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The RADIO CONSTRUCTOR

for the Radio and Television Enthusiast

JUNE 1953

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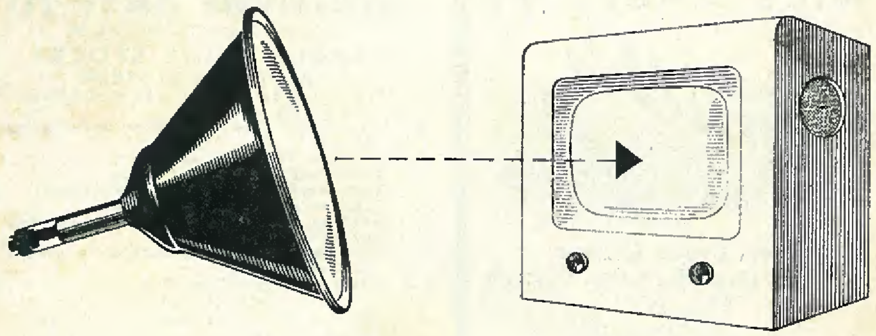

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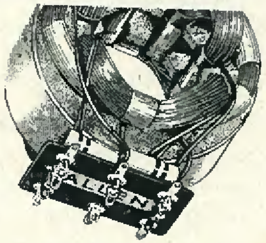

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The Radio Constructor

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Edited by C. W. C. OVERLAND, G2ATV

CONTENTS

NOTICES

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

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

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A Companion Journal to THE RADIO AMATEUR

Suggested Circuits for the Experimenter

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

No. 30 An Accurate Null Indicator

The accurate presentation of null indications as obtained from bridges and similar measuring devices can sometimes be a little difficult to achieve. When a high degree of accuracy is required it is usual to employ a meter or a cathode-ray indicator (Magic Eye) to indicate the point of balance. Very often, however, an aural method is employed, in which case the point of balance is given by an AF tone at minimum volume level.

This month's circuit illustrates a simple device which is capable of giving a very accurate presentation of balance. The indication is still of an aural nature, but the point of balance is not shown by changes in volume level. Instead, it is shown by variations of frequency of an AF tone; the null point corresponding to maximum frequency change. It is this point which gives the indicator its high degree of accuracy, since the ability of the ear to differentiate between audio frequencies (even when they closely approach each other) is greater than its ability to judge volume levels.

To use the indicator described here, it is essential that the bridge to which the indicator is connected is operated from AC instead of DC. The choice of AC has no effect on the AF tone heard by the operator, and its frequency may lie anywhere between, say, 10 Mc/s and 25 c/s.

A simple resistive bridge is shown in the diagram; but this is merely for purposes of illustration and may, of course, be replaced by any other type of bridge.

Operation

The operation of the circuit is quite simple. A varying amount of AC from the bridge is fed to the CR circuit C1/R1. The values of these components are such that the rectified negative voltage (relative to cathode) appearing at the grid of V1 very nearly equals the peak voltage of the AC output from the bridge.

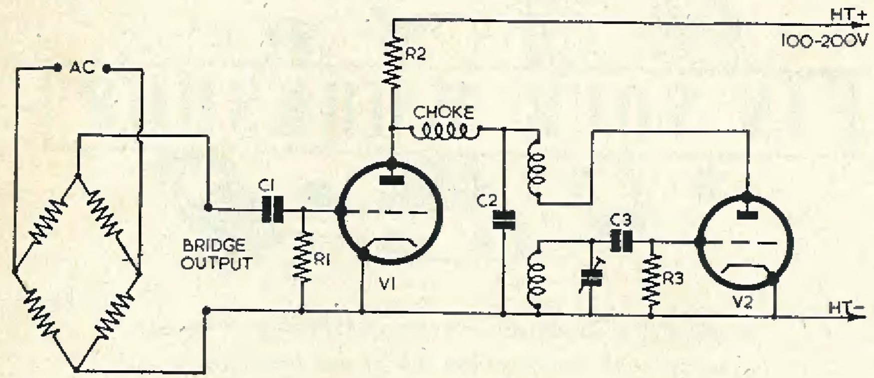
The grid voltage of V1 varies, therefore, according to the AC obtained from the bridge. When this AC is at a minimum (corresponding to the point of balance) the negative grid voltage of V1 is at a minimum also, its anode current being, consequently, at a maximum. The result of this is that the voltage dropped across R2 is at a maximum also.

V2 is an RF oscillator which receives its anode voltage via R2. When the bridge is balanced, the action of V1 causes this anode voltage to be at a minimum. Owing to the fact that a simple oscillator (such as the tuned-grid circuit of V2) varies in frequency when its anode voltage varies, it follows that the frequency of V2 will vary as the bridge is balanced, maximum variation occurring at the point of balance. The oscillations generated by V2 are picked up on any receiver fitted with a BFO, whereupon the change in oscillator frequency is converted to a change of AF tone.

Practical Details

The circuit shown here should offer little trouble in practice. The valves used may be of the 6J5 class, and, if desired, can be combined in a single double-triode. V2 should be capable of oscillating comfortably over the fairly wide range of anode voltages passed to it. The choke in the anode circuit of V2 should be an RF or an AF component according to the frequency of the AC used by the bridge. If the frequency of this AC is very low, C2 may have a value of 1 μF. For higher frequencies 0.1 μF should be sufficient.

The value of R2 will need to be determined



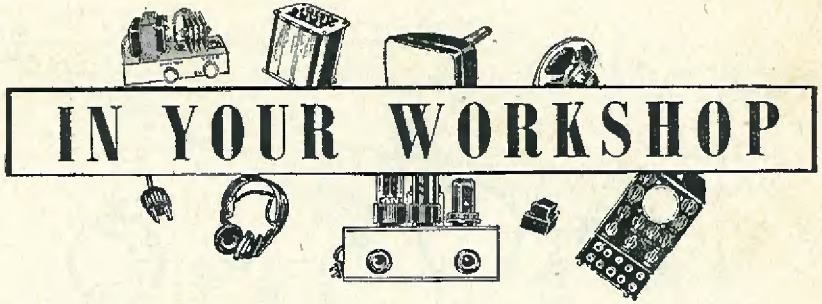
AN ACCURATE NULL INDICATOR

RC180

experimentally. It should be sufficiently high to cause a relatively large variation of oscillator frequency without dropping the anode voltage of V2 to too low a value at the point of balance. A value of 5 to 50 kΩ will probably be needed here.

The oscillator should work between 10 and 20 Mc/s, the actual frequency being unimportant. The receiver should be so set up that the point of balance is indicated by a fall in audio frequency, and not by a rise. Sufficient input to the receiver will, in most cases, be obtained by positioning its aerial lead close to the oscillator.

"Tell me, how long have you been suffering from reversed line scan?"



IN YOUR WORKSHOP

In which J. R. D. *discusses Problems and Points of Interest connected with the Workshop side of our Hobby based on Letters from Readers and his own experience.*

It is interesting to note how popular in the United States are commercially-made cathode-ray tube "rejuvenators" for television receivers. These rejuvenators are used with cathode-ray tubes whose emission has fallen with age, and it is claimed that they bring a large number of these tubes back to their original emission and brightness. They function by applying a greater heater voltage to the tube than is supplied by the set in which it is fitted and for which the tube was designed. Not quite so popular, apparently, are "reactivators." These are intended also to bring low-emission tubes back to normal and function on the "flashing" principle which was applied to battery valves many years ago. A reactivator subjects the tube heater to something like a 50 per cent overload for a minute or two, this being reduced to a slight overload which is held for a longer period. Reactivation does not seem to offer as many "cures" to worn tubes as does rejuvenation.

Rejuvenators

Rejuvenators function by permanently increasing the heater voltage to the tube; this being achieved usually by connecting a simple step-up auto-transformer between the heater voltage supplied by the receiver and the heater pins of the tube. The voltage increase given by the auto-transformer is around 25 per cent. Some rejuvenators use transformers with isolated primaries and secondaries, this being done mainly to obviate cathode-heater shorts which may occur at the increased temperature. One rejuvenator uses a transformer with a mains voltage primary. The heater voltage originally applied to the tube then heats a resistance element fitted to a bi-metal strip. On switching on the receiver the original heater voltage causes this strip to bend, thereby switching in the primary of the rejuvenator transformer. This type of rejuvenator is especially useful for receivers with AC/DC power circuits.

Owing to the fact that the low-voltage transformers used in nearly all rejuvenators may be made very small indeed, these components can be more or less "hung in the wiring" or built into plug adaptor housings. All rejuvenators appear to have an adaptor plug and socket joined together by a short flexible harness, and are installed by simply unplugging the tube socket and fitting the adaptor socket in its place. The original set socket is then fitted to the rejuvenator adaptor plug. In one or two instances, however, the rejuvenator transformer is mounted in a case which has to be screwed to the set chassis or cabinet.

Many American technical radio magazines nowadays carry rejuvenator advertisements; and it is possible to obtain a very good idea of their respective physical sizes and trends in circuit development by studying these advertisements. The retail prices lie between three and ten dollars.

Rejuvenators seem to be becoming fairly standard servicing practice in the United States, so far as one can judge from isolated articles on this subject. Whether the same will occur in Great Britain is difficult to decide. So far as the home-constructor is concerned, of course, rejuvenator transformers would be very easy to make or adapt. One point not stressed in the American literature or advertisements, however, is that, whilst a rejuvenator may bring a new lease of life to a low-emission tube, it may also ruin it. Nevertheless, if a tube is in such a bad state that it would be thrown away in any case, the use of a rejuvenator transformer might not be disadvantageous

Another point which is also not stressed is the question of how long a tube stays rejuvenated at its new heater voltages. This is understandable, of course, because such a period of time can hardly be predicted. Apparently, increased lives of a year have been obtained; whilst, on the other hand, no one is surprised when the tube becomes "un-rejuvenated" all over again within a month.

Before concluding on this subject, I should like to point out, as my own opinion, the fact that some of the spectacular successes claimed to have been given by these rejuvenators might, perhaps, need to be taken with a pinch of salt. Low mains voltages and inefficient mains transformers are not unknown, even in the States. It might happen, in one or two cases, that a cathode-ray tube has been working for a long time at a heater voltage, say, 10 per cent lower than that it was designed for. Increasing that voltage by 25 per cent (or, even, increasing it just to the correct value), would be almost certain to result in higher emission for quite an appreciable length of time.

Cheap Rectifiers

I was very interested in R. W. Hill's article in the December issue in which he described how he managed to use a surplus double-triode as a full-wave rectifier by strapping together the anodes and grids of each section. It also brought back war-time memories to me (and doubtless to other readers) of some of the haywire power supply circuits we used during this period, when rectifiers and transformers could not be obtained.

I remember building one receiver (a four-plus-one with 6V6 output), in which a single home-made 6.3 volt transformer supplied all the heaters including that of the "rectifier." HT was obtained direct from the mains by half-wave rectification, and I found that American "metal" valves used to cope quite well with the resultant 200 volts or so which appeared between heater and cathode. The "rectifier" used was a 6J5 with grid and anode strapped! It says a lot for the manufacturer that it never broke down.

An even more spectacular circuit (for which I was not responsible!) gave half-wave rectification at 300 volts with no limiting resistor. The builder had fitted a 200 mA fuse in the HT circuit, but the ripple current used to burn it out now and again. The heater of the "rectifier" was at chassis potential. In this case, a metal 6L7 was used.

It seems incredible that valves can be so execrably treated and still continue to work. These two circuits, incidentally, are very definitely not recommended for present-day use!

Tag-Board Leakage

I recently had the task of servicing a receiver which had an HT leak. This leak showed a steady resistance of approximately 500 ohms between the HT positive line and chassis, and was a little difficult to discover. I eventually ran it down to a tag-board which had a hidden leak on the underside of the paxolin between an HT positive tag and a chassis-mounting rivet.

Leaks on the surface of an insulator of this type are common enough, although it is rare for them to have a constant value of resistance. They are usually caused originally by a spark which breaks down the material on the surface of the insulator, and so causes a fine carbon track. This assists further sparks until a definite leak or short is established. The fault is usually prevalent if the equipment has been kept for a long time in a steamy or humid atmosphere which had allowed condensation on to the surface of the insulator.

An easy way of discovering such a leak consists of connecting an ohmmeter between the two associated lines (such as HT positive and chassis in the case just mentioned), and lightly pressing suspected tag-boards and similar components one by one. As the unwanted carbon track makes contact to the circuit via solder tags or chassis-mounting nuts riveted to it, this pressure causes it to be momentarily connected and discovered, whereupon the ohmmeter needle flickers or shows a new reading.

The same sort of fault occasionally occurs in valve holders and switch wafers. In switch wafers it can sometimes be particularly difficult to find, since the leakage may occur in the small rotating disc in the centre of the wafer.

ASTIGMATISM IN ELECTROSTATIC CATHODE RAY TUBES

(*Continued from page 528*)

have been undone, and the spot will be elliptical once more.

The only method would appear to be to carry out the adjustments on a picture or test card. This can be a little tricky. It is not too easy to adjust two potentiometers at once and observe the effect accurately.

A rather simpler method, shown in Fig. 4, is particularly applicable if control of spot shape is required on one pair of plates only. This is to retain the single potentiometer control of shift, and to supply the final anode of the tube also from a separate potentiometer.

Valves and their Power Supplies

Part 7

By F. L. Bayliss A.M.I.E.T.

Voltage Doubling Circuits

This short series of articles is not meant to be a treatise so much as a handy and possibly useful guide to the radio constructor in his dealings with power supplies. It cannot, therefore, even pretend to cover the subject fully, but even as such it cannot be conducted without a mention of television and voltage doubling practice.

The two — voltage doubling and television—are not mentioned together because they have always been associated thus. Voltage doubling existed long before television even left the dreams of its pioneers; only latterly has the marriage occurred, and a highly convenient wedlock it has been, and is.

In fact, it is pretty safe to say that nowhere, except in television, will the constructor have to use a doubler circuit.

Our first circuit, however, is not concerned with doubling a high voltage in order to get an even higher one.

It may be of close interest to the constructor of a VCR97 tube televisor, though. He, perhaps taking his HT voltage from a 250V transformer for vision and sound receivers, is left stranded for the 400 to 500V necessary to operate a Miller-transitron timebase circuit.

Usually, only the anodes of four paraphase valves need to be supplied at 500 volts, and the current is well under 20 mA.

By taking 250 volts from the cathode of the full-wave rectifying valve, via C_3, Fig. 19, to the junction of the metal rectifier MR1 and MR2, the ripple voltage across MR2 is again rectified by MR1 and the full mains voltage (250V) appears across each rectifier, giving double the voltage between the final HT point and chassis.

The value of C_5 is chosen to pass a current not exceeding the rating of MR2.

The rating of MR1 and MR2 should be adequate to cover the external circuit current, 20 mA.

Selenium rectifiers rated at 250V 30 mA are quite inexpensive, and are suitable.

To find the value of C_5, MR2 may be assumed to have negligible DC resistance and, therefore, the voltage across C_5 to be the full 250V.

The reactance of C_5 is

$$\frac{10^6}{2\pi fC}$$

where f=mains frequency and C=μF.

As, by Ohm's Law, this reactance also equals $\frac{E}{I}$, we may say that

$$\frac{10^6}{2\pi fC}=\frac{250\times 1{,}000}{30},$$

where 250=the supply voltage, across C_5, and 30=the current to be passed by C_5 (to the rectifier rating).

Therefore $C\mu F=\frac{10^6\times 30}{2\pi f\times 250\times 1{,}000}=0.382\ \mu F.$

In practice, MR2 will have resistance, although its value compared to the reactance of C_5 at 50 c/s (8,333Ω) will be small.

As the current through MR2 is not steady DC, the value of C_5 may be much greater than the calculated one and, in practice, 0.5 μF or 1.0 μF are permissible.

C_3 should have a DC working voltage of at least 750.

An EHT Circuit

If the constructor has a transformer rated at 500–0–500 volts he has no HT problem, except to drop this voltage to a value suitable for the sound and vision receivers.

If he were content with a fairly low EHT voltage — 1,500 volts — his EHT, too, could be obtained in a manner similar to Fig. 19 previously discussed.

The connections for such an EHT arrangement are shown in Fig. 20. MR1 and MR2 may each be rated at 600 volts. The capacitors C_4, C_5 and C_6 should be rated at 1kV DC working voltage, at least; 1.5kV if possible.

