be considered as the electronic switch—raising it above the cathode potential and rendering the valve conductive. The resulting negative signal pulse at black level appearing across R7 is fed through C4 and rectified by MR1 to form an AGC bias at two different potential levels across R8 and R9.

Clearly, then, if the black level of the received signal varies, the potential across R5 will vary in sympathy, as will also the AGC bias potential fed back to the RF and vision IF amplifier valves.

R3 functions as a manual contrast control by varying the signal level at which V1 (b) begins to conduct.

Using the Back Porch to the Sync Pulses

It will be well known that the picture signal falls to black level (30 per cent modulation) directly before and after a line sync pulse. These black level intervals, or porches, as they are often termed, are necessary to give the receiver circuits time to respond to a sudden and large change in picture signal amplitude that may occur at the start or finish of a line scan.

The porch preceding a sync pulse lasts for 1.5 μsec, while the back porch, following a sync pulse, has a duration of 6.5 μ sec (it should be noted that these black level interval times have recently been increased from 0.5 μ sec and 5 μ sec respectively).

The Pye system of AGC utilises the 6.5 μ sec black level intervals, since, of course, as during the blank line periods, the signal at these instants is unaffected by picture content and can, therefore, be used as a reference level for evaluation by the AGC rectifier.

The general set-up is clearly illustrated in the block diagram at Fig. 4. Examination will reveal that the basic function is somewhat similar to the Murphy AGC system. An electronic switch is interposed in the video AGC rectifier line, and is arranged to remain open during the synchronising and picture period of the signal, and close—to connect the video signal to the AGC rectifier—only during the 6.5 μ sec black level intervals.

The switch is this time actuated by a pulse derived from the line output stage during the line flyback. Since the line flyback is initiated by the leading edge of a line sync pulse, however, a pulse delaying network is necessary, and this—consisting of a resistor capacitor combination—is included in series with the line output stage and the electronic switch. The associated circuit constants are arranged to delay the pulses a few microseconds so that they occur precisely at the instant of the black level intervals.

With the basic function of the system in mind, the circuit itself—Fig. 5 (a)—proves very simple to follow. Diode V1 (b) is essentially an electronic switch, which, being influenced by the circuit constants, is held at cut-off (open) throughout the synchronising and picture signal period.

When the negative-going delayed flyback pulse occurs, however, the cathode of V1 (b) is swung much less positive than the anode and the valve immediately conducts (closes). This permits the instantaneous black level magnitude of the video signal to gain connection with the cathode of V2.

Owing to the conduction of V1 (b), the line flyback pulses, also present at the cathode, are restored to the DC value of the black level intervals in the video signal. This creates a composite waveform as shown in Fig. 5 (b). From this it can be seen that the waveform assumes an overall positive potential, the absolute value of which is bound to follow any variation in black signal level.

This signal reference waveform at V2 cathode is reflected into the grid circuit, and appears in the form of a pulse across R1. It should be noted, of course, that V2 also follows the conduction pattern of V1 (b) by reason of the pre-adjusted positive potential at V2 grid, and the fact that V1 (b) and V2 cathodes are strapped.

The signal across R1 is fed, via C1, to the cathode of diode V1 (b) which functions as the AGC rectifier (or detector). This valve, again, is normally held at cut-off in virtue of the positive potential at its cathode. The occurrence of an AGC pulse, however, drives the cathode less positive than the anode, and a potential directly proportional to the actual video strength is developed, in negative sense, across the load resistor R2.

This control potential is smoothed and filtered before being applied to the first vision IF amplifier.

A manual form of contrast control is provided by the potentiometer R3 in the grid circuit of V2. The setting of this control determines the amplitude of the AGC pulse across R1, and consequently the gain of the video channel. [END

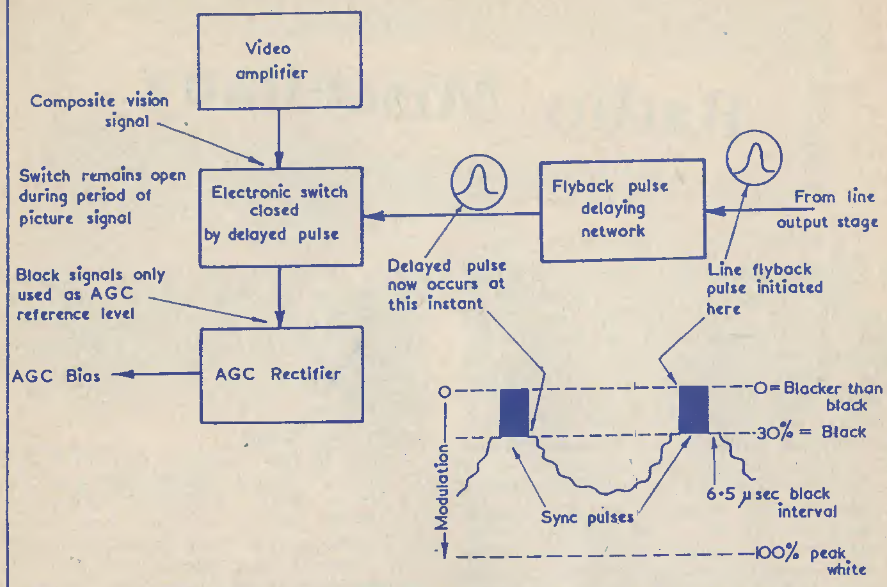


FIG. 4. BLOCK DIAGRAM ILLUSTRATING THE PYE METHOD OF AGC

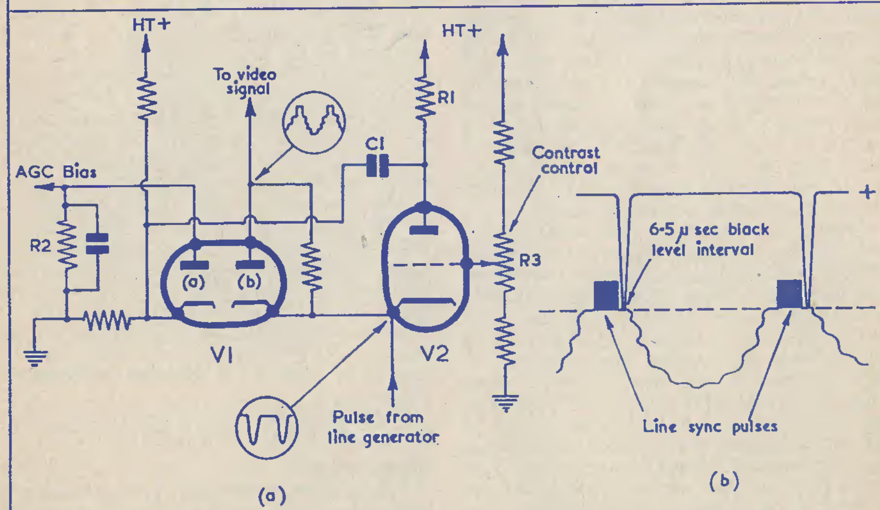


FIG. 5.

(a) THE CIRCUIT OF THE PYE AGC SYSTEM

(b) AGC PULSE FORMATION AT V2 CATHODE

G89

Radio Miscellany

I REMEMBER AS A SMALL LAD OUR MATHS master in giving us our introduction to trigonometry asked how else one could manage to measure heights of hills, distances between mountain peaks, etc., without its use. Eager to prove such a loathsome subject had little practical value, but was merely a form of torture devised by a sadistic educational Authority for the sole purpose of making the otherwise care-free lives of small boys miserable, all sorts of ingenious methods were suggested by my hopeful class-mates. In fact, some of their alternatives seemed so plausible that even today I find myself instinctively groping for some way of finding the answers to sticky problems rather than do it by mathematical calculation! Maybe it is bad psychology to try to induce reluctant schoolboys to take an interest in detestable subjects simply to find out facts about things they are not likely to want to know. I remember I felt it would be far more reliable (and exciting) if, when I wanted to know the height of a steeple, I could shin up it and drop out a plumbline, rather than depend on squaring the hypotenuse and juggling with tricky little sums.

Among the ingenious ways of solving some of the problems he exampled, several of the lads suggested the use of echoes. Not that there was anything original in that. It had been thought of by our early ancestors and, no doubt, as soon as man learned to sail he used the echoes from the cliff to find out how far he was from the shore when it was dark. That may well have been the first application of the basic idea of radar. Of course, my clever school-fellows never thought of doing it by radio, nor had any adult for that matter, but then there were no cathode ray tubes in those days.

The first use of radio echo-sounding was, I believe, made by Appleton in measuring the height of the Heaviside layer—and thus discovering the Appleton layer in the process. As with radar, they used a short interval pulse and obtained a continuous record on a cathode ray tube of the reflected signals. It was R. A. Watson-Watt who first proved the possibilities of radar. He used the 50 metre Empire Broadcasting beam from the Daventry Station for the purpose, in February, 1935, when reflections from aircraft were obtained over a range of up to eight miles.

Render Unto Cæsar

I seem to have digressed somewhat, but the train of thought started after watching the recent B.B.C. Television Film series *War in the Air.* I could not help feeling the emphasis is too much on the spectacular side, complete with enough noise and fury to leave the viewers dizzy. Scant attention is given to the Boffins and aircraft designers, although some shots of the uses of "Oboe" and H_2S are included in Part 8. Yet the outcome of the war might have been vere different if the Nazis had possessed thy lead we held in radar design. Often we feel we have occasion to censure those in authority for tardiness in taking up and developing new ideas, but this, at least, was one occasion when they were way out ahead of the critics.

The existence of the Tizard Committee is almost unknown to the lay mind, despite the credit due to them for guiding and channelising the efforts of the many in the perfection of radar. The lion's share of the credit for its early accomplishments goes to Watson-Watt who staked so much on its success, but I wonder how many of the viewers of *War in the Air* even know of his name.

Come to think of it, I don't know what the initials R. A. stand for, either!

Identification

The success of February, 1935, was only a beginning. To be able to simply detect the presence of an aircraft at eight miles, although a feat of outstanding importance, would be of little value in aerial warfare. By increasing the aerial height greater ranges could easily be secured, but the essential question of distinguishing a hostile plane from one of our own had still to be solved. Nor would positional accuracy be sufficient for defence against bombing attacks. The height of the attacking force had to be gauged within reasonable limits. Interception aircraft would be helpless if they found themselves a couple of miles below the raiders.