With this arrangement, the cathode ray tube anodes and deflector plates are connected to the HT+ line (via their control resistors and potentiometers), whilst the tube grid and

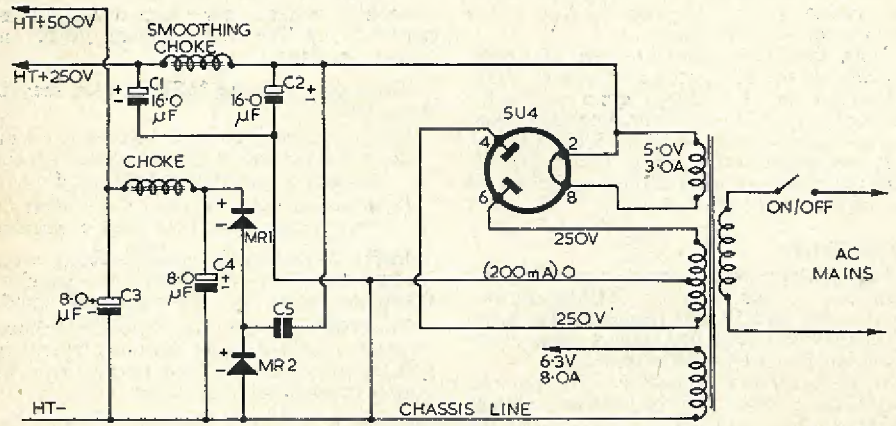


FIG. 19

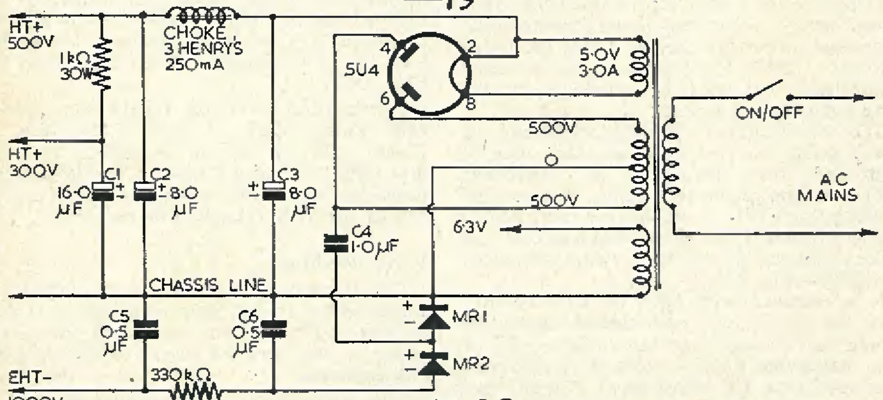


FIG. 20

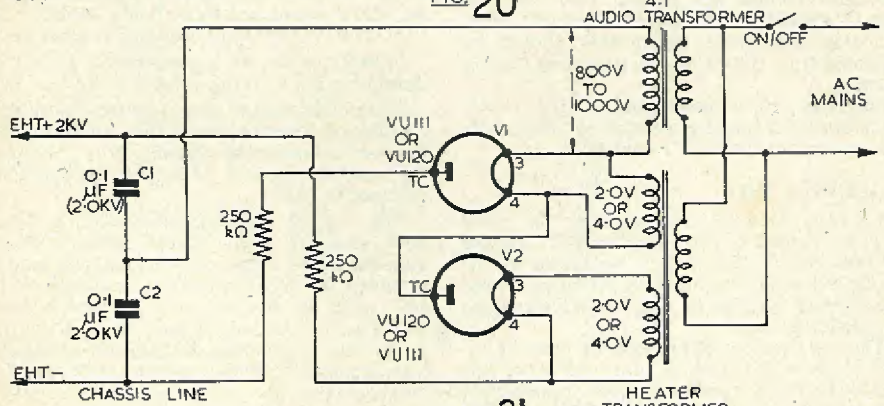


FIG. 21
AN ARRANGEMENT FOR POSITIVE EHT

Magnetic Recording Equalisation

—with some amplifier modifications

By L. F. SINFIELD A.M.I.P.R.E.

One of the chief difficulties in magnetic recording is to obtain correct frequency compensation in the amplifier.

If a recording is made on good grade tape, such as "Scotch Boy" tape at 7½″ second, with a head gap of between 0.5 and 0.75 "thou," then if the recording is made at constant current the playback amplifier will require approx. 18–20 db boost at 100 cycles, no boost around 2 kc/s and approx. 15–18 db boost at about 8 kc/s.

To obtain maximum signal-to-noise ratio it is obvious that the maximum recording level should be used, but the peaks should not extend into the saturation point of the tape. This is almost unavoidable, however, in general practical applications, but the number of such peaks can be kept down by good recording technique, and the best use of microphones and the best recording level can soon be determined with experience.

The fall-off in bass reproduction at a rate of 6 db per octave is a basic characteristic of magnetic reproduction of a constant amplitude recording (similarly the bass fall-off in disc recording). Consequently, it is not advisable to emphasize the bass frequencies during recording as the tape would easily saturate. If the microphone response lacks bass, however, enough compensation can be added to correct it.

The drop at the high frequency end is due to the transfer characteristic between head and tape, and includes iron losses and gap effect losses. These are common both in recording and reproduction, so that an equal amount of top boost may be applied in each of these positions. If, in fact, all the boost were applied only on playback, the recording signal level at these frequencies would be correspondingly down relative to tape noise level, and signal-to-noise ratio would not be so good.

The usual type of simple compensation filter consists of a bridged-T network as in Fig. 1, and such an arrangement was used in the magnetic recorder described in the Sept., Oct. and Dec., 1952 issues.

The condenser C2 is shorted out on "record," giving top boost only. When C2 is in circuit on "play" both bass and treble boost results. While such a circuit can give correct bass compensation, the rate of rise at treble frequencies is not sharp enough to give perfect correction at the top end. It is important that negligible boost occurs in the region of 1500–2000 cycles relative to other frequencies, either on "record" or "play."

A method employed by some commercial recorders is to use an inductance tuned to about 7 kc/s. This method has many disadvantages, however—(a) expense, (b) it is prone to hum pick-up by magnetic induction, (c) the circuit "rings" on transients and the response to square wave testing is in general undesirable, unless some form of artificial hangover is required to compensate defects elsewhere in the system.

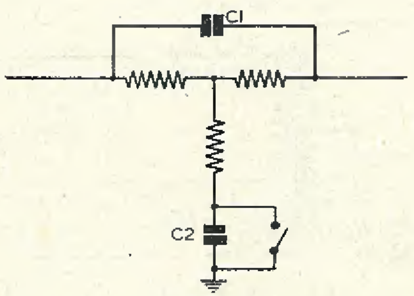


FIG. 1
'BRIDGED-T' NETWORK
SWITCH CLOSED ON 'RECORD'

RC194

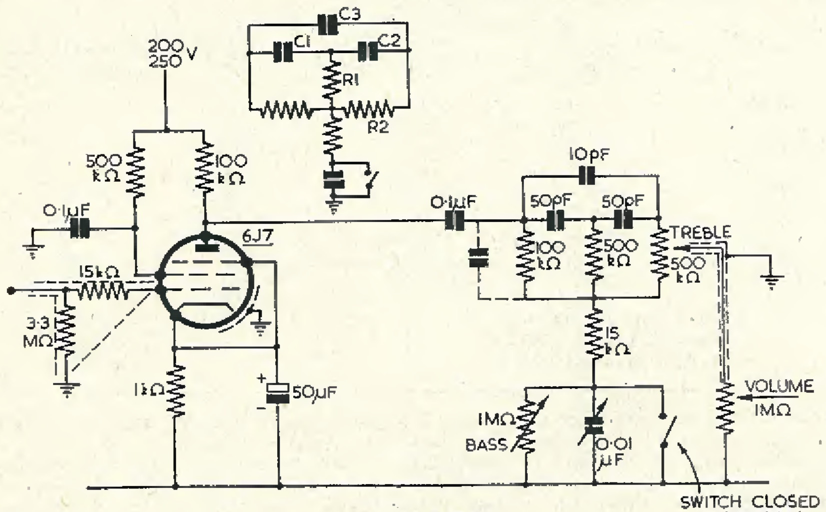


FIG. 2
PRE-AMPLIFIER AND COMPENSATION NETWORK

RC195

After extensive tests with an oscillator and oscilloscope on a large variety of networks the circuit of Fig. 2 has been found to be most satisfactory. The bass boost action is similar to that of the bridged-T of Fig. 1. The treble boost, however, now consists of a two stage high pass filter C1/R1–C2/R2. The bridging condenser C3 corrects a small chip in the curve caused by phase shift. R2 is made a variable to have some form of boost control. This is effective on both "record" and "playback" to allow for acoustic and other conditions. The 1 MegΩ bass boost control is only effective on "playback," and this combination will be found to be most adaptable in practice.

The actual bass boost is rather more than the "calculated" network boost, as there is a reduction in shunting of the anode load at low frequencies, so giving greater stage gain in the valve.

Figures of gain, etc., at maximum boost are given at Fig. 3. These were taken with about a foot of screened lead to the 1 MegΩ output load (next stage grid resistor) to simulate actual installation conditions. This 1 MegΩ grid resistor should be in fact, a 1 MegΩ volume control to the second stage. The second stage should also be a pentode in order to reduce input capacity caused by "Miller effect" which would attenuate high frequencies, especially at midway settings of the volume control.

The overall gain of the pre-amplifier and network at 1500 cycles (the point of maximum network attenuation) is 10.5 db, valve gain being 35 db and network loss 24.5 db. The output waveform is sinusoidal for similar input if input level to the 6J7 is kept below 0.3 volts. However, the output of microphones or tape heads is well within this limit.

If a condenser of 0.00025µF is fitted in parallel with the 100kΩ in the network, then the treble boost can be limited to 9 kc/s. Beyond this frequency the effective shunt on the anode load reduces the output. This condenser also improves the phase shift of the network, but gives a slight amount of treble boost at minimum position of treble control:—+3 db at 10 kc/s; this amount is negligible, however, when compared with tape losses. Its fitting is optional.

The compensation given by this pre-amplifier and network almost perfectly compensates for tape losses in a good system. The amplifier following should be flat, preferably with negative-feedback. The output resistor for constant current recording should

Fig. 3. Relative gain of pre-amplifier and network

Frequency	*Maximum treble and maximum bass* Record db	Playback db	Overall db	*Minimum bass and minimum treble, db*
50 c/s	–3.0	+23.75	+20.75	–3.0
100 c/s	–1.25	+20.75	+19.5	–1.25
200 c/s	0	+17.5	+17.5	0
500 c/s	0	+11.0	+11.0	0
1 kc/s	0	+ 4.75	+ 4.75	0
2 kc/s	+1.0	0	+ 1.0	0
4 kc/s	+5.3	+ 5.8	+11.1	0
6 kc/s	+7.5	+ 8.6	+16.1	0
8 kc/s	+8.7	+10.0	+18.7	0
10 kc/s	+9.3	+10.5	+19.8	0

Valve gain at 1500 c/s . . . . +35 db
Network loss at 1500 c/s . . . . –24.5 db
Overall gain at 1500 c/s . . . . +10.5 db

be several times the impedance of the head at the highest recorded frequency. The bias should be about 50 kc/s and of sinusoidal waveform, with a rejector circuit to isolate it from the audio output. The correct bias level for good response will be found by experiment. On "playback" the frequency response of the head and any head matching transformer should be flat, with the possible exception of a shunt resistor and condenser to give cut-off beyond 9 kc/s.

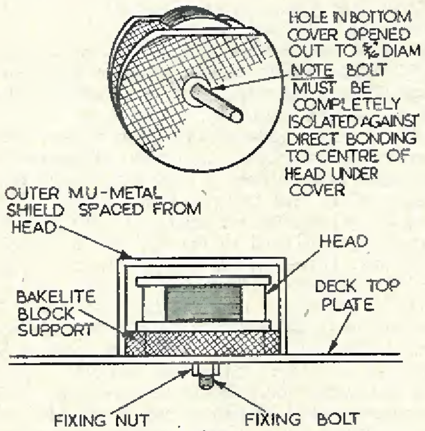


FIG.4
MODIFICATION TO HEAD TO PREVENT "SHORTED TURN" EFFECT

A) REMOVE OUTER NUT
B) " BOTTOM PLATE
C) " INNER NUT
D) OPEN HOLE IN BOTTOM PLATE TO 5/16" DIA
E) REPLACE BOTTOM PLATE BUT DO NOT USE INNER NUT
F) MOUNT HEAD ON INSULATED BLOCK AS SHOWN TO PREVENT BONDING TO BOLT

RC196

The pre-amplifier and network may also be used with a high fidelity pick-up for gramophone reproduction if the pick-up output is less than 0.3 volt. Bass and treble boost controls can be adjusted as required. Any treble cut required for scratch filter, etc., should be in the form of resistor and capacity shunt directly in parallel with the pick-up and should, therefore, be mounted on the player unit.

There is a slight drop in valve gain (independent of the network) at 50 cycles of about 3.0 db due to the value of the screen decoupling condenser. If it is desired to reduce this drop, then this condenser should be increased to 0.25μF or 0.5μF.

Modification to Magnetic Recorder in Sept., Oct. and Dec., 1952 issues

The recorder previously described can be improved by incorporation of this network in place of the original bridged-T.

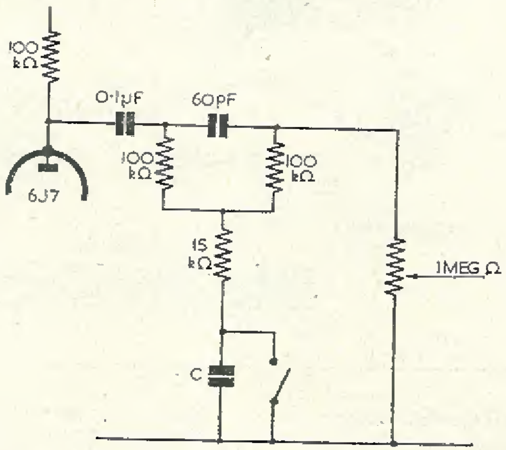
After experimenting with the Qualtape head, certain improvements have been found possible. In its normal condition the fixing bolt shorts together the centres of the head cover-plates. Therefore, a continuous shorted turn is formed by the case and the fixing bolt around each pole piece. By insulating the bolt from the lower cover-plate, the shorted turn is eliminated and the inductance, impedance and output are increased and damping considerably reduced. Fig. 4 gives full details of the alteration.

In view of the increased impedance, the load resistance on the secondary of the input transformer should be increased to about 500kΩ.

Another alteration is in the deck layout. One of the guides is removed and the erase magnet mounted on a swinging arm.

FIGURES FOR COMPENSATION NETWORK OF MAGNETIC RECORDER AMPLIFIER

(These are actual figures taken with calibrated attenuator and oscilloscope. The bass boost is actually greater than the calculated value as the shunting on the 6J7 anode load is reduced at low frequencies on "playback," so giving greater stage gain. The figures also allow for valve and stray capacities normally encountered, if built to the instructions which were given.)



RC198

Alternative values are given for C=0.01μF and C2=0.005μF. C is shorted out as for "record" position and no bass boost occurs on this position.

Treble response is given for a trimmer set to a fixed 60 pF capacity. If the recorder circuit trimmer is set to zero, the treble response of the network will of course be flat with no treble boost—All figures in db lift.

C=0.01μF

Frequency	100 c/s	200 c/s	500 c/s	1000 c/s	2 kc/s	4 kc/s	8 kc/s
Record (C Out)	0	0	0	0	1.8	4.5	7.6
Play (C In)	17.5	14	6.6	1.3	0	3.0	6.3
Total	16.2	12.7	5.3	0	0.5	6.2	12.6

C=0.005μF

Frequency	100 c/s	200 c/s	500 c/s	1000 c/s	2 kc/s	4 kc/s	8 kc/s
Record (C Out)	0	0	0	0	1.8	4.5	7.6
Play (C In)	19.7	17	11.5	5.5	0	2.7	5.7
Total	17.9	15.2	9.7	3.7	0	5.4	11.8

Use 0.01μF for 7½ ins/sec—normal heads—medium coercivity tape
Use 0.005μF for 15 ins/sec—normal heads—medium coercivity tape
These figures do *not* include other slight compensations incorporated in the amplifier.

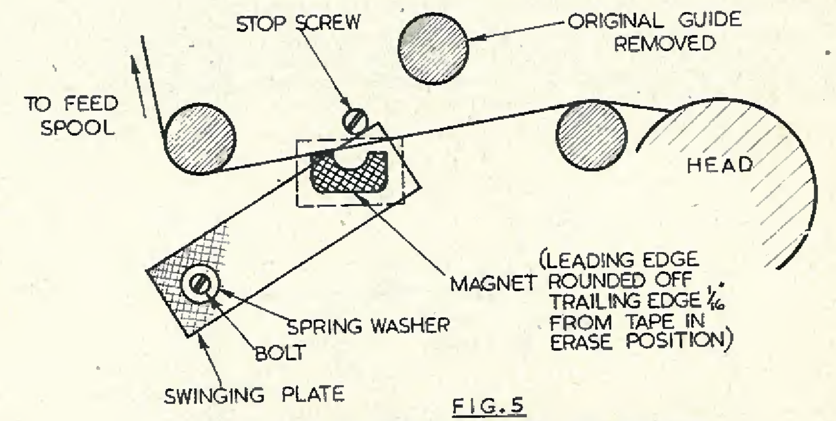


FIG. 5
ERASE MODIFICATION TO REDUCE THREADING & TO STABILIZE TAPE FLATNESS

RC197

There are several reasons for this.