It was also necessary to know the strength of attacking forces in order that our fast interception planes could be used to advantage.

Six months after the first successful test it was possible to "count" up to three aircraft, and results up to forty miles (at sea) were being attained. The problem of distinguishing friend from foe was not solved until a couple of months before the outbreak of war.

Several volumes would be needed to describe how these problems were solved. The development of the cavity Magnetron would also need a book on its own, let alone "Gee" and "Oboe" and other applications. These latter systems, by the way, are not strictly radar. They are based on determining the position from signals sent out by the 'plane — not by reflections from it.

There are several good radar books, but it is not easy to follow the development in logical sequence. For security reasons much of it was kept secret and only revealed piecemeal. Some of it was so secret that only a few can tell just how it comes into the story, although much on the "secret list" remained there long after everybody knew all about it. Early after the war the Americans released a lot of information weeks before we did, and their technical publications (which have quite a fair European circulation) often contained quite detailed accounts of things that were still hush-hush as far as we were concerned.

Changed Conception

The question of secrecy or the free international exchange of scientific research and discovery has, in recent years, been one of bitter controversy. At first many scientific workers had some doubt as to the extent of the guilt of the early Atom Traitors. There had long been a tradition that the results of all scientific research should be available to all other investigators. Science was held to be international, and the pooling of knowledge made for more rapid progress. This was a grand thing in a peaceful and well-intentioned world, but not when it began to become a one-way traffic and the political ambitions of one of the Great Powers led to the swallowing up of smaller nations.

At the time of the development of radar there was the menace of Nazism. The screen of secrecy became essential for our own defence. We live today in a world of suspicious distrust, and, at times, barely-concealed aggression. The free exchange of scientific knowledge has now to be tempered with the need for security. Humanity seems already to be centuries behind our technical knowledge.

Snip

Over the Christmas holiday I found myself roped in to help in hoisting an aerial mast. Armed with a heavy pair of cutters I tried to snip the steel cable (used for guying) to suitable lengths but found, as one often does, that it was impossible to get a clean first-time cut. Then someone handed me a cheap, combined wire stripper and cutter and said "Try these." I accepted them rather disdainfully, I'm afraid, half-expecting to see such a light tool buckle up if much force had to be used. To my amazement they went clean through it time after time.

The sequel, of course, is that I have bought a pair of my own. Now I am itching to have a go at some steel cable—only I am afraid of spoiling them!

CENTRE TAP *talks about* RADAR AND BOFFINS— WIRE CUTTERS— A NEW SCOPE CRT

No Tall Storey

This month I had intended to write about an exchange of views with an American friend who has been here for a few days, breaking his return trip from Europe. Most of it will have to keep for another time, but while he was with me advance details of the Mullard DG16-21 rectangular faced oscilloscope tube came to hand. He was quite fascinated and said he hadn't seen anything like it in the States up to the time he left. The screen size is $5\frac{1}{2}''$ by $1\frac{1}{2}''$.

For many uses when only a horizontal strip is required it has obvious advantages over the conventional circular ended tube. It saves considerable space, taking only a third of the panel height of the normal type tube—an important factor in test equipment. Moreover, it enables two (or more) to be easily stacked to facilitate direct comparisons.

I'll bet if he finds they have a similar one when he gets home, I shall hear all about it by the next air-mail!

A TRANSISTOR "ONE-VALVER"

By **B. H. JAY**

INTEREST IN THE APPLICATION OF TRANSISTORS is growing apace. However, the subtleties of transistor circuitry, and the lack of widely disseminated information, has rather restricted the use of transistors among home experimenters. But with transistor production now in full swing, and with prices down to a modest 30/–, it seems an opportune moment to describe the simplest form of "one-valve" transistor receiver. While this is not the most advanced design possible by any means, it does provide a start for those anxious to experiment with transistors. It is clear, in fact, that the transistor has come to stay, and sooner or later the plunge into transistor units must be taken. It is hoped that the little set described will enable this to be undertaken simply, thus providing a start for more ambitious experiments later on.

A sample of the Mullard point transistor type OC51 was chosen for this receiver, as it is very reasonably priced, and moreover a "point" type of transistor is the only one at present on sale that has a good high frequency performance. The OC51 operates in the medium waveband perfectly, and indeed has been used for transmission and reception on somewhat higher frequencies.

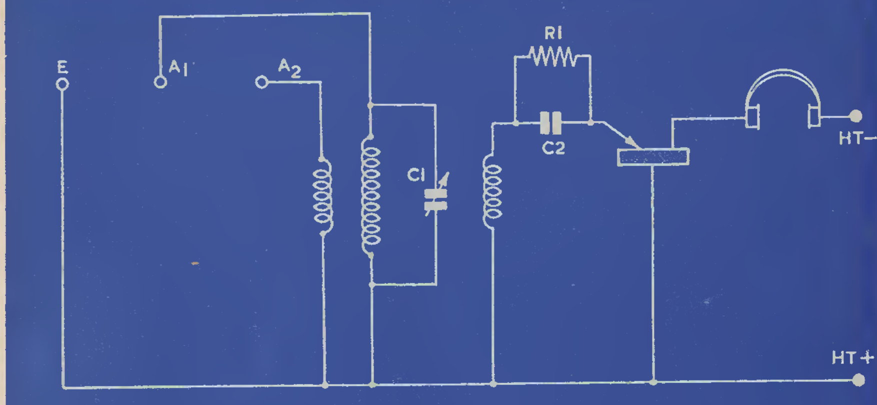
An important aspect of designing a transistor receiver is that a specially designed coil is necessary so that the very low impedance of some 250 ohms of the emitter (which corresponds to the grid of a triode valve) may be effectively matched into a high-Q high-impedance tuned circuit. Preliminary experiments with makeshifts showed that a specially designed coil with a tightly coupled step-down winding to correctly match into the emitter circuit was necessary. Fortunately a commercially-wound coil designed especially for transistor circuits is made by the Teletron Co., and was found to give outstanding results. The present transistor receiver was designed around the Teletron coil, and immediately gave excellent results. In fact, in the London area the Home and Light programmes were very comfortable headphone signals on a few feet of wire, together with an earth connection made to a gaspipe—even with 3 volts of HT! It should be mentioned that earlier, with makeshift coils, some 9 volts were needed before reasonable signals were obtained.

The circuit given in Fig. 1 is intended to be as simple as possible, and works either into high resistance headphones, or into low resistance phones via a step-down transformer. The writer uses a surplus jackplug "Headset adapter MC385D— High to Low Impedance" together with a pair of low impedance phones. The transformer unit plugs directly into a standard jack socket.

The construction adopted was a base of ¼" paxolin 2¼" square as the base plate, with small side panels for the aerial plugs at the back, and the tuning knob and phone jack at the rear. The "HT" leads were taken through a grommeted hole at the rear and terminated in wander plugs; the "HT" battery, in fact, being a 9V grid bias battery. At this point it is necessary to warn readers that a reversal of polarity of the battery will immediately destroy the transistor, so the fact that the "collector" (the equivalent of

Parts List

2¼-inch square Paxolin Base ¼-inch Thick.
Two strips of Paxolin 2¼-inches by 2-inches for side panels.
Miniature Variable Condenser, see text.
Miniature Diode Holder.
One Octal Spring Topcap Clip.
One Open Circuit Jack Plug.
One TCC Metalmite .001μF.
One 1.2kΩ Resistor ¼ Watt.
One OC51 Transistor (Mullard).
One HMX Special Transistor Coil (Teletron)
(Or One HLX Teletron Transistor Coil if Long Waves needed).
One Knob.
5Ediswan-Clix Master Wander Plugs.
3 Ediswan Clix Master Panel Sockets.
6 volt grid bias battery.



C1 = Minature variable   C2 = ·001 μF Metalmite   R1 = 1·2kΩ

FIG. 1. CIRCUIT DIAGRAM OF THE SIMPLE RECEIVER

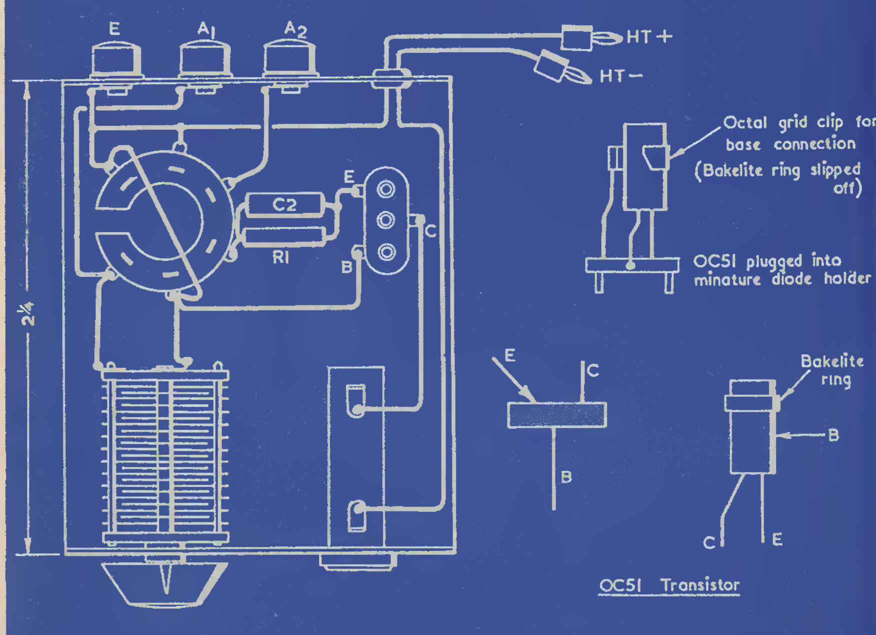


FIG. 2. RECEIVER & TRANSISTOR DETAILS

a valve anode) goes to the NEGATIVE end of the battery must be firmly remembered! Once one is used to the HT line being negative with transistors instead of positive as with valves, then one can proceed without fear of the disastrous destruction of an expensive transistor at the outset!