(a) Less threading is involved

(b) As threading is similar on both "record" and "play" the frictional losses and load are equal, and so ensure correct speed.

(c) The greater "wrap" around the pillar adjacent to the head eliminates tape tilt which was found to occur when feed spool braking was light enough to eliminate capstan loading.

The arrangement is shown in Fig. 5.

The magnet will produce least background noise if the trailing edge is spaced about 1/16th inch away from the tape by tilting the magnet. The leading edge has been rounded and polished to prevent it scraping the coating off the tape.

A further modification incorporated was to increase the series constant current resistor in the amplifier from 50Ω to 100Ω, due again to increased head impedance.

The bias isolation choke can be made to give better rejection by tuning it and making it into a proper tuned rejector circuit. A value of about 0.02µF should be satisfactory for the tuning condenser.

Book Review

TELEVISION RECEIVER DESIGN—I.F. STAGES. By A. G. W. Uitjens. 172 pages 114 illustrations. Price 21*s*. Distributed in England by Cleaver-Hume Press Ltd., 42a South Audley Street, London, W.1.

The Philips Technical Library has this latest addition, Book VIII.A, as a companion volume to those already established as standard references on radio theory. Dealing entirely with the I.F. stages in television receiver design, this present book adequately covers all the factors which need careful attention in order to produce maximum gain with required bandwidth. The attainment of satisfactory noise level, and the calculation of noise factor, is of particular interest where the design of "fringe area" receivers is concerned.

In an exposition such as this where one specialized branch of design technique prevails, it is inevitable that the mathematics of the subject should be given some prominence. The author has kept the mathematics as simple as possible in the main body of the book, and gives the derivations of many of the formulae in the several Appendices.

Gain and bandwidth with two-terminal and four-terminal networks occupy only a few pages, but their applications in multi-stage amplifiers employing staggered tuning, and the response curves obtainable, are given fuller treatment. Distortion in double-, and vestigial-sideband systems is discussed in another chapter.

The effects, and the use of, feedback in I.F. amplifiers is given over to a large part of the book. It is enlightening to read that the chassis can become a wave-guide for feedback energy, and that a remedy is to be found in the use of a long, narrow chassis.

The practical considerations of circuit design have not been forgotten; a chapter on this aspect deals with some typical examples of sensitivity, gain, selection of valves, staggered tuning and distortion.

There is no doubt that this reasonably-priced book can be of considerable value to the design engineer.

NORMAN CASTLE

"Bass-Lift Four"

For AC Mains

By A. CARPENTER

The receiver to be described was built originally as a simple 3-valve arrangement using an RF stage, diode detector and LF amplifier feeding into an output pentode.

This proved fairly satisfactory, but the output was not quite sufficient, and, as the author likes plenty of bass, experiments to obtain it still further decreased the output—as is usually the case. After various changes the following circuit was evolved.

Circuit

As will be seen from Fig. 1, four valves are used. V1 is a high gain RF pentode supplying a good signal to the detector, and fed via a small trimming condenser (C5) to the second tuned circuit. This method provides a certain amount of variable selectivity, and when the best position is found should require no further adjustment.

Demodulation is obtained at the diode of V2, which is a duo-diode triode. The second diode, normally used for AVC purposes, is not used and can be connected to cathode.

The triode portion of V2 is usually used purely as an LF amplifier, but in this circuit it is arranged principally as a bass amplifier. The resistors R6, R7 and the condenser C10 cause the valve to discriminate in favour of the lower frequencies, and afford a considerable degree of bass lift. This is not achieved without a severe loss in gain, and the output from V2 is, therefore, only small.

HF is filtered out by R4 and C9. R5 is the diode load, C8 is the coupling condenser and R9 serves as grid leak. The grid is fed from the junction of R6 and R7.

Output from the anode of V2 is fed via C11 to the volume control potentiometer, R15, and thence to the grid of V3 which is another RF pentode. This valve acts well as an LF amplifier when connected as shown.

Coupling to the output valve is by means of a para-fed LF transformer with a ratio of 1:4. This was used in place of RC-coupling so that the negative feedback circuit, C17, R17, R18 could be used to cancel out distortion, which may be as much as 10% in the output valve.

The introduction of feedback causes a decrease in gain, as may be expected, but this has been taken care of in the earlier stages.

Operation of the potentiometer R18 varies the amount of feedback, and with the values specified gives a wide range of tone control. With feedback at a minimum, speech is crisp and clear. As the control is rotated bass becomes more and more evident.

The writer uses a 10-inch speaker mounted on a sheet of asbestos 3*ft* 6*in* × 2*ft*. Reproduction is good and in the order of 5–6 watts. Bass is plentiful.

Lower Supply

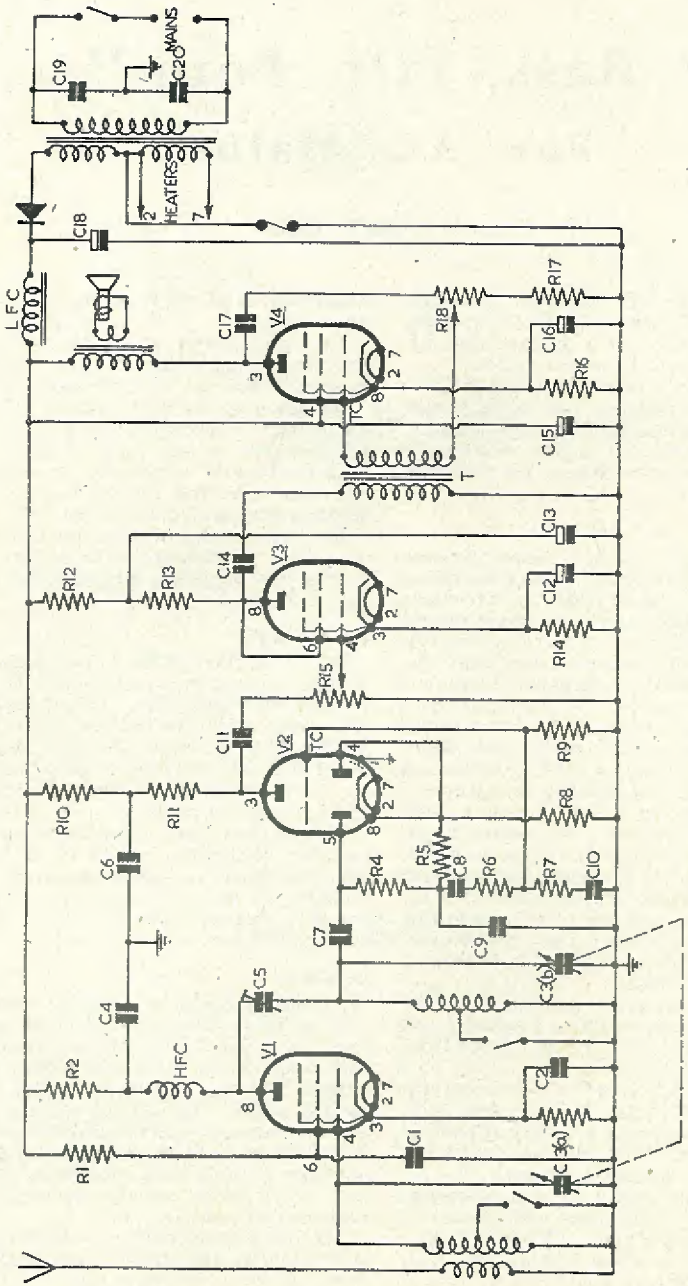
In the original receiver a selenium metal rectifier is used in conjunction with a half-wave mains transformer. This transformer is of ex-Govt. origin and has a secondary of 300V at 100mA, plus a 6.3V winding. Mains hum is not noticeable and so it was decided not to go to the expense of installing full-wave rectification as is usual.

Theoretically, and probably practically, full-wave rectification would be an improvement and this is a point to bear in mind when building this receiver. One point in favour of the metal rectifier is that it is cheap. It is also cool and requires no heater supply.

Conclusion

No definite layout is shown as constructors will doubtless have varying ideas regarding this. The original was built on a metal chassis 12*in* × 8*in* × 2*in*, fitted with a black crackle-finished louvred lid 7*in* in height, both of ex-WD origin. No internal speaker is fitted and the underneath of the chassis is left open. In case of breakdown or alteration, all that is necessary is to turn the receiver upside down and the majority of the components are accessible immediately.

The four controls, tuning, wave-change, tone, volume-on/off are arranged along the front panel, in that order, from right to left.



'BASS LIFT FOUR' CIRCUIT DIAGRAM

COMPONENTS LIST

Resistors		C16	50μF–12V
R1	250 kΩ	C17	0.002μF
R2, R7, R17	10 kΩ	C18	8μF–500V
R3	150 Ω	C19, C20	0.1μF–2000V
R4, R10, R12	50 kΩ	Mains transformer–300V, 100mA; 6.3V, 1.5A (or see text)	
R5	500 kΩ		
R6, R11	100 kΩ	Selenium metal rectifier; 250V, 100mA	
R8, R14	1000 Ω	Chassis–12*in* × 8*in* × 2*in*	
R9	1 MΩ	LF Choke–20H, 100mA	
R13	20 kΩ	LF Intervalve transformer 1:4 (Premier Radio or similar)	
R15	1 MΩ Pot. and switch		
R16	490 Ω	Aerial and RF coils, long and medium wave (Premier Radio)	
R18	50 kΩ Pot.		
Condensers		2-pole 2-way Yaxley type switch	
C1, C2, C10	0.01μF–350V	High Frequency Choke	
C3	500pF ganged with trimmers	Tapped output transformer	
C4, C8, C11, C14	0.1μF–450V	Four I0 valve holders	
C5	100pF trimmer	Fuse (2.5V bulb)	
C6	1μF		
C7, C9	100pF	**Valves**	
C12	25μF–12V	V1, V3 —	6SH7
C13	16μF–450V	V2 —	EBC33
C15	32μF–500V	V4 —	EL32

Trade Review

We have received from **Kendall and Mousley**, 99 Dudley Port, Tipton, Staffs., samples of their products for review. One of these, a pair of meter stands, was at once " snaffled " by Centre-Tap, and is described by him in *Radio Miscellany* in this issue.

The other items submitted consisted of a cabinet, front panel, chassis, and a pair of handles. These were stoutly constructed and nicely finished in black crinkle.

The prices charged are reasonable: for example, a cabinet 10½″ × 12″ × 10½″ deep with light alloy panel costs 21*s*. A chassis to suit, measuring 10″ square by 2½″ deep, is available at 10*s*. 6*d*.

Items are obtainable in other colours than black. Brown, blue and green can be supplied, at 10% extra.

Another useful item, and one which we have not seen elsewhere, are metal plates punched to take an international octal or similar valveholder, and designed to allow easy fitting in place of existing larger holders of obsolete types. These are also reasonably priced, at 3*s* 6*d* per dozen.

The firm also supplies valves, components, and sundry other items, and readers interested are invited to send a 2½*d* stamp for their lists.

Clydesdale Supply Co. Ltd., 2-Bridge Street, Glasgow-C.5., have sent us copies of the new List -No. 8D and Supplement. These are charged at 1*s* 6*d*, which is refunded on the first purchase.

We cannot think of a more comprehensive list than this, with its 260 pages which, with the numerous illustrations, forms a most handy reference book apart altogether from its primary purpose.

Radio Control Equipment

PART 4

By RAYMOND F. STOCK

Manual Unit

A simpler but very effective device which also carries out the same function is the pulsing switch shown in Fig. 18, which I recently developed for another purpose (mentioned later).

A is an insulating arm conveniently cut from a ¼" thick perspex, and it is mounted on the end of a short control shaft. The latter, complete with its bush, can be taken from a discarded potentiometer.

Pivoted on a 6-BA bolt at the end of the arm is a small swinging link *B*, which is normally kept at 90° to the arm by the light spring *C* soldered between the link and an 8-BA screw in the arm *A*.

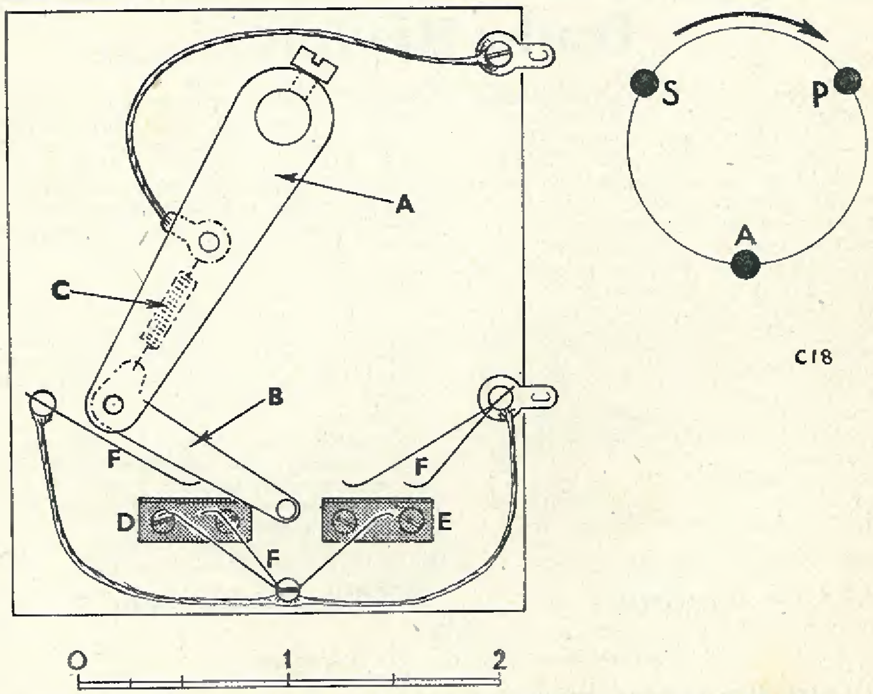


Fig. 18. *Manual pulsing unit; scale in inches. In the sequence diagram* A, S *and* P *represent Amidships, Starboard and Port.*

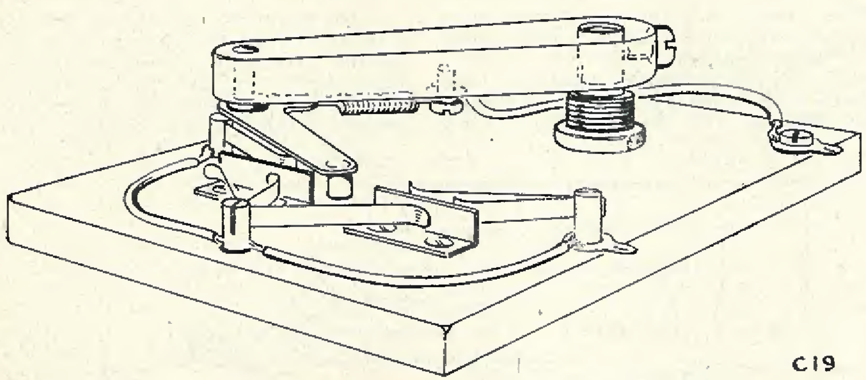


Fig. 19. *Manual pulsing unit, complete on perspex base.*

As the arm is rotated through its three positions, the link tends to move through an arc of a circle, but it carries a small peg at the end which interferes with the two guides *D* and *E*. These cause it always to move under them when travelling away from the centre, but trap it above them when travelling inwards. The peg therefore follows a kind of figure eight path as the arm *A* is rocked from side to side.

Several contact strips *F* are soldered to pillars screwed into the insulating baseboard, and as the peg moves through its path it brushes against these strips and in so doing keys the transmitter. The keying leads are taken, one to all the contact pillars, and one (via a copper pigtail) to the end of the spring *C*.

If the movement of the peg is studied against the small sequence diagram printed alongside, it will be seen that the correct number of pulses are sent to step the escapement round correctly.

In making this device, the peg at the end of link *B* should be allowed to pass well clear of the ends of guides *D* and *E*, or there may be a tendency for the peg to return along the incorrect path. The position of the peg at the ends of its travel is, of course, determined by the travel permitted to lever *A*.

The guides are made up from scraps of 18 swg brass sheet bent to shape, and sufficiently accurate dimensions may be taken from the scale in Fig. 18. The sketch Fig. 19 shows a view of the completed parts.

When either of these two pulsing units are used, a simple press button should be included in the control box, wired in parallel with the pulsing contacts. This is useful for getting the mechanism in the model into phase, and enables the operator to correct any error which may creep in when under way. A means of sending signals by hand should always be available, as the chance of a spurious or undetected impulse is always present, and once the system gets out of phase it can be most confusing !

Selector Mechanisms

A more complex and, therefore, generally more flexible way of using a sequence system is by utilising a circuit selector.

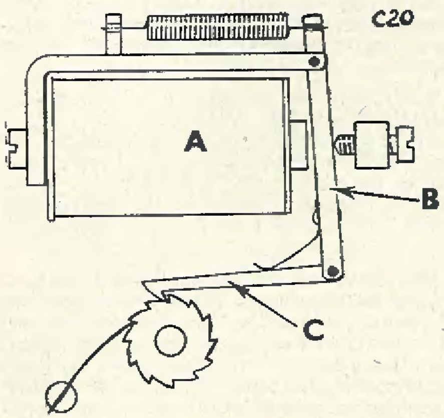


Fig. 20. *Selector; operating mechanism*

Most readers will know how these components work, but Fig. 20 is a guide to the construction of a typical unit.

A is the electromagnet which in radio control work is energised from the receiver relay contacts. *B* is its armature and *C* is a pawl which works on a ratchet wheel. Very often a detent is provided against the wheel to prevent reverse rotation, as shown in the drawing.

Each time the magnet is energised, on receipt of a signal, the pawl rides over a tooth of the wheel; when the signal terminates, the armature returns by spring tension and carries the wheel round one tooth. A wiper arm (or arms) is mounted on the shaft of the wheel, and rotates over a ring (or rings) of contacts, thus switching various circuits.

Obviously, the limitations of this device are decided by the number of wiper arms and the number of positions, and an enormous number of combinations are available. In most cases the constructor will arrange these to his own requirements, but some illustrations of the commoner circuits in which selectors are used will be given.

In one scheme the selector can be regarded as the equivalent of an escapement, with a set sequence of positions provided by the various steps. Each step can then be wired to an electrically driven follow-up device and represents a definite rudder position. Initially this may seem no advantage over the escapement, but there are two important differences—the follow-up mechanism need not operate until the selector finally "homes" on a selected position, thus avoiding moving the rudder through unwanted positions. Secondly, the selector can work at very high speeds, so that a larger number of steps can be used in the sequence (providing finer control) without slowing down the response.

An example of this straightforward use of a selector is given in Fig. 21, which shows the circuit of a nine-step selector wired to give four port, four starboard, and one amidships position.

Each of the selector contacts is wired to its own brush, and these nine brushes bear upon the surface of an insulating disc driven at slow speed by a permanent magnet motor. Mounted on the disc are two copper segments with a small gap between them, and they are polarized positive and negative by pigtail connections to a battery. Since the motor is connected between the battery centre-tap and the selector (common) it is supplied with power via one of the brushes—the one selected—and either of the two segments, whichever one the brush happens to be resting upon will decide the polarity of the voltage applied to the motor, and thus determine its direction of rotation.

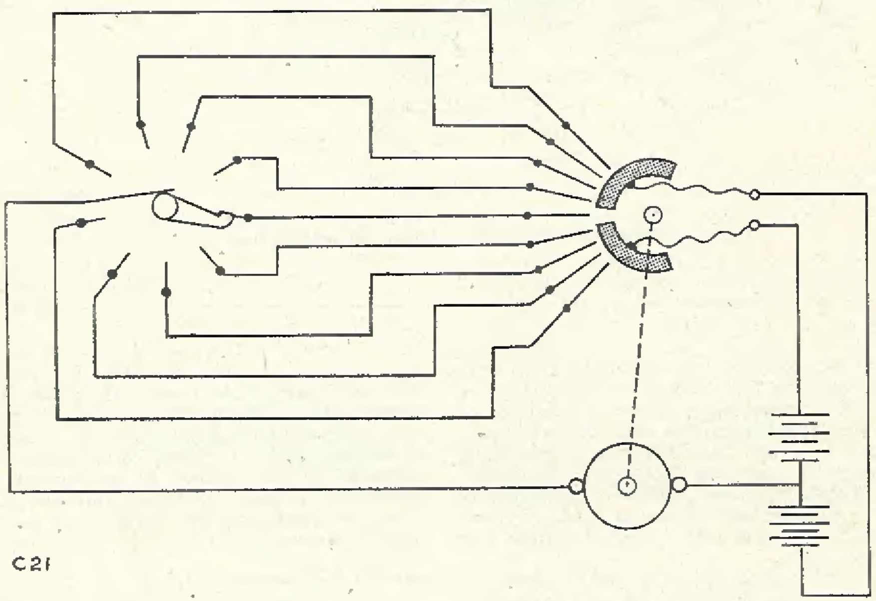


Fig. 21. 9-Way selector in simple steering unit.

This direction is such that the insulating space between the copper segments *always moves towards the supplying brush.* In effect, then, the gap between the segments homes on the selected brush, and the unit forms a simple follow-up device, sensitive to nine different positions.

The contact disc shown is a circle of paxolin bolted to a brass hub; contact segments are cut with scissors from hard brass or copper foil having mounting lugs turned over through corresponding slots in the paxolin. Copper foil brushes are arranged firmly to bear on the disc at 5° intervals, their fixed ends being supported by a perspex arc; alternatively, they can be soldered to the tags of a suitable radio connection strip bent into an arc.

Flexible insulated pigtails carry power to the two moving segments. The final power take-off to the steering gear can be by a push-pull rod pinned to the end of the operating lever shown, which moves with the disc. The lever on the rudder shaft can be the same length as the operating lever so that the two move in step, and in this case one obtains full control from port 20° to starboard 20° in 5° steps.

Any small commercial motor will do for a power unit, a number of inexpensive permanent magnet motors being available. As an index of performance the following notes may be of interest.

An electrically driven actuator was recently made up using an *Electrotor* driving a gear train of 1000:1 ratio. On 4.5V applied to the motor, the current consumption (light) was 0.25A. A load of 1*lb* was then applied to the output lever, which had an effective radius of 1.7", and the current rose to 0.35A, the lever taking 4 seconds to move through 60°. A force of 1*lb* is, of course, far more than is needed to shift the rudder of a model boat, and in this case was designed to operate the steering gear of an armoured car model (total weight 8½*lb*).

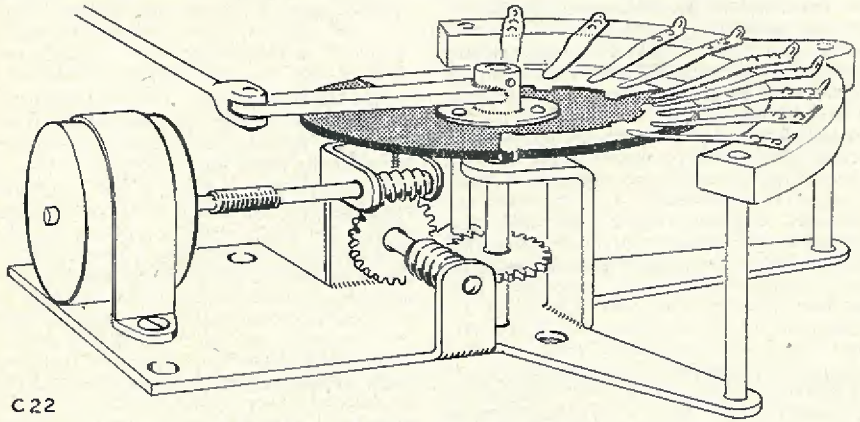


Fig. 22. 9-Position follow-up mechanism.

Fig. 22 is a drawing of an easily made unit on these lines. The small motor is coupled by a short length of spring to a reduction gear train which is most compactly made from two worm and wheel stages, as shown, but if these are not available the gear train from a small clock will do very well; often the motor can be coupled to the seconds hand shaft, which projects beyond the frame sufficiently to take a soldered coupling, and the final drive can be mounted on the hour shaft, thus giving a reduction ratio of 3600:1. The rest of the mechanism is cut away.

Selector systems similar to the one described can be designed with any number of positions, the limiting factor being the time delay that can be accepted for operation through a complete sequence. Any selector should be capable of interpreting at least 10 pulses per second; in model work it is advisable to check the positive operating speed when the batteries have fallen to their accepted miminum voltage.

(To be continued)

Radio Miscellany

TV and its alleged rival, the third dimensional film, have been much in the news of late, and this, added to my recent comments on colour and stereoscopic TV, seems to have provoked a number of letters from readers. So much so that I feel I am left with no other alternative than to treat these as the topics for the month. As so few details of the colour and stereoscopic processes have been made public it is only possible to consider them in a general sort of way, and we are still very much at the guessing stage about the probable date of their full introduction.

There is, however, one outstanding development which may have an important bearing on the proof of their practicability. I refer, of course, to sponsored TV. The Assistant Postmaster General recently revealed that 46 enquiries for sponsored TV licences had been received. There were also 26 enquiries about buying time in the sponsored programmes. The possibility of alternative TV programmes being available before the end of next year will, for many, make cheerful reading. Unfortunately the more alternative programmes we have, the narrower the chances of getting colour or stereoscopic transmissions become. All present systems require three times the bandwidth of monochrome TV, and the only way of squeezing them all in is to move them to still higher frequencies. Apart from disturbing the present allocations in the VHF spectrum, the further HF we go the more restricted becomes the range of each transmitter.

Competition

Nevertheless, it is becoming increasingly important for these problems to be seriously tackled. We must regain our diminishing lead in technical developments. A couple of years ago, we, and America, had a very long lead over the rest of the world. But TV has expanded rapidly since then. According to Unesco, 55 countries are now engaging in some form of regular TV activity. Japan, Cuba and most of latin America are all well in the running. Even the small republic of Dominica has had regular transmissions for over eight months!

Admittedly we have supplied much of the transmitting equipment, but the sales of our receivers has not been in proportion. With the entry of Japan into the receiver market at cheaper prices, the need for retaining our technical superiority becomes paramount. The same, too, applies to a lesser degree to Germany. Before we can "sell" colour or stereoscopic TV to the rest of the world we must provide a system which necessitates only a cheaply-produced, reliable receiver and a daily service to prove its practicability.

Just how important the 3-D aspect will become is a matter of speculation. Colour seems to be not only the more important, but also the more logical step.

To meet a few requests, and for the sake of beginners, a brief review of the colour systems is included in augmentation of my comments of a couple of months ago. Two of them are based on the fact that by adding together in suitable proportions red, green and blue light, any desired colour can be produced. This may be achieved in two ways. Firstly by projecting them simultaneously, and secondly by scanning them consecutively. Just as it is impossible for the eye to detect a single "scan," repetition at a high rate presents an apparent single, complete colour picture to the human eye.

The principle of adding two or more colours to produce another—generally referred to as the "additive" system—has already been widely used in other fields. Painting, printing and filmcraft readily spring to mind. The disadvantage of additive systems for photographic and TV purposes is that it entails the use of filters. The high absorption of light in the colour filters reduces the recorded image to a dimness that demands an extremely high order of sensitivity or an intense subject lighting, or more usually a combination of both.

The subtractive system, widely used in cinematography, produces colour by subtracting from white—which is a combination of all colours.

A limited colour system can be obtained by employing only two colours, red and blue-green. In fact, a two-colour system was actually used in a pre-War Baird demonstration which employed a twin cathode ray tube projecting two beams on the same fluorescent screen. The superpositioning gave a fairly wide and reasonably accurate colour range.

The RCA system has been developed on similar lines. Three separate images, after sorting out from the signal, are superimposed on the same screen. Such a system, although it means complication in the CRT, is theoretically practical and development will lead to its simplification. It would, however, make all our present equipment obsolete.

Not only are three separate beams each from their own "gun" required inside the tube, but a great many circuits in the receiver will have to be in triplicate. No wonder designers have given much thought to providing a means of producing colour with minor modifications and additions to our existing receivers.

Mechanisation

The most direct way of adding colour to our existing system is mechanical. Again, of course, we are dependent on the mixing or subtraction of primary colours. Columbia developed a system using a revolving filter disc in front of the camera. A similar disc has to be rotated in synchronisation in front of the CRT of the receiver. It was used for a time in America and a number of receivers sold, but it had to be discontinued by government intervention on the grounds that it would upset the Defence Programme.

Pye Radio, EMI, the Marconi Co. and the BBC are all carrying out experiments along these lines, and although satisfactory colour demonstrations have been given, just what sort of results could be achieved on ordinary domestic receivers in the home is rather problematical. Those of us who are still beset with nightmares of our disc-scanning days will find some difficulty to work up much enthusiasm for mechancial colour discs. Nor does anyone dare to commit themselves on the question of costs—not only the cost to the viewer but also at the transmitting end. We still need three times the bandwidth, and a move to the HF means lessened ranges and more relay stations.

RCA are making strenuous efforts to develop an improved all-electronic system, and those of us who think mechanical colour discs too high a price even for reasonably accurate colour, watch with eager eyes.

Unfortunately the development of colour TV in Great Britain, at least, is not solely based on the near-perfection of any system. It depends on the provision of programmes. No programmes—no receivers. No receivers—no programmes. Thus we find ourselves in a vicious circle, but having completed that circle we ourselves have gone round in another. We get back where we came in—sponsored TV! This might yet prove our ray of hope.

If sponsored TV doesn't develop colour it may very well help by relieving the BBC of some of its programme commitments so that they can open up new fields in experimental colour transmissions.

Alternatives

Colour and stereoscopic TV must come, and we all want to see Great Britain in the vanguard. With the present set-up we are hamstrung to our 405 line, 50 traversal-interlaced f.p.s. system which we started in 1936! Would we decide on it again if we were free to choose to-day, and what alternatives are open to us? Firstly we can supersede it completely while we temporarily carry on the present system side-by-side with a modernised system, until the existing sets "wear out." This sounds very nice, but it's wasteful nationally and we still shan't know if the new system is going to prove the ultimate one.

Secondly, we can have a patchwork arrangement whereby we attempt to make existing receivers adaptable by minor modification (or additional stages) to gain partial improvements. Unfortunately the BBC seem to be moving along these lines. This sort of compromise has little to recommend it and there is always a danger that we shall land ourselves in such a tangle of makeshifts that further progress becomes impossible without, at some remote date, having to make a completely fresh start. Timidness on the part of the BBC may be storing up a much bigger hardship for viewers in future years.

The third possibility is wired TV. In any case VHF gives only a local range. Wired circuits could give nation-wide coverage with alternative programmes. The question of bandwidth no longer has to be solved. It would, however, be an enormous undertaking and might take years to get into operation even if there are no unexpected snags. By

[*Continued on page 533*

Centre Tap *talks about* STEREOSCOPIC AND COLOUR TV — A GADGET

The "UNIVERSAL" Large Screen AC/DC Televisor

Part I. Described by A. S. Torrance, A.M.I.P.R.E., A.M.T.S.
(*By kind permission of* IKOPATENTS LTD)

A recent survey of the electricity supplies in this country has surprisingly revealed that many people are still tied down to the limitations imposed by DC (direct current) mains. It was, therefore, decided to present a design encompassing both AC and DC mains, and which also covered all voltages from 200 to 250.

Fortunately, valves and equipment are available for this design, which is based on series heater-chain technique, and is approved by Mullard, Ltd.

Such a design also, of course, means that the intending constructor must bear in mind at all times the dangers attendant upon the chassis being at mains potential. This need for caution is particularly important whenever operating tests are carried out during the building period, when the chassis is not protected by the cabinet and a careless moment may have serious results. We do not intend to be macabre, but you will not be allowed to forget this highly important aspect of AC/DC technique, for we shall make constant reference to it.

The system also has its advantages, and the compact and remarkably lightweight design possible with this method is readily appreciated from the illustrations which will be appearing. A good idea may be obtained from the accompanying view of the chassis structure, which when properly installed in a cabinet will be perfectly safe for all members of the family to handle. On the structure shown will be the complete receiver; CRT, speaker, sound and vision strip, timebases and all the requirements to suit electrically the various mains supplies wherever it may appear.

All five transmitting channels will be covered by a modern superhet design and, of particular interest to fringe area dwellers, a highly efficient sync circuit will be incorporated. We should like to make it clear, at this stage, that this is an assembly design for which all items will be available from commercial sources.

All the mechanical structure is being supplied by Denco (Clacton) Ltd., and may be obtained through your usual supplier. Valve holes, etc., will be ready drilled.