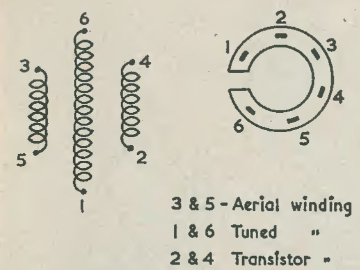


FIG.3. Connections for Teletron Transistor coils
HMX - Medium waveband
HLX - Long waveband G79

Incidentally, there is at present no "official" holder for the OC51 transistor. In this case a D1 miniature diode holder was used. However, if this is copied, be careful to select one that has loose contacts, so that the OC51 may be inserted without undue force on the two wire contacts. If unduly strained, the points may become shifted with bad results. An octal top cap connector of the spring type, if slightly squeezed to a smaller diameter, makes a convenient clip connection for the shell of the OC51, which is the base connection. A short piece of 23 gauge

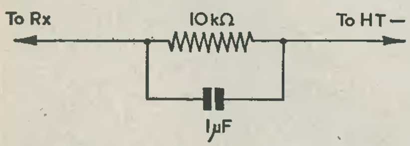


FIG.4. How a protective resistor may be used in initial tests, or if voltages exceeding 9 volts are used G80

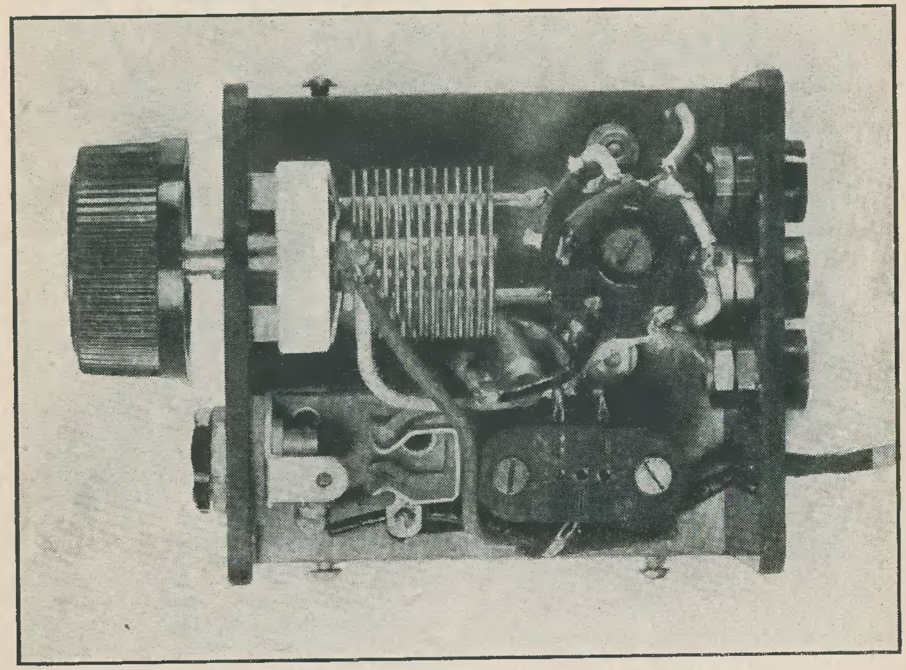
tinned copper wire from the clip may be tucked into the third contact of the diode holder, so that all circuit connections may be soldered to the diode holders. Soldering to the transistor wires is a dangerous proceeding liable to damage the transistor, so that the use of the diode holder has advantages.

Providing care is taken to avoid undue strain when inserting the OC51 into the holder, all should be well. No adverse effects have been noted with the present receiver to date, although in the course of experiments the OC51 has been plugged in and out very many times.

Readers owning a miniature 500pF variable condenser may like to use it for tuning in place of the 100pF miniature variable used by the author. The small 100pF condenser was the only small condenser to hand when building, so to make a compact receiver it was used. As shown in Fig. 1, two aerial terminals are provided. One intended for short aerials is taken directly to the tuned winding. Here the capacity will load the tuning, so that both Home and Light programmes can be tuned on the sweep of the 100pF condenser. The iron core of the HMX coil may also be adjusted to enable Home and Light to be tuned with only 100pF. When a large aerial is used, this is connected to the proper aerial winding, and the tuning coil may then be padded up to cover the London Home and Light programmes by an outboard fixed capacity plugged in between the aerial and earth sockets. Alternatively a suitable fixed capacity may be wired across the coil, and this enables a small cheap surplus type of compact variable to be used rather than the expensive miniature condensers of higher capacity. Bakelite dielectric variables could be used, but are somewhat lossy compared with air condensers, and would probably deteriorate the very excellent Q of the Teletron coil. If Droitwich reception is required, the appropriate Teletron Long Wave transistor coil may be used, and this can be padded with fixed capacity if a large variable is not available.

Wiring is so simple that no difficulty should be experienced. However, carefully check that the transistor is properly inserted in the holder, with the collector connection correctly made. Initially use a series resistance of say 4.7kΩ in series with the HT lead, and tune in the local station. After adjusting padding condensers, if used, the 4.7kΩ resistor may be shorted out if no more than about 9 volts HT is used. If *more* HT, up to say 20 volts, is used, a 10kΩ resistor should be used in series with the negative HT line, and bypassed by a 1μF condenser. (Fig. 4). This limits the current so that the 50 milliwatt rating of the OC51 is not exceeded.

Finally a metal cover plate may be fitted to the receiver after padding values are wired in, and the receiver is complete. In strong signal areas, even 1½ volts is an adequate HT supply for headphone reception. In fact, very feeble reception is possible with no HT. Up to 9 volts HT, however, gives considerably improved results. Beyond 9 volts no particular improvement was noted, and in fact the hiss level became appreciable, so that 9 volts was the best position under the authors particular conditions. As this is the voltage of cheap grid bias battery units, such is an economical power source, and should last almost indefinitely under the milliampere or so drain of the transistor. No special merit is claimed for the circuit, which is about the simplest possible, and in fact the Teletron Coil efficiency is responsible for the results obtained. More advanced circuits will give higher performance, but these must be left until later. The intention of the present receiver is to serve as an introduction to using transistors with the minimum of complexity.



Plan view of receiver, approximately full size

NEW MULLARD MINIATURE TRIGGER TUBE

The Z900T is a new Mullard all-glass miniature cold cathode trigger tube on the B7G base. In such tubes, which are gas filled, operation of a positive voltage pulse to a trigger electrode can cause a large current to flow between two main electrodes. Trigger tubes are, therefore, of considerable use for relay operation. They have the advantages over normal thermionic valves that no heater supply is required, nor is any current passed by the tube when not actually operating. Thus running costs are reduced, problems of heat dissipation in large equipments employing many valves are avoided, and, since there is no warm-up time, the equipments remain permanently ready for instantaneous operation.

The Z900T trigger tube, which is the first to be produced in this country on the miniature B7G base, should find applications in welding timers, counting circuits, and a variety of remote control and automatic control circuits. The ability of the tube to operate instantaneously, even after long periods of idleness, is an outstanding advantage in safety devices.

The Z900T may be operated from DC supplies of up to 200V or AC supplies of 115V. AC operation results in automatic tube extinction. The Z900T is directly equivalent to the American 5823.

Query Corner

A *Radio Constructor* Service for Readers

Amplifier Noise

I recently constructed a pre-amplifier and tone control unit to be used in conjunction with a push-pull quality amplifier. The pre-amplifier functions very satisfactorily in most respects, but the noise level is very high. Without a signal the noise is heard as a steady hiss. Thinking that the valve, a double triode, might be defective, I removed it and the hiss stopped, but upon substituting a new valve the trouble still persisted. Does this indicate that both valves are faulty, or can the cause of the hiss be elsewhere?

E. Morgan, Cardiff

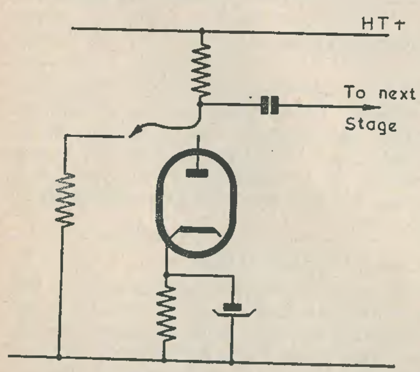


Fig. 1
Replacing a valve with a resistor when checking for noise

This hissing noise is quite frequently heard from high gain audio amplifiers, and can usually be traced to either a valve or a resistor. In either case the noise usually disappears when the valve is removed. If the gain of the complete amplifier is such that the input required for full output is above 50 millivolts, which is usually so, then it is most unlikely that the trouble originates in the valve. There is one proviso to this statement. Should the valve be gassy (poor vacuum) it may generate a frying noise; this can be checked by either changing the valve or having the original one tested.

Having dispensed with the valve as a likely cause of noise, we now turn to the resistors in the circuit. Unless the gain of the amplifier is exceptionally high, only current carrying resistors in the signal circuit need be considered. This generally narrows the search down to the anode load resistors of the first or second stage. A resistor produces noise due to the movement of electrons within it. This is termed thermal agitation noise and, as the name implies, its magnitude is dependent upon temperature. Because of this the noise produced by a resistor which is not carrying current can be very small, but when the anode current of the valve flows through it the temperature rises and hence also the noise.

For those who are interested in calculating the noise voltage produced by a resistor, the following formula applies:

$V=\sqrt{4KTR(f_2-f_1)}$

where

K=a constant 1.374×10^{-23}

T=absolute temperature (273+temp. in °C)

R=value of resistor (ohms)

f_2 and f_1 are the frequency limits of the amplifier or receiver (c/s).

A simple test to determine whether, in fact, the noise does originate in the resistor, and not the valve, may be arranged as shown in Fig. 1. Here a resistor is connected in place of the valve, its value being such that the anode load resistor passes the same current as it does when the valve is connected. Thus, if with the valve out of circuit the noise persists, it must come from the resistor.

The cures for the noise may be one or more of the following, depending upon its severity.

(*a*) Use a higher wattage anode load resistor so that the resistive element can operate at a lower temperature.

(*b*) Use a high stability resistor.

(*c*) Reduce the current in the resistor so as to reduce its temperature.

EHT Booster

I have recently overhauled my 12-inch television receiver and I would like to still further improve the picture by increasing the EHT voltage applied to the tube. Is there any simple way of obtaining the additional voltage?