A device enabling external focus control, unusual with permanent magnet type focusing, has been incorporated into the design. This has been done to obviate the necessity to delve into the back of the set, and particularly to **avoid any contact by the unwary with possibly live parts in a set operating under AC/DC conditions when a focusing adjustment is required.** The Elac *Duomag Focaliser* to be used, is undoubtedly the most advanced type of PM focus unit, and an explanation of its functioning will be given later.

The cabinet, which will be available from Lasky's Radio, is also unusual and worthy of special comment. Basically a table model, the manufacturer will construct a lower section exactly conforming to the upper part in design and style. It is hoped in the near future to produce a first-class radio/gram unit for inclusion into the lower cabinet, thus creating stage by stage the complete home entertainment, which the reader may build in instalments.

To return to construction—Voltage selection will be achieved by resistors, one for the heaters and the other for HT. These resistors are tapped. Careful marking by the makers will avoid any possible confusion between the two, and in addition an explanation of their working will be given as the description proceeds.

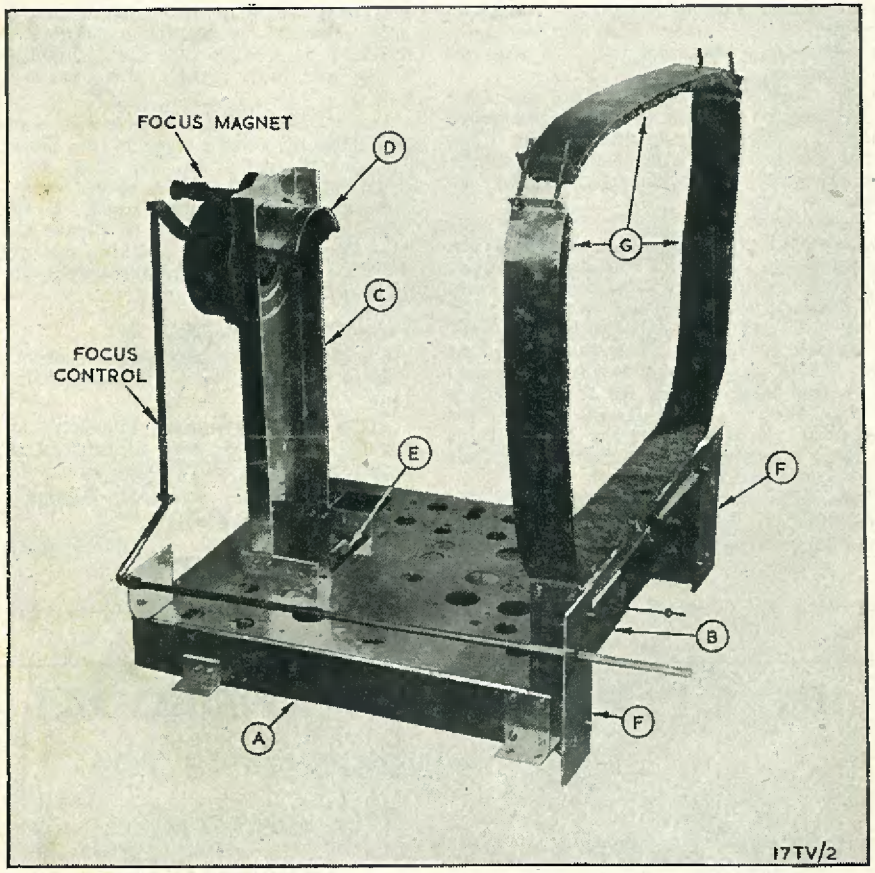


Illustration of complete assembly, annotated to indicate sections. See also diagrams on page 527.

A simple yet effective method of keeping the tube screen dustproof has been evolved, and this, together with a perspex protection guard, is permanently attached to the structure shown in the photograph.

Order of Assembling Chassis and Parts

First, study the photograph and sketches. To avoid any confusion which may have resulted from an overdrawn set of sketches, the valve holes and component drilling have been omitted.

The chassis **A** is the fundamental item, and all other parts are attached with BA nuts and bolts. The use of shakeproof washers is recommended.

Item **B** is bolted to the front of **A**. This is further strengthened by the two angle brackets at the sides, which also provide eventual fixture to the base of the cabinet.

Next attach and assemble parts **G**. To the insides of these, stick with *Bostik* or other suitable adhesive four pieces of felting ½" thick. Carpet felt cut into strips is very suitable.

Bolt into position the rear tube support **C** and, underneath, the section **E** with, at the same time, the two small angle brackets. Seen at the rear (sides), these also are used for cabinet fixing. (Note that the rear holes are used in the bent-up parts of the chassis).

D may now be loosely fixed in position, with four 6-BA screws, but these should not be tightened up until the deflection coils are purchased. It will be seen that provision has been made for rotating the coils (for straightening the picture), and for a vertical movement for centralising the coils into line with the focus magnet.

The focus unit (fixed with four 1½″ 2-BA bolts), may be attached to C and the external focusing device placed into position. The small supporting bracket is fixed as shown, and the two chassis bushes inserted front and rear.

Thread through, from the rear, the long angle-section of ¼″ rod. Two half links are threaded on the rod between supporting brackets, the purpose of these being to prevent the long rod moving in and out. With two 4-BA nuts and bolts join the shorter crank to the arm on the focus magnet and the long rod. These are not bolted tightly, sufficient movement being allowed for them to act as pivots. Also for smooth, noiseless action cut two small pieces of rubber or PVC sleeving to serve as bushes over the bolts. A locking nut is added to both bolts.

Two 4-BA bolts (or 1/8″ Whitworth) 2½″ long, and one 1″ long, with nine nuts are required for fixing the speaker. The sketch and final assembly will explain this. The holes provided are accurately disposed to fit the Elac 5″ speaker type 5/45. Eight 4-BA bolts, nuts and washers are necessary for part C.

It is not expected that anyone will encounter any difficulty at this stage of the assembly. The one thing that we can think of is the possibility that the longer 4-BA screws or bolts may not be easily secured. In such a case, it is quite permissible to use the nearest equivalent, 1/8″, in either Whitworth or BSF threads—there should be no trouble in obtaining these.

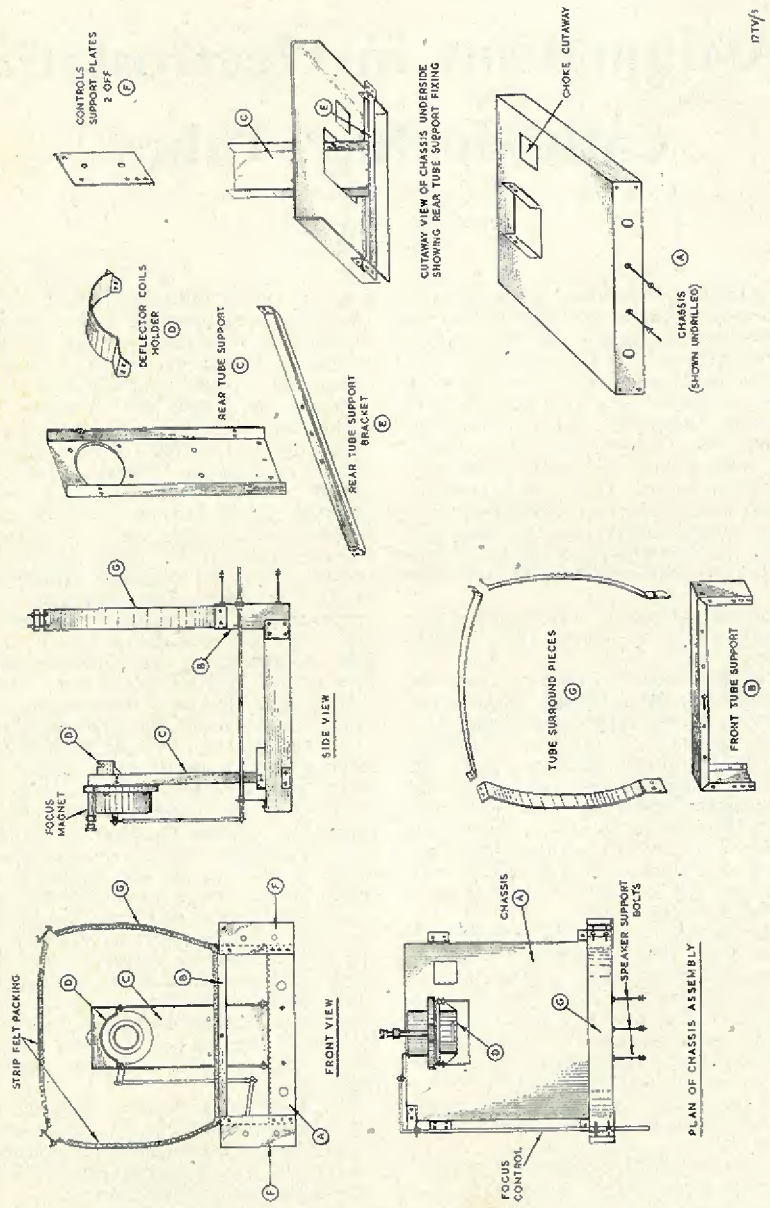
Parts Mentioned in Text

Chassis, bushes, mechanical parts, and Wide Angle Deflection Coils, Denco (Clacton) Ltd.

Focus magnet (Duomag Focaliser) and 5″ Speaker type 5/45, Elac (Electro Acoustic Industries Ltd).

17″ Escutcheon, Prepared Perspex and Cabinets, Lasky's Radio.

[To be continued



Details of structure assembly. See text and illustration on page 525.

Astigmatism in Electrostatic Cathode Ray Tubes

By C. R. DRAYTON

Many amateur television experimenters have managed to get really well defined pictures from their war-surplus six inch cathode ray tube receivers. Many too must have reached the point where it seems impossible to improve no matter what is done in the way of band-width adjustment, video valve compensation etc. When this stage is reached it would seem to indicate that maybe the tube itself is the limiting factor. It is well known, of course, that these small tubes possess characteristics not ideally suited to television. In this connection, the writer has found it profitable to devote some attention to spot size and shape.

So far as size is concerned, the best procedure seems to be to use as high an EHT voltage as possible.

Quite often, however, there remains the defect which has been termed astigmatism. Astigmatism is usually apparent when focusing. It may be possible to detect two distinct positions of the normal focus control which give relative sharpness. At one point the scanning lines will be sharp, and horizontal picture detail somewhat lacking. The second point will give improved horizontal definition —the vertical elements of the picture will be sharp—but the scanning lines will have disappeared, or nearly so.

The effect is easily explained. Each pair of deflector plates acts as a focusing electrode but, being split into two parts, can only be effective as such on one axis. Thus, if the mean potential of a pair of plates is varied the spot will be compressed or elongated in one direction only. That focus does not vary to any extent when the tube is being scanned is due to the fact that with a push-pull timebase the mean potential of the plates does not change.

It does not necessarily follow that a little astigmatism is a bad thing. A spot which is slightly elongated in the vertical direction may give a "solid" and sharp picture. The effect is similar to that obtained by "spot wobbling" or spot squashing, and merely serves to fill in the spaces between the lines. On a six inch tube the spaces between the lines are very narrow and little vertical spot elongation is tolerable, as the lines will soon merge and vertical detail will be lost.

Before attempting any correction it is as well to determine the degree of the defect, and whether or not both pairs of plates are involved. This is easily done if the timebase is disconnected and the stationary spot de-focused to about 3/16" diameter (the brilliance must first be reduced, of course). The spot is then moved from side to side, using one shift control only, and observing the spot shape as this is done. The experiment is then repeated, this time moving the spot up and down. In all probability it will be found that movement in one direction will have little or no effect on spot shape. Movement in the other direction, however, is likely to cause the spot to change from an ellipse with its major axis, say, vertical through an intermediate circular shape to an ellipse with its major axis horizontal. Fig 1 illustrates this. This is because altering the potential of one plate alone changes the mean potential of the pair. The fairly obvious remedy, and the one which is given in the text books, is to fit a second potentiometer to control the potential of the second plate of the pair which exhibits the effect. This enables the spot to be moved about the screen by adjusting the sliders in opposite directions, and thus maintaining the mean potential and the spot shape constant. It may be necessary to do this for both pairs of plates. Figs. 2 and 3, show the normal circuit arrangement and the modification respectively.

This method is capable of good results, but there are drawbacks. It might seem that the procedure would be to adjust the spot position to give a central picture, and then with a stationery de-focused spot as before, to adjust the shape. Unfortunately, when the spot is returned to its normal brilliance and re-focused the good work will probably

[*continued on page 505*

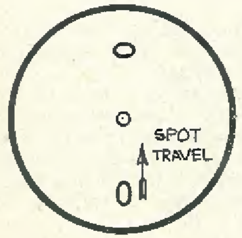


FIG. 1 CHANGE OF SPOT SHAPE DUE TO SHIFT

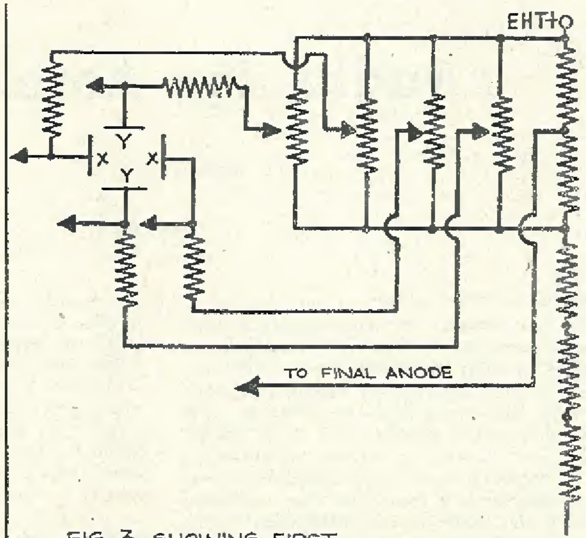


FIG. 3 SHOWING FIRST MODIFICATION OF POSITIVE END OF EHT NETWORK

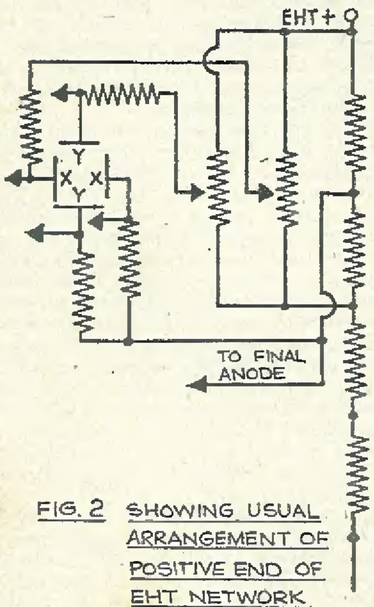


FIG. 2 SHOWING USUAL ARRANGEMENT OF POSITIVE END OF EHT NETWORK

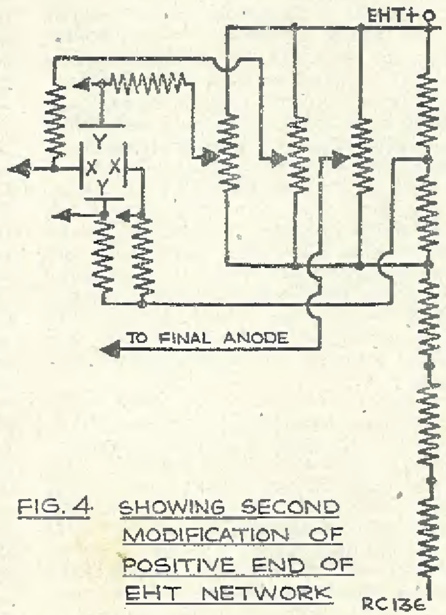


FIG. 4 SHOWING SECOND MODIFICATION OF POSITIVE END OF EHT NETWORK

RC136

Audio Pre-Amplifiers

By D. NAPPIN

PART 3

Design of a Pre-amplifier

The requirements for a pre-amplifier have already been stated; however, certain other problems present themselves.

As the pre-amplifier is necessarily a high gain unit, steps must be taken to reduce hum and other extraneous noises such as "Johnson" noise. Such noise is introduced mainly at the grid of the first stage, as the amplification at subsequent points in the circuit is not sufficient to cause any appreciable contribution to the over-all noise by extraneous signals introduced at these points.

To reduce noise in the input resistor, it must be of the high stability cracked carbon type, as the composition type often possess a very high noise level due to the semi-conducting properties of carbon.

This resistor is R1 in the circuit diagram (Fig. 6), which represents a pre-amplifier suitable for use with the quality amplifier described in a previous issue (May, 1952).