N. Mathews, Leeds

There are probably a number of readers who are either modernising television receivers, or perhaps are just replacing the existing tube with a larger one, and who wish to increase the EHT potential. Such an increase in EHT has two very desirable effects; it increases the brightness of the picture and also sharpens the focus. Resulting from the increased highlight brightness the contrast ratio is also improved. There is, however, one disadvantage; the deflection sensitivity of the tube is decreased. The current required in the scanning coils for full scan increases as the square root of the increase in EHT potential, so that for an increase of from 5.0 to 7.0kV the scanning currents must be increased by 12%. Unless an overscan of at least this amount is available, there is little point in increasing the tube potential.

Turning to the methods employed to increase the EHT, the most obvious is the voltage doubler. This has, however, two disadvantages; it normally becomes impossible to fully scan the tube with the existing timebase, and the EHT regulation is seriously impaired. The circuit which has proved most successful gives a gain in voltage of about 40% without any loss of regulation. The circuit of the additional unit is shown in Fig. 2. Quite a large positive-going pulse appears at the anode of the line output valve, and this pulse is rectified and added to the existing EHT potential. Between line pulses the junction of R_1C_1 is at the same potential as the original EHT source. When the positive pulse occurs on the anode of the output valve, the metal rectifier conducts and charges C_2 by an additional 1.5 to 3kV. This booster arrangement is equally satisfactory when used with either a flyback EHT system or a 50 cycle mains transformer unit. The circuit diagram of Fig. 3 shows the booster added to a typical flyback

> ## *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.

EHT supply. The values of the additional components are not particularly critical, and it has been found convenient to employ the following:—$C_1=C_2=0.001\mu F$, 6kV working; $R_1=2\times1M\Omega$, 1 watt resistors in series. The metal rectifier must be capable of withstanding the additional peak inverse voltage. However, it is most unlikely that this voltage will exceed 3kV, and hence the Westinghouse rectifier type 36EHT40 is suitable.

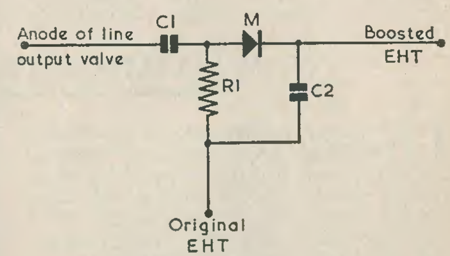


Fig. 2
Complete circuit of EHT booster

Some care is required in the mounting of the booster circuit components, as they are all at high potential. It is most convenient to mount the two capacitors side by side on a paxolin strip, and support the metal rectifier and resistors from the upper tags on the capacitors. The complete unit is then mounted over or alongside the line transformer. A clearance of at least 1 inch must be left between points at EHT potential and those at earth potential, in order to avoid corona discharge.

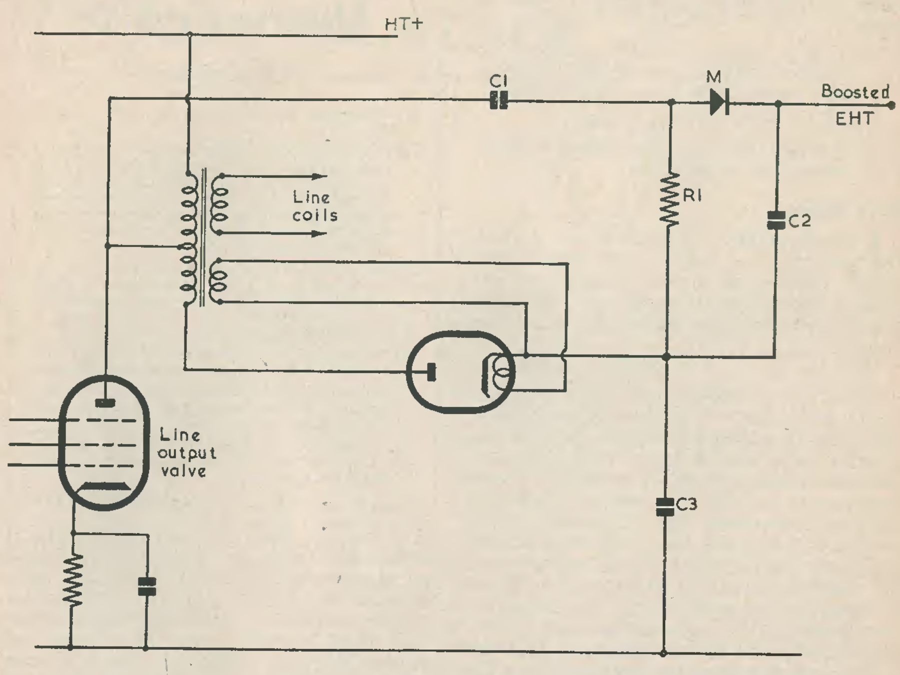


Fig.3
The booster circuit added to a typical flyback EHT system

NOW—ILLUMINATED PANEL SIGNS

THE "RADIO CONSTRUCTOR" PANEL-SIGN TRANSFERS were obviously designed primarily for use on opaque panels of metal, bakelite, wood or plastic. But the ones which comprise large tuning scales printed in black on a white background can be used in another way, as I have recently discovered!

If mounted on glass, perspex, talc, "non-flam" celluloid or other suitable transparent sheet, and fitted with bright dial-lights behind the panel, they form quite good illuminated tuning scales.

As the paint-film which forms the transfers is only moderately translucent, the dial lights should be fairly brilliant and correctly positioned to give maximum illumination if the idea is to be a success. Polished metal reflectors behind the lights are an improvement.

The gum on the back of the transfers should be moistened lightly and very evenly, to avoid any streaky appearance when dry and illuminated from the rear. If preferred, the transfer can be "sandwiched" between two thin transparent sheets of suitable material; this gives complete durability without the need for varnishing.

Given attention to these points, the illumination should work quite well and will certainly facilitate reading the scale on a set that happens to be in a dim corner of the room or shack.—G3XT.

IMPRESSIONS OF AMERICA

By **NORMAN H. CROWHURST** A.M.I.E.E.

READERS OF *The Radio Constructor* WILL probably be firstly interested in the difference between radio constructors in America and those back home. The big difference seems to be that the American trend is far more towards the packaging of items of all kinds, so that all the constructor has to do is use a pair of wire cutters (known as "dykes") and a screwdriver, to connect up the various items and produce his own rig. Certainly the meaning of construction seldom, if ever, goes any further than this amongst the American radio constructors, or hams.

Similarly, the American serviceman needs to know surprisingly little about the functioning of radio or television, and some of them seem to manage to stay in business with extraordinarily small working knowledge of the subject. The situation is such that the householder finds it difficult to know where to find a reliable man to call in when the radio or TV fails to perform. The local newspapers have been running a campaign against "gyp" servicemen quite recently. Many of these operate by changing a tube, which usually is the only thing defective, and charging an exhorbitant fee for what they call a complete overhaul. In the event that they can't trace the fault, many of these operators advise the customer that the set is beyond repair and he requires a new one. These remarks, of course, do not apply to all radio and TV servicemen in America. There are other honest ones who will do a good job of fault tracing and make an efficient repair for a reasonable charge, but they are not too easy to find.

In the radio and electronic industry there are noticeable differences between American and English practice. The trend in American industry is much more completely toward the development of watertight compartments. In producing new products, even comparatively small organisations operate with distinct divisions between research, development, design, styling or packaging and production. This means that information concerning a new product from the research and development departments, which find what kind of product is possible, passes over to the design department which is responsible for applying the information obtained to a practicable design. This is worked out in its essential details for performance, and is then passed to the styling or packaging department who are responsible for making the item look presentable to the customer. When these people have finished with it, it is passed to the production people who lay out the new product from the viewpoint of making it easy to mass produce.

This attitude has probably been responsible for the fact that American products cannot compete with the quality of British products, which is particularly noticeable in the field of microphones, pick-up cartridges, and loudspeakers. This fact was interestingly but unintentionally highlighted at a recent session of the Audio Engineering Society at the Audio Fair in New York. A lecturer from one of the prominent radio concerns had described the development of a new type of microphone, explaining the problems involved from the design viewpoint and how these had been met in order to produce a microphone with a satisfactory performance. When question time came, one of the audience asked the question as to how the case of the microphone influenced its performance—whether the grille or housing in front of the diaphram in any way modified the frequency response. The reply of the lecturer was to the effect that he did not know the answer to this question, since he had only developed the microphone from its performance standpoint. It had then been handed to the styling people who had developed a suitable case for it, and he did not know what influence the case had; but since it was only a case it probably had no effect on the frequency response. Any English microphone designers who read this comment will realise its significance, as it is well known to those who have worked in microphone design as a whole that the partial cavities behind the mesh in the housing in front of the diaphragm can cause quite serious resonances in the frequency response. Undoubtedly the foregoing attitude explains why sample microphones received from America in England do not have the same response as the published curves issued by their manufacturers. The published curves are undoubtedly the combined work of the research and design departments, and production models, after the styling people have finished with them, very seldom produce a curve approaching that of the ideal curve achieved in the experimental stage.

Another difference between American and British industry is the fact that practically all operations are geared for production from the one or two man outfit, that works in a basement or backroom, to the large factory. This aspect is rather apt to trammel development because it is difficult to obtain any kind of special component for experimental work. An example of this has been encountered by the writer in a project he has been engaged upon. When first handed the project, some special filters with unusual frequency characteristics were required. The writer designed the necessary filters himself and then sought to find some manufacturer who would supply samples of this filter. At that stage it was a new project, and there was a certain amount of uncertainty as to its public demand. Several manufacturers of filters were contacted, but they all quoted long term periods for the delivery of a few sample coils to a new design. Eventually the writer had a coil winding machine imported from England, and the filters were wound under his own personal supervision much more quickly this way than would have been possible by getting people outside to deal with it. However, now that the project is a going concern, amounting to approaching a million dollar a year business, all the filter manufacturers are falling over themselves to try and get the business of making these special filters. This attitude is perhaps not unique to America, but it is probably more strongly emphasized than in Britain due to the greater accent, from top to bottom, on gearing for production.

A final word about the difference between the kind of people in American and British industry. As elsewhere, one finds two kinds of people: there are the people who do not know very much about any one thing, but have a little knowledge about many things, and what they don't know they try to bluff their way through; occasionally their bluffing fails, but they pick themselves up and carry on. And then there is the competent type of man who really knows about everything he does, and who is really responsible for most of the original work done which lays the basis for real progress. Men of this type usually suffer from not having an adequate "trumpeter," and therefore it frequently occurs that the bluffing type of individual has better success in his career than many who are more competent. The writer's impression, after a little over twelve months in America, is that there is a bigger ratio of bluffers to the more solid type here than there was back home in England.

The writer hopes, by giving these comments to the folk back home, to encourage some of those who may be thinking that Britain is going to the dogs to the realisation that, relatively speaking, things are not as bad as they seem. However, if any of *The Radio Constructor's* readers are thinking of emigrating to America to try a new start over here, the writer believes that any radio man who can save up enough money to pay his passage over here, by hook or by crook, need not fear the possibility of failure. Any man with a British radio background can make good without any difficulty in America. In fact, some seriously think that the key to success in the radio field here is the possession of a British accent!

TRADE REVIEW

We have received for test and review a sample '*Litesold*' Soldering Instrument, manufactured by Light Soldering Developments, Ltd., 106 George Street, Croydon, Surrey.

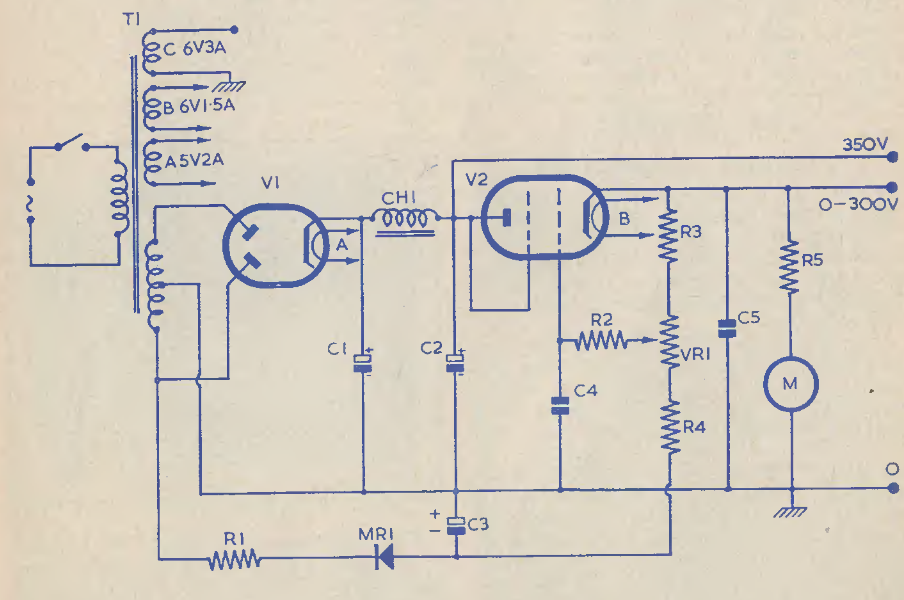
The range of '*Litesold*' instruments comprises ⅛″, 3/16″, ¼″, and ⅜″ diameter bit models with either fixed or replaceable bits, designed to operate on 6/7, 12/13, 20/22, 22/24, 50/55, 100/110, 200/220 and 230/250 volts AC or DC. Models for special voltages or low melting point solders are supplied to order at no extra charge. In the case of the smaller bits, the bit is merely pushed into the stainless steel body by which it is gripped, but the ¼″ and ⅜″ bits are held in place by a stainless steel split pin. The smallest model, that is the ⅛″ bit size, is provided with a protective removable cover which makes this instrument ideal for carrying in the tool bag.

Our sample was of this latter type, and our first reaction was that it would be ideal for compact miniature work, but hardly suitable for the normal run of work. However, we were greatly impressed when we found ourselves able to make a sound joint, though naturally with a little difficulty, on the heavy metal body of a G.P.O. jackplug. After that, the successful soldering of normal size components and 14 swg wire, plus the greater accessibili y, has resulted in the larger 65 watt iron of another make being relegated to "the reserves"!

A CONTINUOUSLY VARIABLE HT SUPPLY

By J. W. BAGNALL

THE POWER PACK ABOUT TO BE DESCRIBED is a very useful piece of equipment for the enthusiast who is in the habit of constructing and experimenting with his own circuits. It was primarily intended for use in servicing battery receivers, as invariably it was found that the HT battery had seen better days, and it avoided delay while a new battery was purchased.



A continuosly variable HT supply

E116

Normally, to drop the voltage from a standard HT supply a series resistance is used, which usually needs to be of a high wattage. If the load is changed it means replacing the original resistance with a more suitable value. This is not only a tedious undertaking, but also it increases the impedance of the supply.

These troubles can be eliminated by using a valve in place of the series resistance, controlling the current flow and thereby the voltage by means of a suitable potential applied to its grid. This results in a power supply that is continuously and smoothly variable from zero to 300 volts.

Operation of the Circuit

On examination of the circuit it will be seen that it follows conventional lines as far as obtaining the DC is concerned. The valve V2 is in series with the positive supply and the voltage applied to the grid may be varied by the control VR1. A metal rectifier MR1 supplies the negative potential across the chain R3, VR1, and R4. When the slider of VR1 is nearest to R3, the grid is held at almost cathode potential and the full output voltage is available; as the slider travels down towards R4 the grid is driven more negative, reducing the output voltage until finally the point is reached when V2 is cut off and the voltage between the cathode and earth is zero.

It is essential that the negative supply be well smoothed, for any AC ripple reaching the grid of V2 would be superimposed on the final DC. With the values shown the ripple content of the output voltage is less than 200 millivolts, which is considered to be adequate for any normal use. The condenser C4 should be a paper type, this being readily available on the surplus market. Also, it should be noted that MR1 is connected in the reverse manner to normal; that is to say, with the red end to the AC line and the black end to C3. If an electrolytic condenser is used in this position, make sure that the positive end is joined to chassis.

As the heater-to-cathode insulation of the KT66 is only 150V, a separate heater winding is needed for V2. The heater and cathode are joined together to avoid any potential being developed between them.

The resistor R1 is to keep the voltage applied to the metal rectifier from exceeding 230V. The layout is in no way critical, but the use of a meter to monitor the output voltage is advised. The writer is using for this purpose a surplus 5mA movement with a resistor in series to give a reading of 300V full scale.

Component List

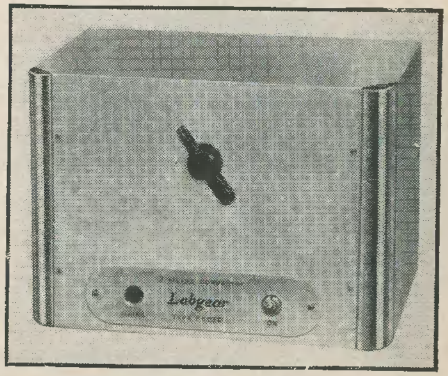
R1	47kΩ 1W
R2	47kΩ ¼W
R3	4.7kΩ ½W
R4	47kΩ 1W
R5	60kΩ 2W
VR1	100kΩ 1W
C1	8μF, 450V wkg.
C2	16μF 450V wkg.
C3	4μF 350V wkg.
C4	2μF 250V wkg.
C5	8μF 450V wkg.
V1	5V4G
V2	KT66
MR1	230V 30mA
T1	350–0–350V 120mA; 5V, 2A; 6.3V 3A; 6.3V, 1.5A.
Ch1	20H, 60mA.
M	5mA FSD.

The LABGEAR 2-Metre Converter

THIS ALL-TRIODE CRYSTAL CONTROLLED converter permits a high standard of reception on 144–146 Mc/s, at the minimum of cost. Although only two valves are used, the performance bears a good comparison with more elaborate and expensive converters.

One of the new 6QB7A dual-triodes is used as a combined grounded grid RF stage and mixer. A 12AT7 is employed as crystal oscillator and multiplier. The crystal has a nominal frequency of 11,666.67 kc/s, and twelfth harmonic operation provides an injection frequency of 140.0 Mc/s, which allows the 2-metre band to be covered with a 4.0–6.0 Mc/s tuning range on the main receiver. This is particularly convenient since it allows direct calibration from the receiver dial (144 Mc/s corresponds to 4.0 Mc/s and 146 Mc/s to 6.0 Mc/s), and every normal communications receiver covers the 4.0–6.0 Mc/s band with good performance.

A variable impedance matching network, adjustable from the front panel, has been included so that the output may be correctly matched to the input impedance of virtually any communications receiver. The converter input is arranged for 75Ω co-ax, but 300Ω twin lead can be catered for by arranging a half-wavelength section of 75Ω co-ax as a "balun."



The converter, manufactured by Labgear (Cambridge) Ltd., Willow Place, Cambridge, is made in two styles. The E5030 is supplied complete with power pack for operation on 200–250V 40–60 c/s mains, and is housed in an attractive cabinet. The consumption is 24 watts, and the price £15. The E5030/A is the converter unit only, but complete with valves and crystal, and is sufficiently small to be housed inside the cabinet of many receivers. The supply needed, which can usually be obtained from the receiver, is 200V HT at 20mA, and 6.3V LT at 0.3A. The price of this version is £9 10s.

A NURSERY RADIO

By **S. FIELD**

IT IS PROBABLY TRUE THAT A GOOD QUALITY TRF receiver is one of the most attractive propositions for the modern home hobbyist who is called upon to construct the domestic radio equipment. It is especially true where a receiver, subsidiary to the main set of the household, is required. The most popular uses of these secondary receivers—if they may be so termed—are as bedside radios, kitchen midgets or even as nursery sets; where the younger members of the family are able to select their own programmes without interfering with the adult listening pleasure. Such a receiver is usually of the TRF type by virtue of the absence of lining-up troubles and the all-important consideration of cost. In any event, a set of this nature could undoubtedly find a niche in the average household.

A well designed and constructed TRF receiver, using modern valves and components of good quality, is quite capable of producing good results both with respect to audio reproduction and selectivity. As with all TRF designs, the aerial has an important bearing on the final outcome and, in this respect, it is worth noting that the prototype receiver about to be discussed was operated on a length of plastic-covered wire some 20 feet in length. It is therefore recommended that a similar length of aerial should be used by the intending constructor if satisfactory results are to be achieved. A good earth connection, preferably direct to ground and not via a water pipe, etc., is also of importance to the final performance. Provided these external considerations are complied with, perfectly good results are obtainable from the design offered here.