As the input circuit is of high impedance, it will be seen that hum may be very easily introduced electrostatically from either heater leads or mains leads. It is therefore advisable in construction to screen the grid lead, and to keep the heater leads close to the chassis. It may be found necessary to employ a centre-tapped resistor across the heater line, with the tap connected to a point on a potential divider across the HT line and earth of equal potential to the input valve cathode. The writer, however, has achieved a suitable low hum level with one side of the heater supply earthed.

The valve employed has a considerable effect upon the hum and random noise level, and may if badly chosen introduce microphony and acoustic feedback from the speaker. Thus it is seen that the valve must have a rigid electrode structure, to avoid microphonic vibration, and be suitably designed to reduce shot and partition noise. The heater is best of balanced helical construction to reduce the hum field. The Mullard EF37A has a suitable structure for this job, and is also available in the miniature range on the B8A base as the EF40. A similar valve is the Brimar 8D5 or 6BR7 on the noval base.

The first stage employs a modified form of Williamson's single valve pre-amplifier, in which negative feedback is applied from anode to grid via a potential divider composed of either R7–C5 and R9, or R8 and R9. The latter position gives a level response with a gain of $\frac{1}{B}$ where B, the feedback ratio, is $\frac{R9}{R8+R9}$. As R9 is 22kΩ and R8 220kΩ, this gives a gain of 11 or 21 db. The capacitor C5 introduces extra degeneration at high frequencies to cater for the top boost in Decca discs. If desired, this feature may be deleted from the pre-amplifier and incorporated in a plug-in equalizer. In this stage good HT decoupling is essential, and at least 16 μF was found necessary despite the power supply having a two stage filter with 32 μF smoothing capacitors.

To allow for larger inputs from radio feeder units, etc., a third position was provided on switch 5, allowing V1 to be cut out and feeding the input directly to the volume control R10. V2 is a normal voltage amplifier providing sufficient gain to counteract the loss in the tone control network. It will be noted that double decoupling is provided in the anode circuit, this being to provide reasonable attenuation of hum without the use of electrolytic capacitors.

Immediately consequent upon this follows the previously described frequency compensation circuit, feeding directly into V3 to avoid modification of its characteristics by shunting of the output. The valve V2 is preferably an EF37A or similar type, but due to the higher signal level it is possible to use an EF36 or 6J7.

The same comments apply to V3, which is again a simple voltage amplifier, although it may be possible to employ a 12AX7, a double triode on the B9A base, for these two valves.

All the circuitry following V3 is the variable slope steep cut-off filter, and if it is desired to omit this the output may be taken from capacitor C38. The switch S3 provides various frequencies of cut-off and a straight through position where the stage functions as a negative feedback amplifier, B the feedback factor being given

by—
$$\frac{R22+R23+\frac{R21\times Ra}{R21+Ra}}{R29+R30+R32+R22+R23+\frac{R21\times Ra}{R21+Ra}}$$

where Ra is the AC anode impedance of V2. Assuming Ra to be 60 kΩ, this expression becomes

$$\frac{100+500+\frac{60\times 100}{160}}{100+100+500+100+500+\frac{60\times 100}{160}}=\frac{637.5}{1337.5}$$

The gain is therefore $\frac{1}{B}=\frac{1337.5}{637.5}=2.1=6.4$ db.

The resistor R33 is the slope control and its variation affects the feedback factor and thus the gain.

It may be seen by a similar calculation to that already performed that the gain when R33 is shorted will be—$\frac{1137.5}{637.5}=1.8=5$ db. Thus the maximum change in gain is 1.4 db. and as 3 db. is a just perceptible change 1.4 db. will be unnoticed. The capacitors C25–C37 with resistors R29, R30, R31 form the frequency sensitive parallel T network while C19, C20, C21 provide the required capacitance to cause a suitable phase shift around the feedback loop. C15–C18 provide in conjunction with R22 high frequency loss to counteract the rise in response of the unbalanced parallel T before resonance. R28 is included to provide a grid return for V4, a further EF36, via R32, R30 and R34.

Further Notes

It has already been mentioned that good smoothing is essential, hence the power pack should be designed to provide 250 volts or thereabouts with an extremely low hum level. The writer has achieved good results using what is, in effect, two power packs in series employing separate smoothing. The pre-amplifier and radio feeder are fed by one power pack, while both in series supply the main amplifier for which a higher hum level is tolerable.

For the benefit of those who have laid in stocks of 6SH7's, it may be stated that this valve is quite suitable for V1 provided normal precautions to avoid hum are taken. It was found essential to well clean the valve base and socket with some form of cleaning fluid to remove flux residues and dirt, as leakage otherwise occurred from heater to grid. Methylated spirits or lighter fuel may prove useful, although carbon tetrachloride should be better. The writer successfully employed a mixture of trichlorethylene and ethyl acetate for this purpose. A ceramic socket improves matters, as dirt is more easily detectable and removable from a glazed surface.

Some authorities claim that hum may be reduced by demagnetising the valve. The writer has not noted any appreciable difference in hum level by demagnetising a 6SH7; however, the metal envelope of this valve probably screens the electrodes from the influence of the demagnetising field. Readers who wish to try demagnetising valves may proceed by using a speaker energising coil of almost any resistance above 2000 Ω connected across the mains. A 1" diameter coil should serve to demagnetise miniature valves and those of the EF36, EF37 class; however, for such valves as the SP61 and EF50 a 1½" diameter coil will prove necessary.

NOTE. A misprint occurred in Part 1 of this series, in section (3) Non-Linearity Distortion, para. 3, where the ratio of intermodulation to harmonic distortion was given as "2J½". **This should, of course, have been "$2\times\sqrt{2}$."**

Fig. 6 and Component Values are given on next page.

References

(1) *Roddam, T., Intermodulation Distortion, Wireless World, April 1950.*

(2) *Cocking, W. T., Diode Detector Distortion, Wireless World, May 1951.*

(3) *Williamson, D. T. N., High Quality Amplifier, Wireless World, October 1949.*

(4) *Correspondence, Wireless World, December 1949.*

(5) *Olson, H. F., Elements of Acoustical Engineering, pages 481-2.*

(6) *West, R. L. and Kelly, S., Pickup Input Circuits, Wireless World, November 1950*

(7) *Williamson, D. T. N., High Quality Amplifier Modifications, Wireless World, May 1952.*

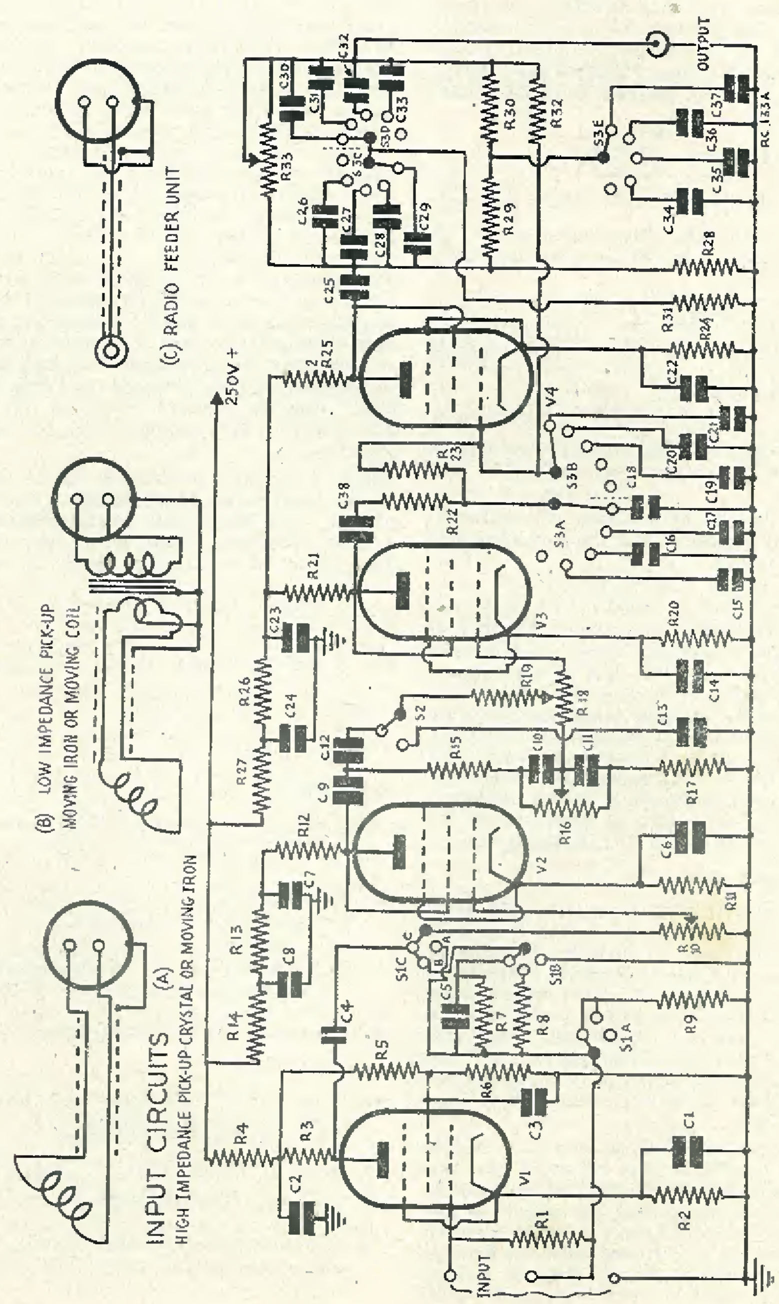


Fig. 6. Theoretical Circuits of Audio Pre-amplifiers

COMPONENT LIST

Resistors

R1	500 kΩ ½W HS
R2	4.7 kΩ ½W HS
R3	220 kΩ ½W HS
R4	47 kΩ ½W Composition
R5	470 kΩ ¼W HS
R6	68 kΩ ¼W HS
R7	220 kΩ ¼W HS
R8	220 kΩ ¼W HS
R9	22 kΩ ¼W HS
R10	250 kΩ Logarithmic
R11	3.3 kΩ ¼W Compo
R12	47 kΩ ¼W Compo
R13	22 kΩ ¼W Compo
R14	22 kΩ ¼W Compo
R15	100 kΩ ¼W Compo
R16	250 kΩ Logarithmic
R17	10 kΩ ¼W Compo
R18	100 kΩ Linear
R19	10 kΩ ¼W Compo
R20	1 kΩ ¼W Compo
R21	100 kΩ ¼W Compo
R22	100 kΩ ¼W Compo
R23	470 kΩ ¼W Compo
R24	3.3 kΩ ¼W Compo
R25	100 kΩ ¼W Compo
R26	22 kΩ ¼W Compo
R27	22 kΩ ¼W Compo
R28	1 MΩ ¼W Compo
R29	100 kΩ } ¼W 1% or matched
R30	100 kΩ }
R31	50 kΩ }
R32	470 kΩ ¼W Compo
R33	1 MΩ Logarithmic

Capacitors

Where no voltage rating or tolerance is given, these may be taken as 250V and 20% respectively.

C1	50 μF 12V Electrolytic
C2	16 μF 350V Elect.
C3	0.25 μF 250V Paper
C4	0.1 μF 500V Paper
C5	100 pF Silver Mica 10%
C6	25 μF 25V Elect.
C7	0.5 μF 350V Paper
C8	0.5 μF 350V Paper
C9	0.1 μF 500V Paper
C10	0.005 μF 500V Paper
C11	0.05 μF 500V Paper
C12	100 pF Silver Mica
C13	1000 pF Silver Mica
C14	25 μF 25V Elect.
C15	100 pF Silver Mica 5%
C16	200 pF Silver Mica 5%
C17	300 pF Silver Mica 5%
C18	500 pF Silver Mica 5%
C19	50 pF Silver Mica 5%
C20	100 pF Silver Mica 5%
C21	250 pF Silver Mica 5%
C22	25 μF 25V Elect.
C23	0.5 μF 350V Paper
C24	0.5 μF 350V Paper
C25	0.1 μF 500V Paper
C26	75 pF } Silver Mica 1% or Matched
C27	100 pF }
C28	150 pF }
C29	200 pF }
C30	200 pF }
C31	150 pF }
C32	100 pF }
C33	75 pF }
C34	150 pF }
C35	200 pF }
C36	300 pF }
C37	400 pF }
C38	0.1 μF 500V Paper

RADIO MISCELLANY

(*continued from page 523*)

way of an afterthought, we might also add, there could be no more pirates! Only this week somebody was quoting their number with a string of five noughts on the end.

Judged on present form, unless the unexpected happens (as it so often does) it looks as if alternative two will be the next step, and my guess is that sponsored TV may prove a two-fold blessing.

Gadget of the Month

From a number of specimens received for review from Messrs. Kendall and Mousley of Tipton, Staffs., a pair of meter stand ends took my eye. While their first appeal was largely prompted by novelty (I certainly cannot remember anything like them having previously been popularly marketed) their usefulness makes them worthy of recommendation for workshop, control console, transmitting table or laboratory use.

They consist of a light, but rigid frame neatly finished in crinkle enamel, upon which panels of various lengths can be fitted. Thus a single meter, such as an "S"-meter, or a whole row of instruments can be mounted at an angle of 45 degrees from bench or table level. This is an ideal angle for observing meter readings or other visual indicators, whether one is standing up or sitting, as well as making the best use of whatever illumination happens to be available. The price of the frame ends is 2*s* 6*d* per pair and panels of any required length can be supplied at 1*s* 9*d* for six inches plus 3*d* for each additional inch.

The address of the manufacturers will be found under the review of a selection of other items from their extensive range of laboratory and workshop metal-ware.

A Simple AC-DC Amplifier

By JAMES S. KENDALL

ASSOC.BRIT.I.R.E. M.I.P.R.E.

There are on the market today some valves of very low heater consumption, only 100 mA in fact. Three typical examples, the UBC41, UL41 and UY41 are used in this circuit. The base used is the B8A, which is of the eight-pin, pin type; the valves, being of the all-glass type, alleviate the troubles due to the loosening of the valve base owing to the heat from the valve itself. The writer has had experience of quite an amount of this trouble with octal based valves, especially in some of the continental types where the base is very shallow.

The circuit is quite conventional, except for the bass lift circuit. It is well known that in recordings the level of the bass has to be cut so that the needle does not have to be moved excessively for the reproduction of the low notes. The anode load of the UBC41 is divided into two portions, separated by a small condenser joined to chassis. This has the effect of reducing the gain at the higher frequencies, and increasing it at the lower. The actual value of the condenser will depend to a large extent on the listener. There is no reason why several different values could not be joined to a wafer switch and so provide a selection. The writer, however, has found that one of 0.005 μF is about right; it has an impedance of some 50,000 ohms at 700 cycles and only some 5,000 at 7,000 cycles. The higher the value of the condenser, the lower will be the value of the frequency that is lifted.

The coupling to the following valve, the UL41, is by means of a 0.01 μF condenser, into a 1 MΩ resistor. These values of condenser and resistor do not appreciably affect the lower end of the audio range, but help to reduce the chance of motor boating in the amplifier.

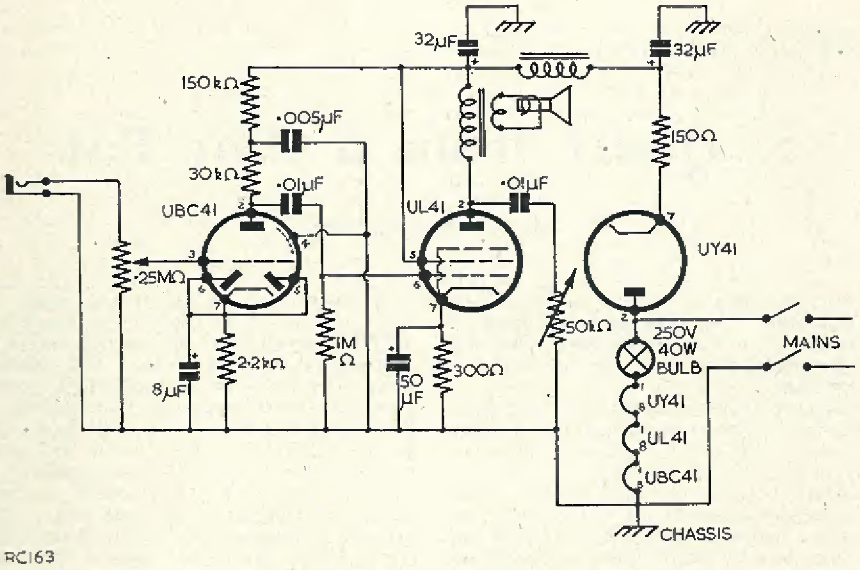
The condenser chosen for the bias of the UBC41 was one of those very small ones made by T.C.C. whereas that for the output valve was a normal sized 50 μF 50 volt job as it has to carry a much higher amount of AC.