Not all constructors will choose to employ a metal cabinet in which to house the completed receiver. Such a cabinet was deliberately used in the present design on the grounds that they are readily available, comparatively cheap, and may be easily painted to conform to almost any colour scheme that is preferred by the distaff side of the household. In addition to the foregoing, the purchaser has a little flexibility in the placing of controls, whereas in most commercial wooden cabinets, one has to conform to those positions already drilled, not to mention the possible unsuitable finish given to the cabinet by the manufacturer.

The Circuit

The circuit diagram is shown in Fig. 1, and from this it will be seen that it is an AC-operated receiver using the Mullard B8A series of valves. The RF stage consists of an EF41 RF pentode with a potentiometer in the cathode circuit controlling the receiver gain. The EF41 is a variable-mu pentode particularly suitable for this receiver. The slope of this valve, in the absence of any control, is some 2.2mA/V. The entire electrode system is enclosed within a metal shield internally and therefore no external shielding is required. The anode and control grid wires are also screened and the grid-to-anode capacitance is only some 0.002pF. The risk of feedback from anode to control grid is therefore reduced to a minimum. In the RF stage, a conventional arrrangement, the component values have been so chosen that the output from the EF41 is sufficient to adequately drive the detector stage without, at the same time, any overloading.

The following portion of the circuit is constructed around the EF42 RF pentode which serves admirably as a detector. The EF42 has a slope of 9mA/V with an anode current of 10mA; the input capacitance is 9.4pF while the output capacitance is only some 4.3pF. Again, the valve is internally screened and all the electrodes are connected to separate pins.

In the circuit diagram it will be noted that the reaction circuit is shown in thicker line than the remainder. The reason for this is that the prototype, operated near London, did not require these connections and therefore they were omitted. Partly due to the layout adopted, it was found in practice that both the Home and the Light programme could be tuned in without difficulty—or the application of regeneration. In other areas further removed from local transmitters, however, it may be found that the inclusion of a reaction circuit is necessary.

The resulting rectified signal from V2 is fed into the output stage via resistance capacitance coupling. In regions where a

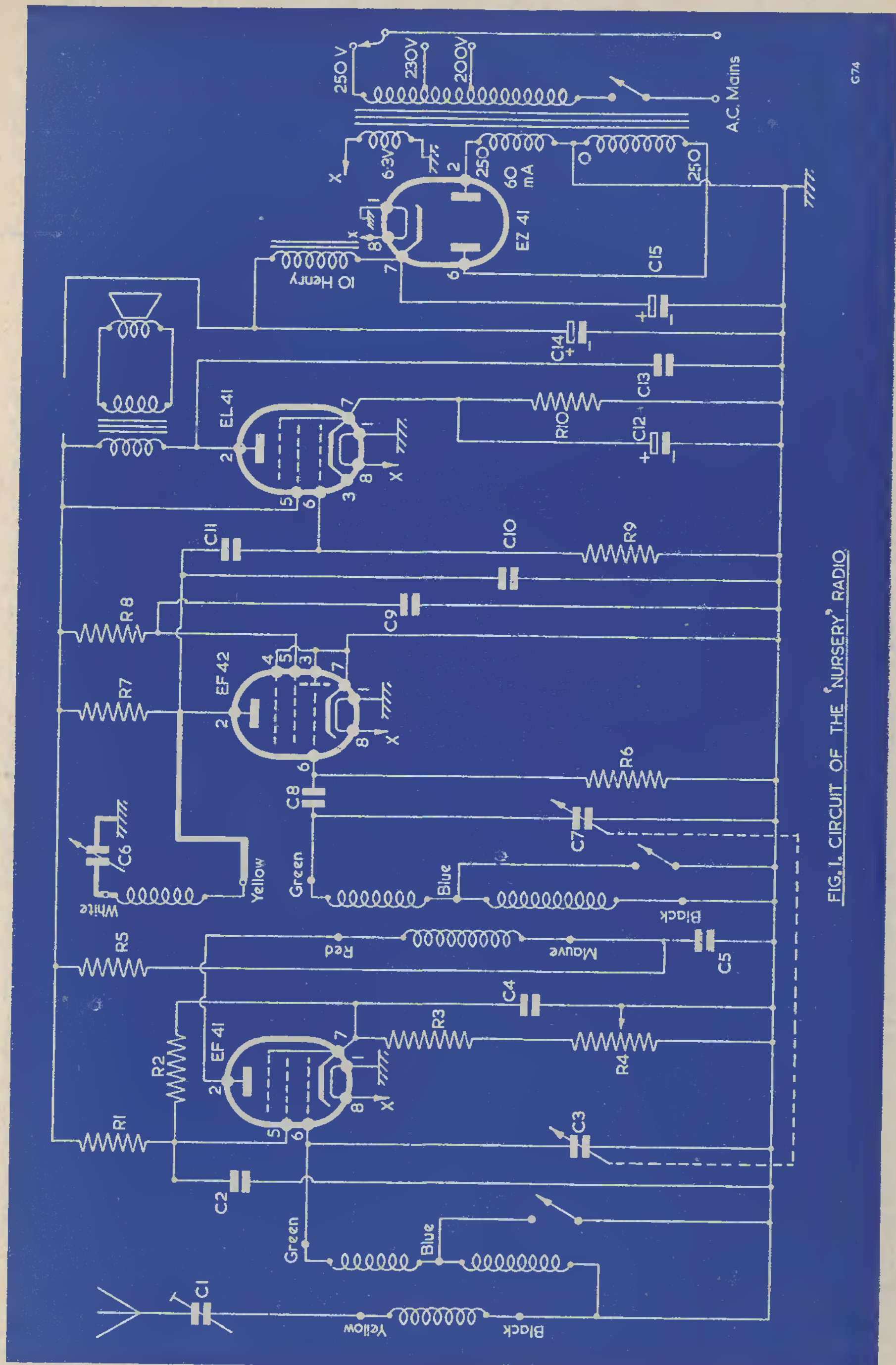


FIG. 1. CIRCUIT OF THE 'NURSERY' RADIO

very strong signal is apparent, it may be advisable to insert an additional resistor of some 10kΩ as a grid stopper in the output valve. This valve, the EL42, has a maximum output power of 2.8 watts with 225 volts on anode and screen grid. The heater current consumption is very low, only some 200mA, and with this small amount the slope is some 3.2mA/V. The audio output achieved is ample for the average nursery or child's bedroom—or the kitchen for that matter. The output stage has been kept as simple as possible, mainly in the interests of economy, and therefore no additional circuits such as tone controls, etc., have been incorporated although there is no reason why these should not be included if the constructor so desires.

The power pack includes the EZ41 rectifier which is capable of rectifying current up to 60mA, hence the use of the Ellison type MT162 mains transformer, which is rated at that figure. The maximum AC voltage to be rectified by the EZ41 is 2 × 250 volts RMS.

The receiver will be found most satisfactory for the purpose for which it was designed. As a secondary domestic receiver its performance is well worth the construction and time expended.

Component List

Set out for easy reference to Fig. 1 on facing page

R1	100kΩ ½ watt
R2	22kΩ ½ watt
R3	270Ω ½ watt
R4	25kΩ pot.
R5	10kΩ ½ watt
R6	1.5MΩ ½ watt
R7	220kΩ ½ watt
R8	220kΩ ½ watt
R9	330kΩ ½ watt
R10	270Ω ½ watt

LF Choke—10 Henry, 60mA
Mains Transformer—Ellison Type MT162
Coils—R.E.P. Products, Matched Pair, TRF
Valves—Mullard EF41, EF42, EL41 and EZ41
Cabinet, Panel and Chassis—Kendall and Mousley
Speaker Transformer—Goodmans, Type 74/243.
Speaker—Miniature 2½″.

C1	250pF Mica
C2	0.1μF Tubular TCC
C3, C7	500pF variable, ganged
C4	0.1μF Tubular TCC
C5	0.1μF Tubular TCC
C6	300pF Mica variable
C8	100pF Mica
C9	0.1μF Tubular TCC
C10	500pF TCC
C11	0.01μF Tubular TCC
C12	25μF, 25v wkg, Electrolytic
C13	0.005μF Tubular TCC
C14	32μF, 350v wkg, Electrolytic
C15	16μF, 350v wkg, Electrolytic

FM COMPETITION

The Radio Constructor is offering prizes of (1) 2 guineas, (2) 1 guinea, and two consolations of 10*s* 6*d* to the senders of the most informative report of reception at distances greater than 80 miles from Wrotham. The report should be concise, but should cover the following points:

(1) Type of aerial (1, 2 or 3 elements), and height.
(2) Approx. height of location above sea level, if known, or whether the site is shielded by hills from Wrotham.
(3) Comparison of reception with the local medium wave service.
(4) Details of FM Tuner or Receiver.
(5) Details of other equipment in use, e.g. 8-Watt push-pull output with 10″ speaker in bass reflex cabinet.
(6) Reliability of reception, and any other useful information.

ALL REPORTS SHOULD BE SENT TO ARRIVE AT:

"FM Contest," The Radio Constructor, 57 Maida Vale, London, W.9., NOT LATER THAN MARCH 10TH, 1955.

Let's Get Started 20:
TEST EQUIPMENT

By **A. P. BLACKBURN**

If radio covers a wide variety of incidental subjects, the scope of test equipment must naturally be as broad. In fact, probably half the time an enthusiast spends at his bench building receivers, transmitters and similar equipment is given over to the construction of instruments which will enable him to test the performance of that equipment. The reader need only glance through these pages over the last two years to be convinced of that.

But to the beginner, the array of valve voltmeters, signal generators, bridges, and so on, can be a formidable and bewildering one. So this month we shall be talking about what these instruments are used for.

The measurement of voltage and current by direct means has already been covered. This month, some of the other techniques used in radio testing are described.

Generally speaking, test equipment falls into two groups; one is signal sources and the other is the means used to measure all the quantities met with in the receiver itself. For the moment we will concentrate on the first group.

Signal Generators

The purpose of a signal generator is to emulate a radio signal as it is received from a transmitter. In addition, the signal from the generator must be more precise in some respects than an ordinary signal in the aerial. For one thing, as we shall see later, we may wish to know quite accurately the signal voltage. We shall also want to know the frequency, so the instrument must be calibrated. And for overall receiver testing, modulation of the generator RF output must also be incorporated.