The smoothing used was very efficient; two 32 μF condensers of the hole-and-nut type made by Hunts were used in conjunction with a 10 Hy choke of 50 mA carrying capacity. As the condensers were so large, a surge limiting resistance of 150 ohms is joined between the cathode of the rectifying valve and the reservoir condenser. If this resistor is omitted it is highly probable that the rectifier valve will be severely damaged in a very short time. The writer has had experience on more than one occasion of the valve pinch, in the older types of valves, being blown out through the envelope, with serious results to the valve!

The chassis used for the construction was one of the type "10" made by Kendall and Mousley of Tipton, Staffs. The fact that the amplifier is of the AC/DC type makes it unsuitable for use in a metal case, and if a wooden one is used plenty of air space must be given. The mains dropper used is in the form of a 40W 250 Volt lamp. This gives the correct amount of voltage drop when used on the 230 volt mains. The use of an electric light bulb for a dropper is by no means new; it has the effect of reducing the surge through the valves as it warms up very quickly. As the valves warm up and increase in resistance the current is reduced, and the resistance of the lamp drops so that any small voltage fluctuations of the mains are compensated for.

The components required are:—

One Each UBC41, UL41 and UY41.
Three B8A holders.
One 0.25 MΩ volume control W/S.
One 50 kΩ Tone control.
One 2.2 kΩ resistor.
One 1 MΩ resistor.
One 300 ohm resistor.
One 30 kΩ resistor.
One 150 kΩ resistor.
One 150 ohm resistor.
Two 32 μF 350 Volt or higher condensers.
One suitable smoothing choke.
One suitable output transformer.
One 8 μF 6 volt condenser.
One 50 μF 50 volt condenser.
Two 0.01 μF 350 volt condenser.
One 0.005 μF 350 volt condenser.
One Lamp holder.
One 250 volt 40 Watt Bulb.
One suitable chassis.



Theoretical circuit of AC/DC Amplifier.

625-Line Transmissions

The Television Society to Start Experimental Service

Speaking at the Television Society's Annual Dinner on April 13th, Sir Robert Renwick, President of the Society, said that they would shortly be building an experimental 625-line transmitter in order to provide a service to both amateurs and the radio industry and thus help the export market.

It was realised that receivers intended for the continental standard of 625 lines could be more conveniently demonstrated and tested on a radio signal under working conditions, and with the approval of the radio industry, the Society has undertaken to operate a suitable transmitter.

Discussions are shortly taking place between the Society and B.R.E.M.A. on a suitable site and design of the equipment.

Sir Robert said: "I want to make it clear that this is an experimental project undertaken for the advancement of television technique, subject to Post Office approval, and will transmit still pictures for experimental purposes. We shall take advice from the B.B.C. and the industry and hope that the export trade will benefit accordingly."

The principal guest at the Dinner was Mr. David Gammans, M.P., the Assistant Postmaster-General.

An Improved 17 inch Rectangular Television Tube

Mullard Ltd., have recently made an addition to their range of Long-life Television Picture Tubes. It is the MW43-64, an all-glass rectangular tube with a 17*in* diagonal grey glass face.

A feature of this new tube is the incorporation of a new form of electron gun which is designed to give uniform focus over the whole screen. In this new gun assembly the functions of electron acceleration and pre-focusing, which have hitherto been combined by the first anode, have been separated by the inclusion of an additional electrode.

The first anode in the MW43-64 acts as an accelerator having a potential of 200 to 410 volts with respect to the cathode. The second anode exerts a pre-focusing action on the electron beam, thus influencing the spot size and uniformity of focus. When the potential on this anode is zero or negative with respect to the cathode, the spot size at the centre of the screen and the width of the unfocused beam are such that optimum uniformity of focus is obtained over the whole picture area.

Further technical details of the MW43-64 can be obtained on application to the Technical Service Department, Mullard Ltd.

Let's Get Started . . . .

2. Quart from a Pint Pot

By A. BLACKBURN

Don't let that title lead you astray. I am not suggesting you are getting something for nothing when you use an amplifier. But that you are getting more from the little that you already have.

Such a prospect is always attractive, particularly if the process of multiplication is a simple one. And in this article I intend to show you just how easily it can be done.

Amplification often requires the use of two more complex types of valve in addition to the triode we discussed last month, but once you have seen how the simple types of valve work, it is easier to understand the tetrode and pentode, with which we are going to deal, as they really have the same basic construction as the triode, with extra electrodes incorporated in them.

Although popular for many years, the tetrode valve has been largely superseded for amplification of very high frequencies by the pentode valve (see Fig. 1b). The screen in both types has a positive potential upon it, and therefore increases the current from the filament to the anode. We will not worry a great deal at this stage about the special characteristics of these valves—suffice it to say that the mutual conductance is higher than that which can be obtained with a triode. Usually, one can say that the higher the mutual conductance, the higher will be the amplification or "gain," as it is often called, of the valve.

The fifth electrode of the pentode valve is the suppressor grid, between the screen and the anode, which serves to overcome certain

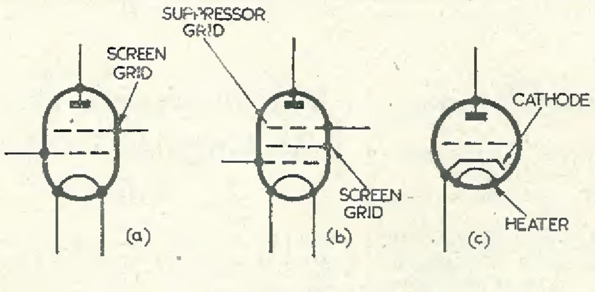


FIG. 1
(a) TETRODE OR SCREEN GRID VALVE
(b) PENTODE VALVE
(c) MAINS TYPE TRIODE

More Electrodes

The tetrode valve, shown in Fig. 1a, has, in addition to the filament, anode and control grid of the triode valve, a fourth electrode placed between the anode and control grid. This is the screen grid which, by shielding the control grid from the anode, reduces the capacity between them, making the valve more stable for some types of amplification.

However, as we are only concerned in this article with simple amplification, more advanced systems will be dealt with at a later stage; I do not want to confuse readers now with half-explained complexities.

disadvantages present in an ordinary tetrode. There is a type of tetrode available nowadays from which such disadvantages are removed, by using plates, mounted in the electron stream between the screen and anode, to form the electron stream into a "beam." Because of this characteristic these plates are called beam forming plates and this type of valve is called a beam-tetrode.

All the valves so far described have only been suitable for use with DC filament supplies. If AC were used to heat the filament, the AC signal would cause the electron stream to vary and would, therefore, produce a small alternating current in the anode circuit. In a practical design this would be evident as an objectionable hum. If, for example, we were to use the mains, via a transformer, to heat the filament, a 50 c/s hum would be superimposed upon the signal. You could, of course, overcome this by changing the AC voltage to DC by the use of a rectifier, but this would be expensive and clumsy. However, we can easily get over this problem by causing the filament to heat a small tube placed around it. This tube, called the cathode, is coated with a material which gives off electrons very easily, when heated. We now have a valve in which the filament emits no electrons at all, this duty being transferred entirely to the cathode.

A cathode may be incorporated in any valve, whether it be diode, triode, tetrode, or pentode, or even more complex types. And in general whenever a cathode is fitted, it is called a "mains" valve.

Coupling

The primary points we have to consider in the design of a simple amplifier are as follows: (i) what it is we want to amplify; (ii) the overall gain; (iii) the power output.

The first of these is obviously of considerable importance to us. In this article we shall confine our attentions to the amplification of signals in the audio range, that is to say, those frequencies which you can hear. Suppose, for instance, we wished to amplify signals from a microphone, a gramophone pick-up, or the tiny audio signals present in the detector stage of a radio receiver, where these frequencies cover a range of approximately 30 to 15,000 cycles per second. For the purpose of our elementary design, we will consider the gramophone pick-up. The voltage produced by a crystal pick-up is about one volt at the very most. The problem with which we are faced is to amplify this signal, and finally

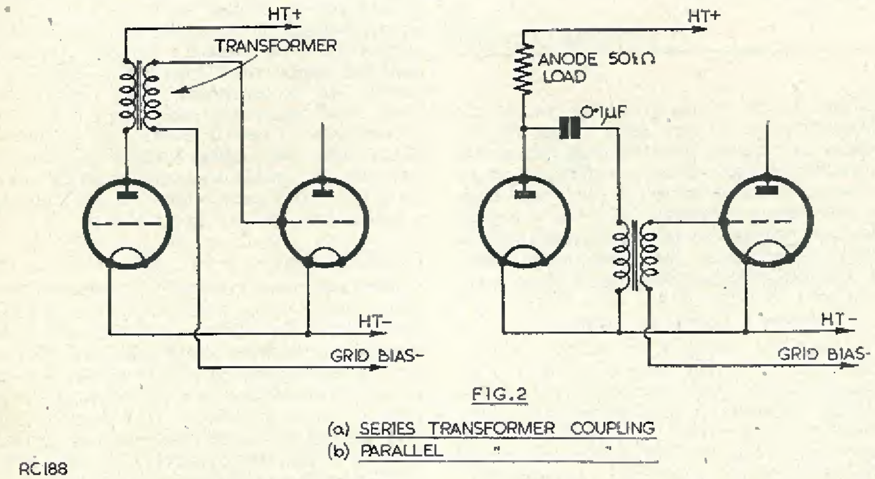


FIG. 2
(a) SERIES TRANSFORMER COUPLING
(b) PARALLEL " "

As a rule, filaments and heaters, as they are called in valves with a cathode, fall into a definite number of voltage ratings. Battery valves, that is those without a cathode, are normally 1.4 and 2V, AC mains types 4 and 6.3V, and AC/DC types, sometimes known as "universal" types, are in many voltages from 12 to 117.

Obviously with a mains type there is no battery problem, and economy of supplies is not so important, so that valves provide higher gain and power output than can usually be obtained in the battery range.

convert it into power, which brings us to points (ii) and (iii).

Normally one valve cannot produce sufficient gain to make such small signals comfortably audible in a room through a loudspeaker. Therefore the output of one valve has to be fed into other valves until sufficient gain has been achieved.

There are a number of ways of coupling one valve to another. Two of the more commonly used systems of coupling between valves are shown in Figs. 2 and 3. Fig. 2 shows transformer coupling. This is very simple and

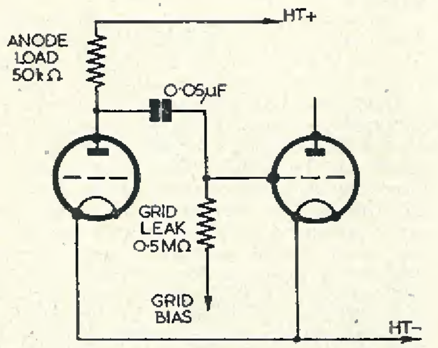


FIG. 3
RC-COUPLING
THE VALUE OF THE COUPLING CONDENSER MUST BE HIGH ENOUGH TO PASS THE LOWER FREQUENCIES, i.e. NOT LESS THAN 0·01μF

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economical, but if high quality, i.e. if the reproduction of a very wide range of frequencies, is required, then the transformer has serious limitations. Quite satisfactory results can be achieved, however, if the transformer is a well designed product. If it has a step-up ratio from primary to secondary, some voltage gain is obtained in the transformer itself. For example, if it had one volt in its primary and a step-up ratio of 5:1, then there would be 5V developed across the secondary.

Although the subject of the design of audio-transformers is a very deep one, which I do not here propose to go into, here is a word of guidance. Generally, the better the transformer, the larger it is. Recently, it is true, new techniques in this direction have resulted in the manufacture of very fine transformers of light weight and of reasonable size, but these are expensive in comparison with the older types which can be found in any friendly enthusiast's junk-box.

Another widely used coupling method is the resistance capacity system shown in Fig. 3. You will see that the valve has a resistance in its anode and, as in the simple amplifier described last month, the output voltage is developed across it. The output voltage at the anode is transferred to the grid of the next valve by a condenser. This condenser also serves to prevent the HT voltage in the anode of the first valve from reaching the grid of the second.

There is a point here which I know many people find confusing—I did myself. The signal voltage developed across the anode resistance *is actually developed at the anode with respect to the HT end of the resistor.* Now, in our circuit we have caused this voltage to be developed between the grid of the next valve and earth, the latter via the grid bias battery, the resistance of which is negligible.

To explain this, it must be appreciated that there are virtually two currents flowing in the anode load resistor: one is direct current flowing from the battery through the valve, and the other is the variation in this current, caused by the action of the valve. In other words, there is a direct current and an alternating current. Now, the HT battery is connected from the upper end of the anode load resistor to earth. However, the variation in current, i.e. signal current in the anode circuit, develops only a tiny voltage across the HT battery (due to the battery's internal resistance)—a voltage which can be ignored in comparison to the signal voltage developed across the load resistor. We may say, then, that the upper end of this load resistor, *as far as the AC is concerned, is in series with a very small resistance* (*the internal resistance of the battery*) *and is connected to earth.* In actual fact, the signal voltage is developed between the anode and earth because, as we have seen above, earth and HT are connected together from the AC point of view.

Final Comments

The resistance connected from the grid of the second valve to the grid bias battery is called the "grid leak." It would be as well to say a word or two here about grid bias. We will not go too deeply into the reasons for grid bias at the moment, but that does not mean that it is not important. The recommended grid bias value for every valve can be obtained from the valve table referred to last month. If, during your experiments, you should find that the recommended bias does not appear to give good results (wrong bias can usually be detected by severe distortion in the amplifier), then simply change the bias until the results improve. So much for grid bias—for the moment.

We will assume, in our specimen amplifier shown in Fig 4, that the input terminals *aa* are to be connected to a gramophone pick-up giving one volt maximum output, and that one watt is to be delivered to the loudspeaker. The voltage from the pick-up is applied to the triode V_1 grid through a volume control R_1. This component merely "taps off" some of the voltage in order that the required

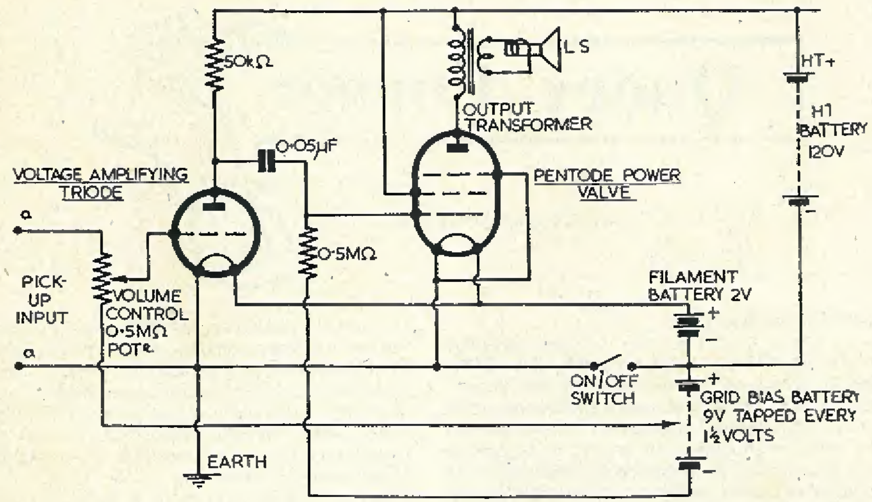

FIG. 4
A SIMPLE GRAMOPHONE AMPLIFIER

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volume level may be obtained. The output voltage from V_1 is applied to the pentode V_2 through a typical resistance capacity coupling network.

V_1 amplifies the voltage of the signal. V_2 converts this voltage into *power*. This is necessary because the loudspeaker cone has to vibrate and move about small quantities of air which strike the ear-drums in the form of sound. Movement of this air requires *power*. It will be seen from the diagram that in the anode circuit of V_2 there is a transformer, the secondary of which is connected to the loudspeaker. This transformer has a large step-down ratio from primary to secondary, and is called the output transformer.

The same remarks concerning good quality performance apply to output transformers as to coupling transformers. But whereas an output transformer must be used, a coupling transformer can be replaced by R-C (resistance capacity) coupling. So it would be to your advantage to see that your output transformer is of the best quality available. There is only one ratio for any set of circumstances that can be used for an output transformer, because it is used to correctly match the valve into the loudspeaker. Incorrect matching results in distortion and loss of power. The ratio is determined from the following expression:

$$N=\sqrt{\frac{R_L}{R_S}}$$

where N is the ratio, R_L is the recommended load for the valve, which can be obtained from the manufacturer's data, and R_S is the speech coil impedance of the loudspeaker. Speech coil impedances are normally about 3 ohms for small speakers and 15 ohms for larger sizes.

Unfortunately, space does not permit me to give a design method for driving a loudspeaker with one watt from a crystal pick-up, but in a later article I shall be showing the steps involved in practical design.

Here we have dealt with the whys and wherefores of simple amplification. There is, of course, more to this technique then we have mentioned here, but these basic facts will apply to more complicated systems. Once these have been understood, the greater part of the groundwork in this particular aspect of radio will have been done.

Query Corner

A Radio Constructor service for Readers

Receiver Ventilation

A significant proportion of the enquiries which this Department receives are either directly about problems regarding ventilation, or they are about faults which have occurred due to inadequate ventilation. This subject is a most important one and it is surprising how frequently it is entirely overlooked by constructors who make an otherwise perfect job of a radio or television receiver. The effects of overheating in equipment are often most annoying, and can also be expensive.

The most obvious effects are caused by a change in value of components; these frequently manifest themselves as a change in frequency, probably allowing a timebase to fall out of synchronism or the local oscillator in a superhet to become detuned. Another and perhaps more troublesome result of overheating is that it may well have an adverse effect upon the life of certain components. Capacitors and metal rectifiers are particularly affected in this way.

Some idea of the importance of providing adequate ventilation is gained when it is realised that almost all the power which is drawn by a receiver is dissipated as heat within the cabinet. Steps must be taken to get this heat away from the power consuming components before it has a chance to reach other parts of the receiver. This is achieved by removing the warm air from around the chassis and replacing it by cooler air from outside the cabinet.

It is well known that warm air rises, so provision must be made for a free passage for the air both above and below a heat generating component. It is quite often difficult to obtain this space above a component, particularly if the receiver is of the semi-portable type, and under such conditions it is necessary to mount the hot parts at the rear of the chassis. Having done this, a heat screen is erected between them and the remainder of the receiver to channel the rising air out of holes in the back panel of the cabinet. This is not in itself sufficient, and holes must be drilled in the chassis to allow cold air to take the place of that which rises. Reference to Fig. 1 will indicate the general layout of this arrangement. In a standard receiver the greatest amount of heat is generated by power and rectifier valves and large voltage dropping resistors. Components such as these should be given the form of ventilation outlined above. To gain the free flow of air past a valve it is convenient to drill a series of small holes around its holder.

A particular layout may result in a hot valve being located near a frequency determining component which must be kept cool. When this happens, a series of holes should be drilled around the valveholder as already

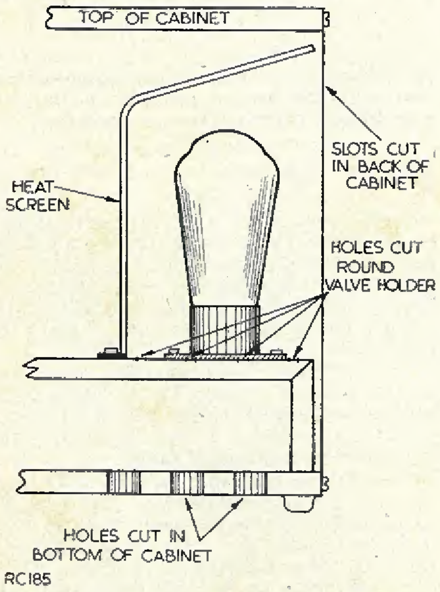

Fig. 1. Method of obtaining uninterrupted flow of air around a hot component.

described and a metal funnel made up to enclose the valve. The heat within the funnel will cause a steady current of air to flow up through the holes round the holder, past the valve and out of the top. An arrangement such as this not only prevents the heat reaching other components, but it also assists in cooling the valve.

Under-chassis ventilation is important; this is particularly so where air is drawn from below the deck to ventilate components which are located on top of it. In general a space should be left between the chassis and the bottom of the cabinet, or conversely the bottom of the cabinet should contain ventilating holes or slots and should be raised off the table. An alternative system is to drill holes in the sides of the chassis. However, regardless of the layout employed, the aim must be to obtain a free path of air past all hot components.

A particular problem of ventilation occurs in television receivers due to the necessity of screening the components of the line timebase. Such screening is necessary to prevent radiation affecting adjacent broadcast sets, and indeed it may well cause trouble in the televisor itself by direct pickup in the vision channel. It is normal to enclose the line output transformer, and the three or four valves which make up the timebase, in the screening can, with the result that a considerable amount of heat can be generated. Ventilation is most easily arranged by cutting some large holes in the top of the screen with a chassis cutter, and a series of smaller holes, about ⅜" in diameter, around the sides of the screen near the chassis. Another series of holes are cut around the valveholders and provision made to provide a passage of air to the underside of the chassis as already discussed.

Enough has been said to indicate the general line of approach to the problem of providing adequate ventilation, and the fact that it is a problem which is worthy of serious consideration cannot be too highly stressed.

Vision on Sound

I have just completed my first television receiver, and have been successful in eliminating most of the more common faults, but one stymied me. The sound quality is poor and seems to be affected by the vision signal. Sometimes the sound is accompanied by a harsh buzzing sound.

A. Welsh, Tewkesbury.

This trouble appears to be due to a part of the vision signal reaching the sound channel. The sound section of the set should be sharply tuned with a bandwidth which is probably in the region of 100 kc/s. The full curve of Fig. 2 indicates a typical sound and vision response for a lower sideband television receiver. It will be seen that the sound sensitivity is such that no significant part of the vision response curve falls within the sound pass-band. Now, should the sound channel be mistuned, or should it be correctly tuned but have too wide a pass-band, the two curves may overlap as shown by the dotted line of the figure. Under this condition a component of the vision signal will be accepted by the sound channel and may, in conjunction with the sound signal, cause severe overloading of one of the valves in the sound RF circuits. The cure is obviously a matter of checking the tuning and selectivity of the sound channel and making good any deficiency in these directions.

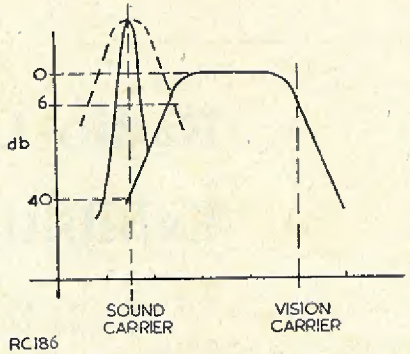

Fig. 2. Response curve of a lower side-band television receiver, showing how the sound response may overlap the vision pass-band.

Whilst on the subject of tuning TV coils, it is worth while pointing out how a false resonant point is sometimes mistaken for the correct tuning position. Most TV coils are tuned by means of adjustable cores, which pass down through the centre of the winding. Obviously, there are two positions of the core which give the same resonant frequency; one is as the core is entering the winding, and the other when it is leaving it on the opposite side. Now between these two positions the circuit may peak somewhere near the required frequency, but it may not actually be on tune. If this is occurring in the sound channel under discussion it will in all probability result in a response curve which has two resonant peaks, though not necessarily of the same magnitude. If this is, in fact, found to be so, the turns on the coil in question must be adjusted, or conversely, if the coil has a shunt capacitor it may be more convenient to change this for one having a slightly different capacitance. If a coil is tuning up correctly the resonant peak will be reached before the centre of the core has reached the centre of the coil.

Radio Component Exhibition — 1953

Visited by

L. A. CHINNERY, G3IIZ

A private Exhibition, organised by the Radio and Electronic Manufacturers Federation, was viewed by a specially invited audience on April 14th to 16th inclusive. The Exhibition was officially opened at 11 a.m., Tuesday April 14th, by Sir Robert Renwick, Bart., President of the Radio and Electronic Manufacturer's Federation from the gallery of the Great Hall, Grosvenor House, Park Lane, London, W.1. Later, at 1 p.m., Sir Robert presided at a private opening luncheon, attended by the Minister of Supply, Mr. Duncan Sandys, M.P., who proposed a Toast to the Guests. An organised party of important buyers from the U.S.A. attended, establishing a precedent in Transatlantic radio marketing. It is also to be noted that the Federation plan to hold a similar exhibition later in the year, the venue being Stockholm.

Your contributor was invited and attempted to view through the eyes of the Radio Amateur and Home Constructor.

The first call was at Stand No. 105, where a display of the AVO range of products was to be seen. Their "Electronic Multimeter," a most comprehensive instrument, was first to catch the eye.

The name of Belling and Lee is not at all unknown in amateur radio circles, and this company were showing their popular products. These included plugs and sockets, aerial and other insulators, mains and ignition suppressors and valveholders, etc. Also featured was a thermal delay switch for TV receiver use.

Making investigations on behalf of the TV enthusiast, we visited the Aerialite stand, where a novel colour-photographed display analysed TV receiving locations and recommended suitable aerial systems. Vision aerials of a variety of types were on show, including the "Aerfringe," a multi-element outdoor system for the fringe-viewer. Still with TV in mind, a visit was paid to the Mullard stand where an interesting exhibit was their long-life Rectangular picture tube. By virtue of a development in electron-gun design, the makers claim uniform focus over the whole screen area. On the Taylor Electrical Industries stand the instruments for television servicing were worthy of mention, including as they did the Television Wobbulator (260A) and the Pattern Generator (240A).

Audio enthusiasts will be pleased to note that Messrs. Birmingham Sound Reproducers Ltd., showed their new "Monarch" autochanger. Features include three speeds and crystal "turnover" pickup. On the tape-recording side of the audio world, visitors were advised at the Truvox stand of that company's Tape Deck Mk.III, and other audio gear, including special speakers, etc.

Salford Electrical Instruments Ltd., were exhibiting the quartz crystals for which they are well known, together with equipment for crystal calibration and measurement of activity.

Erie Resistor Co. Ltd., showed the first printed circuitry that your contributor has seen "in the flesh," so to speak, and included their high voltage ceramicons and small-size type 7AD resistors. The well known transformers of Ferranti and Partridge were to be seen on their respective stands and the products of Messrs. Rola-Celestion Ltd., were displayed to good advantage. Other famous names represented at the Exhibition were Multicore, Telegraph Condenser Co. Ltd., N.S.F. Ltd. (Oak switches, potentiometers, etc.) and Hunts Capacitors.

from our Mailbag

General Purpose Test Meter

Dear Sir,

Referring to the diagram on p. 338 of the March issue, there is an error. The positive lead of the 4.5V battery should go to the positive test lead and NOT to the common switch arm. If this is left as per the diagram, there is no indication when in the "Ohms" position.—FRANCIS A. GRANT, G3FTV (Wakefield Yorks).

Picture Tube Defects

Dear Sir,

Reference Gordon J. King's article on p.349 of the March issue:—When discussing heater/cathode S/C on a cathode modulated tube he, quite rightly, points out that a mains isolating transformer cannot be used to supply the heater. The objections mentioned are truly applicable to the normal type of heater transformer.

There is, however, a special transformer available for this particular application, at a reasonable price. The capacitive and leakage inductance losses are extremely low, and very little loss of definition is noticed. The secondary has tappings for 6.3, 4 and 2V heaters, plus a 3V tapping for low emission 2V tubes!

I am bringing this to your notice as I feel it may enable some constructors to avoid the rather tedious and possibly more expensive method of using two valves, as shown in the article.

The manufacturers of this particular transformer are Norman Rose, Ltd., Hampstead Road, London N.W.1.—A. WARD (Hayes, Middlesex).

Valve Multi-Meter

Dear Sir,

It was with great interest I read the article by Mr. J. S. Reynolds in your April issue.

For the benefit of readers who may not have noticed, I should like to point out that at 1000 volts the resistor network passes 100 µA, and according to Ohms Law passes 1 mA at 10,000 volts. An ex-Govt. 100 µA FSD meter that I bought quite cheaply passes 100 µA on all ranges, but allows me to load most circuits, especially TV EHT, without detrimental effects.

However, the basic circuit, if used in conjunction with the circuit by Mr. T. Hatton in the October 1950 *Radio Constructor*, which had a sensitivity of 100,000 ohms per volt, should prove a prize winner.—P. WILKENS (Southend-on-Sea, Essex).

Can Anyone Help?

Dear Sir,

Would you please be so kind as to insert the following letter in your mag. under the "Can Anyone Help?" column.

I am desirous of building a really good class 'scope, and wonder if any "*RC*" readers have any circuit of tried and proven jobs using current range of valves, say, EF80, ECC80, ECL80, 0.1A type, to have response to 3 Mc/s, switched attenuator, "X" and "Y" shifts, cathode follower input, timebase up to 250 kc/s, and VCR138 or 139A.

I would greatly appreciate full details of any circuits or ideas of any readers on this subject. —L. A. BROWN (33 Barnoldby Road, Waltham, Lincs.).

Dear Sir,

Can anyone assist me to identify three metal rectifiers, purchased with a quantity of other ex-Govt. surplus components?

Each was 3" in length, have 28 fins, are grey in colour, and bear the following inscriptions:—

Positive End (*Red*)	*Negative End* (*Black*)
280/LU (or CO) /422B	V1A+B
280/LU 422 R (or B)	V1A+B
280/LU 422 R (or A, B or P)	V1C+D

I should be grateful if someone can advise me, if possible, the input and output voltages of these rectifiers, as I have no meters to hand. —STANLEY W. J. GREEN, (6 Elmwood Avenue, Baldock, Herts.).

Some Useful Hints

By J. S. K.

Precautions on Renewing the Output Valve

Often after the radio set has been running for a number of years a fault develops in the rectifier valve and it will not pass the required current. The H.T. voltage falls so that the electrolytics do not get their full voltage and tend to "De-Form," and renewing with a new valve can cause the components to rupture as the voltage applied is higher than the condensers are used to. Re-forming is essential and can be done quite simply by slowly raising the voltage across the condenser with current from a separate power pack. The condenser should be disconnected whilst re-forming. The voltage to which the condenser is raised should not exceed its rated maximum.

Changing an indirectly heated rectifier valve for a directly heated one

Often the constructor or repair man sees that two rectifiers have the same current and voltage carrying capacity and thinks that they can be interchanged. For instance a GZ32 used in a T.V. receiver would appear to be able to be replaced with a 5U4G as they have the same voltage and current carrying capacity. The snag comes with the warming up times; with the 5U4G it is only a matter of seconds, whereas with the GZ32 it is longer than the rest of the valves. In the first case, the voltage fed into the set is 1.4 times the R.M.S., whereas in the second it may only be a few volts over the R.M.S. This can cause the electrolytics to rupture and cases have been met where they have exploded. Conversely a directly heated valve can be replaced with an indirectly heated one without fear of trouble.

Increasing the size of the Reservoir Condenser

With the modern trend to use larger and larger condensers it is very tempting to cut down on the size of the choke and increase the capacity of the condensers. This can cause trouble as the reservoir condenser is charged by a series of short pulses rectified by the valve; if these are of too heavy a current the valve can be ruined quite quickly. If the maker's data sheets for the rectifier valves are consulted it will be found that a table of surge limiting resistors to be placed in series with the valve are given. These should be used. In the case of A.C. receivers it is good enough just to bring up the primary resistance to the required value, but in A.C./D.C. receivers the full value must be used.

VERSATILE OSCILLOSCOPE

ERRATA

There were one or two errors in the circuit diagrams of the oscilloscope given last month.

C22 is given in the Component List as 0.1 µF, but appears on the diagram as 0.05. This component is not critical, and either value will be quite satisfactory.

Two resistors in the tube network bear the number R.40. The lower one going to the focus pot should be 300 KΩ, whilst that going to H.T. positive is 50 KΩ.

There should also be two 2 MΩ resistors in series across the shift pots, the centre tap going to chassis. The CRT used in the original design is a VCR 138.

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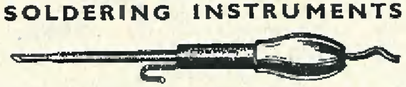

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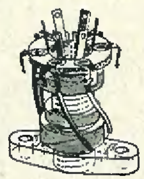

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[*continued on page 551*

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May Issue

Practical Frequency Modulation. Petrol Generator A.C. Supplies for Field Day. Grounded Grid RF Amplifiers. Buffers and Doublers. Bias Supply for the 807. Crystal Grinding. Broadcast Bands Review. Amateur Bands Commentary. On the Higher Frequencies. Round the Shacks—G8UA. Club News, etc., etc.

Small Advertisements

(Continued from page 551)

Announcement

New Service for the Amateur and Experimenter

A stamped addressed envelope will bring you details of the new series of blue-prints of aerial tested circuits, from single valve to six and seven valve superhets. In the near future, kits of parts will be offered, both for the home constructor and the Amateur Transmitter and Receiver. Coming off the drawing board shortly is a Simple Communications Receiver circuit. Further announcements will be made shortly concerning equipment for the T/V home constructor, including wide band pre-amplifiers, etc., at prices which will be right for your pocket. Get your name and address on the files NOW by sending your S.A.E. to J.H.G. Box No. C107.

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