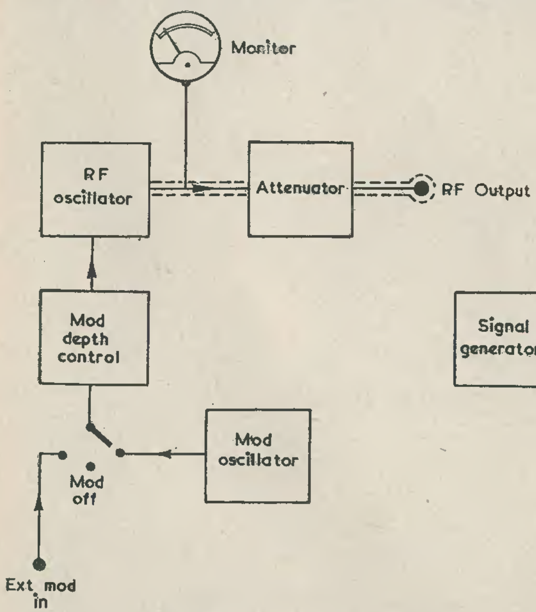


FIG.1.

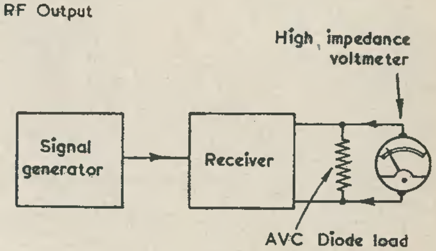


FIG.2.

G110

A block diagram of a typical signal generator is shown in Fig. 1. Basically, it is a stable RF oscillator, continuously covering all the frequency bands from 100 kc/s to perhaps 50 or 60 Mc/s. The output is fed to an attenuator, which is a device for controlling the output. The control is calibrated, so that the RF voltage being fed to the receiver is accurately known.

Incorporated in the instrument is an audio oscillator which modulates the RF carrier in the same way as a transmitter. Switching is included so that external modulation of a frequency may be fed in if desired. The modulation voltage being fed to the RF oscillator is controllable, so that the depth of modulation may be varied.

In this form the instrument provides a signal of known frequency and amplitude optionally modulated to a known depth at a known frequency. Knowing all this about the signal enables you to measure and estimate just what the receiver is doing with it in terms of gain, distortion, bandwidth, etc.

The basic parts of the circuit need little explanation, particularly as a recent series of articles in this publication has dealt thoroughly with signal generator design. The important features are that the RF oscillator needs to be stable in frequency, and calibrated accurately; that the modulation should not introduce frequency modulation, and the modulating oscillator should have a good waveform.

The Wobbulator

An interesting variant upon the straightforward signal generator is what is colourfully described as the wobbulator. Before we go into the workings of this instrument, we should discuss the application of an ordinary signal generator.

We can imagine that we want to measure the frequency response of a receiver. One method of proceeding is shown in Fig. 2. The signal generator is connected to the aerial terminal of the receiver and a high impedance DC voltmeter is connected across the AVC diode load. The receiver is tuned to, say, 1 Mc/s.

The input signal is adjusted to such a level that, when it is also 1 Mc/s a reading is obtained upon the voltmeter. Now the signal generator is detuned both ways from 1 Mc/s in, say, 2 kc/s steps. The reading on the voltmeter will change, and these readings are recorded for each frequency setting. The result may be plotted and should look like Fig. 3. As you can imagine, this takes some time, and if the result is unsatisfactory, and adjustments are necessary in the receiver, the whole process may have to be repeated several times. Which is where the wobbulator comes into the picture.

In this instrument, the frequency is automatically changed at recurrent intervals. The simplest type consists of an ordinary oscillator, but the tuning capacitor is turned continuously by a motor. The frequency will change, therefore, in step. The voltmeter connected across the diode load will now move up and down on the scale, and will therefore mean very little. The remedy is to feed the X plates of a cathode ray tube with the sine wave driving the motor, and the Y plates with the voltage from the diode

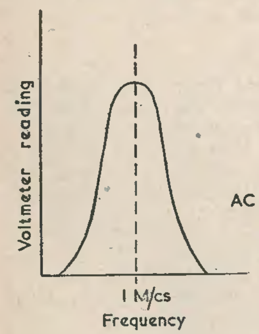


FIG.3.

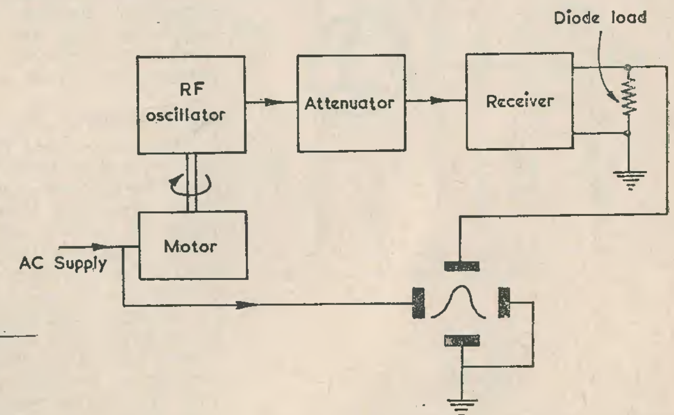


FIG.4.

G111

load. The X plate voltage produces a straight horizontal line on the CRT screen, and the diode load voltage deflects the trace vertically. The result is a picture on the screen like Fig. 3.

Of course, there are numerous refinements in this type of instrument, which I have not mentioned. One is electronic sweeping, where no motor is required. The basic principles are always the same, however.

The wobbulator (sometimes called a swept signal generator) is particularly useful in television work, where accurate and rapid alignment of the various tuned circuits is very important.

A block diagram of a wobbulator is shown in Fig. 4. This may help if the description has been too brief.

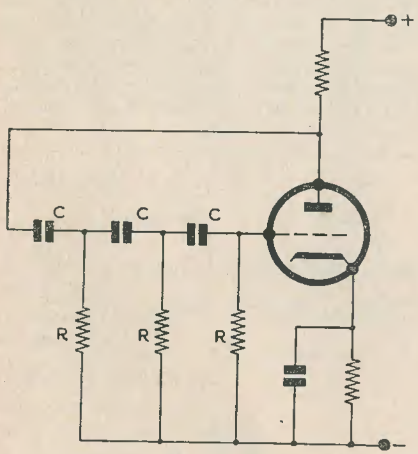


FIG. 5.

G112

Audio Sources

Audio generators serve the same purpose as the RF signal generator, except, of course, in respect of their frequency range. A good audio generator should cover a range of 10 c/s to 20 kc/s. Whereas in the RF generator the tuning circuit consists of an inductance and a variable capacitor, the audio generator is a little more complicated. The reason for this is the size of the L and C required. For example, at 10 c/s with an 0.0005μF tuning capacitor the inductance would have to be 500,000 Henrys! We could, of course, get things into proportion by trying a 20 Henry choke, which would require a 12.5μF to tune it. Although this would be a little more practical, it may be rather difficult to find a 12.5μF variable capacitor! So it looks like we shall have to discard any ideas of L and C tuned circuits, and use instead one of the other two types of circuits that there are. One is the beat frequency oscillator and the other is the resistance capacity oscillator. The first of these really consists of two oscillators, both working somewhere in the lower RF range, at a frequency of 100 kc/s or so. One oscillator is fixed at this frequency and the other tuned. The two are mixed, or beat, together and the difference frequency is extracted. The principle is the same as frequency changing in a superhet, where signal and local oscillator are mixed and the difference (IF) extracted.

If 100 kc/s is chosen, the variable oscillator will need to tune from 100 kc/s to 120 kc/s to produce an output variable from 0 to 20 kc/s. There are many disadvantages in this circuit. One is that when the two frequencies are nearly the same, the oscillators tend to fall into step. This limits the lowest frequency obtainable. The distortion in the output waveform (which should be perfectly sinusoidal) depends upon each of the oscillators, and the mixing system. For these reasons, the RC oscillator has become increasingly popular in the last few years.

RC Oscillators

These take many forms and depend for their operation upon the phase shift produced by resistance-capacitance circuits.

An elementary type is shown in Fig. 5. Each CR section produces a phase shift of 60°. The total phase shift is, therefore, 180°. The operation is as follows: A disturbance at the grid is shifted through 180° by the valve and amplified. The amplified signal is fed back to the grid and shifted a further 180° in the process. The disturbance arriving at the grid is therefore in phase with the original one, and oscillation will take place. Oscillation is only possible, of course, if the signal reaching the grid is larger than the initial signal, i.e., that the valve has a greater gain than the RC networks have attenuation.

A three stage RC network of this type has an attenuation of 29 at the operating frequency. The values of R and C may be calculated from:

$$f = \frac{1}{\sqrt{6}\,\pi RC}$$ where R is in MΩ; and C is in μF; f is in c/s.

In a previous article on Phase Shift, it was pointed out that the phase shift in an RC circuit varied with frequency. There is, therefore, a particular frequency which produces a 60° phase shift in each of our networks. The result is that the phase conditions for oscillation are only correct at this particular frequency.

The disadvantage with this type of phase shift oscillator is that, in order to vary the frequency, three resistors (or three capacitors) have to be varied in step, that is, ganged together. This is rather unwieldy, so another type is often used, in which only two ganged elements are required.

The Wien Oscillator

This type is derived from a circuit known as the Wien bridge. We will have more to say on bridges generally later, but a brief description of this type will make its use in an oscillator clearer.

If a source of AC voltage is applied between terminals CD in Fig. 6a, and a detector (say a meter) were connected between points A and B, current would flow through the meter if the voltages across arms AD and BD were different. Now the reactances of C_1 and C_2 vary with frequency. If, then, the frequency of the applied voltage were varied, it is possible that the impedance of arm CA would become equal to CB, and arm AD become equal to BD. When this occurs, the voltage between points AB is in phase with the applied voltage between points CD. If an amplifier with 360° phase shift (remember that 360° shift brings the voltage back into phase, full cycle, so to speak) were connected between AB and CD, oscillation would result, at the frequency which fulfilled the above conditions. Such an oscillator is shown in Fig. 6b.

Here only R_1 and R_2 or C_1 and C_2 are required to be variable and two elements only, therefore, have to be ganged. A frequency range of 10 c/s to 100kc/s is obtainable from such an oscillator. A large range like this is normally covered in four or five switched ranges. In Fig. 6b, range changing is carried out by switching the value of C_1.

The frequency of oscillation is given by

$$f = \frac{1}{2\pi\sqrt{CR}},$$ where C and R are in the same units as before. Audio generators are normally fitted with attenuators in the same way as the RF type. In some cases where power is required in, for example, loudspeaker testing, an amplifier is built in and a power output stage incorporated.

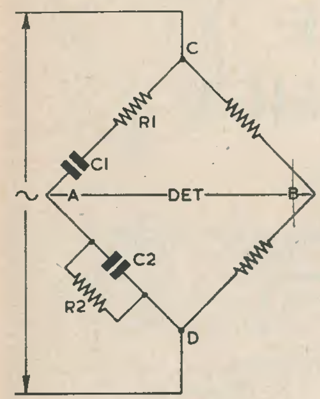


FIG. 6 (A)

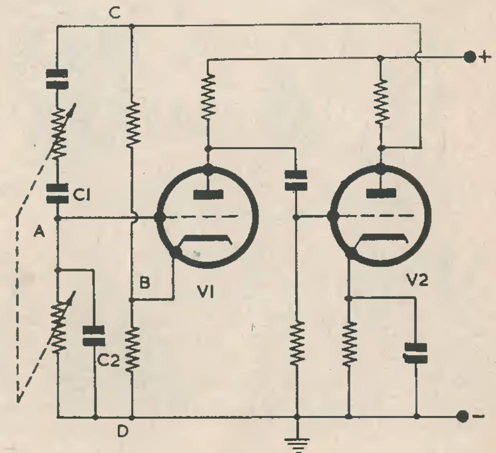


FIG. 6 (B)

G113

Output Monitors

In all tests involving the use of signal generators, whether they be RF or audio, it is important to know the output voltage (or power) and to have means of adjusting it. Also, few oscillators produce a constant output over the full range of the frequency control. This latter point may readily be appreciated if an amplifier response were being plotted, using an audio generator whose voltage output was different at each frequency.

In the case of audio generators, the output may be measured directly with a valve voltmeter, because the voltage required is seldom less than 100 mV.

An RF generator has to provide a voltage output down to microvolts, if the receiver under test is particularly sensitive. To measure such small voltages is extremely difficult. What is done is to measure the voltage at a relatively high level, say, 1 volt, and then to accurately attenuate it.

In order that the output voltage shall be truly what the monitor meter and attenuator indicate, screening becomes very important. In very high grade RF signal generators, it is normal to place the oscillator and all its related components in a box made from copper. All power leads going to and from the box are carefully filtered and the actual RF output leads are heavily screened. The whole instrument is then mounted in a further heavy case, and the mains lead filtered.

A badly made signal generator can overload an average receiver by radiation from yards away, without any connection between them, despite the fact that the attenuator says that the output is only 1 μV.

Having disposed of sources from which to feed the apparatus under test with known controllable signals, next month we can have a look at some ways of measuring what happens to the signal on its way through the circuitry.

A FLEXIBLE AF MIXER DESIGN

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

Most disc or tape amplifiers have provision for only one input to be used at a time. While this is no disadvantage for record playing, a recordist may often wish to mix several microphones, or microphone and radio, etc. Hence, the following basic circuit was evolved to allow two simultaneous inputs to be controlled independently of each other.

Basic Circuit

A twin-triode valve is used, both halves acting as conventional class A R-C-C amplifiers. The cathode resistors, Rk, have no by-pass capacitors: this incorporates a fair amount of negative feedback, serving to even and to extend the frequency response, and to offset the "Miller Effect" inherent in triodes.

Table 1

V	*Rl*	*Rk*	*Rs*	*Gain*
6SL7	250 kΩ	3.3 kΩ	500 kΩ	17
12AU7, 12AH7	50 kΩ	3.3 kΩ	500 kΩ	2.2
			1 MΩ	1.6

Table 2
Value of C

Heater Rating	210/220	230/240
12.6V, 0.15A	2.25μF	2 μF
6.3V, 0.3A	4.5μF	4 μF

The outputs are taken through the series resistors, R_s, which prevent the two halves of the circuit from damping each other. The combined output is isolated from the chassis by 0.1 μF capacitors since no HT transformer is used.

The HT supply is from a half-wave metal rectifier, resistance-capacity smoothed. The LT supply is less conventional, since a capacitor, C, is used as a voltage-dropper. If preferred, a heater-transformer may be substituted.

Variations

(i) Overall gain. Table 1 gives three values of gain to suit the succeeding amplifier. The gain of 17 would allow correction networks for pick-ups to be placed before the mixer, if not included in the main amplifier. The two very-low-gain cases are for use when overloading of the amplifier input is likely.

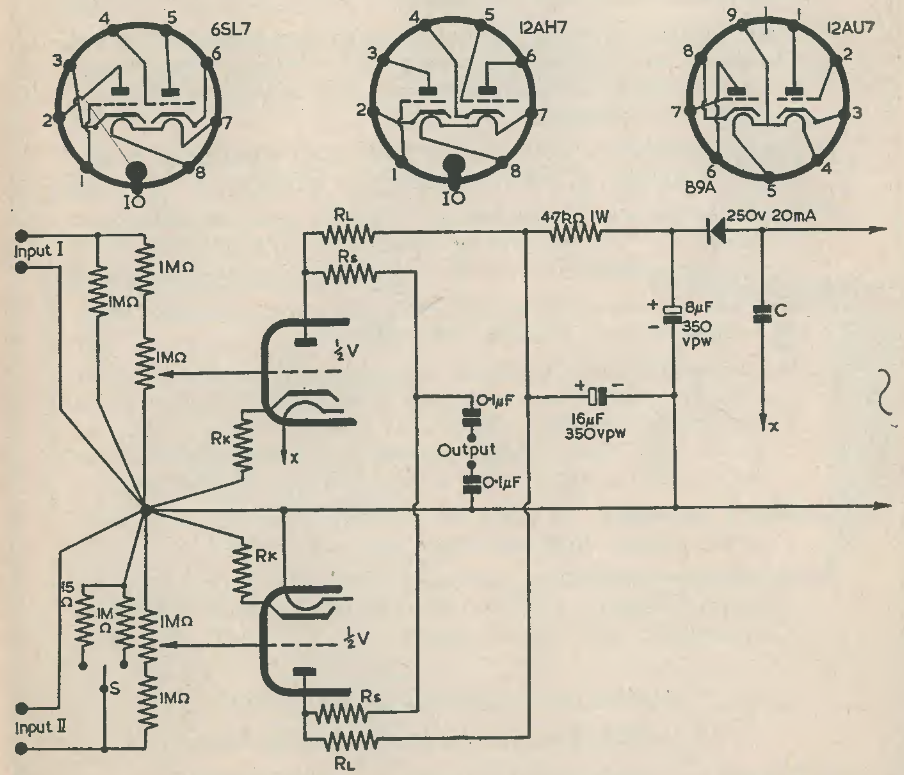
(ii) Input impedance. One input is fixed at 1MΩ, while the other has a switch, S, to select either 1MΩ or 15Ω. These values can, of course, be varied or extended. Both inputs may be made adjustable, and to include 3Ω, 600Ω, 50kΩ, or other frequently occurring values if desired.

(iii) Heater supply. Three valves have been quoted: 6SL7 is 6.3V, 0.3A; 12AH7 is 12.6V, 0.15A; 12AU7 has a centre-tapped heater, and so can be either of these two. Table 2 gives the necessary capacity of C for each valve, over two supply-voltage ranges. If the mixer is to be used always on the same supply-voltage, C can be set permanently to the correct value. But, if variation is likely to occur, C can be made either 2 μF or 4 μF, with the extra 0.25 μF or 0.5 μF brought out to a switch or tapping-panel. All capacitors used here should be good quality, paper types, of at least 500V wkg. Electrolytics are not suitable.

The advantages of using a capacitor rather than a transformer are twofold. First, there is no associated magnetic field to induce hum in other parts of the circuit. Second, since the impedance of the capacitor is far larger than that of the valve heater, it controls the current virtually irrespective of the heater resistance. Consequently, there is no initial current surge through the heater, although the resistance takes the usual 30 seconds or so to build up to its maximum.

Construction

All usual precautions associated with low-level amplification must be observed. The input components and bias resistors should all be connected to the chassis at a single point, as shown in the circuit diagram. Grid leads must be short, and screened where they exceed mere connection length. If the capacitor C is replaced by a heater-transformer, one having a centre-tap should be used. Alternatively, a centre-tap can be created by using a 50Ω or 100Ω wire-wound potentiometer, the slider of which is joined to the chassis, and adjusted for minimum hum-level.



EJ07

Note: Isolating condensers should be fitted to the inputs

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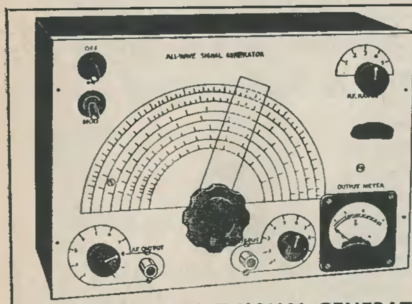

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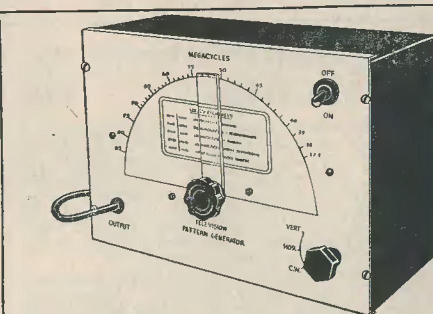

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[continued on page 448

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continued from page 447]

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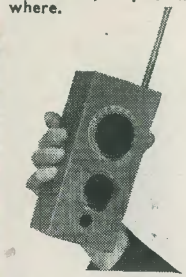

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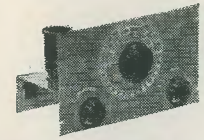

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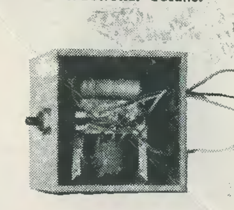

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