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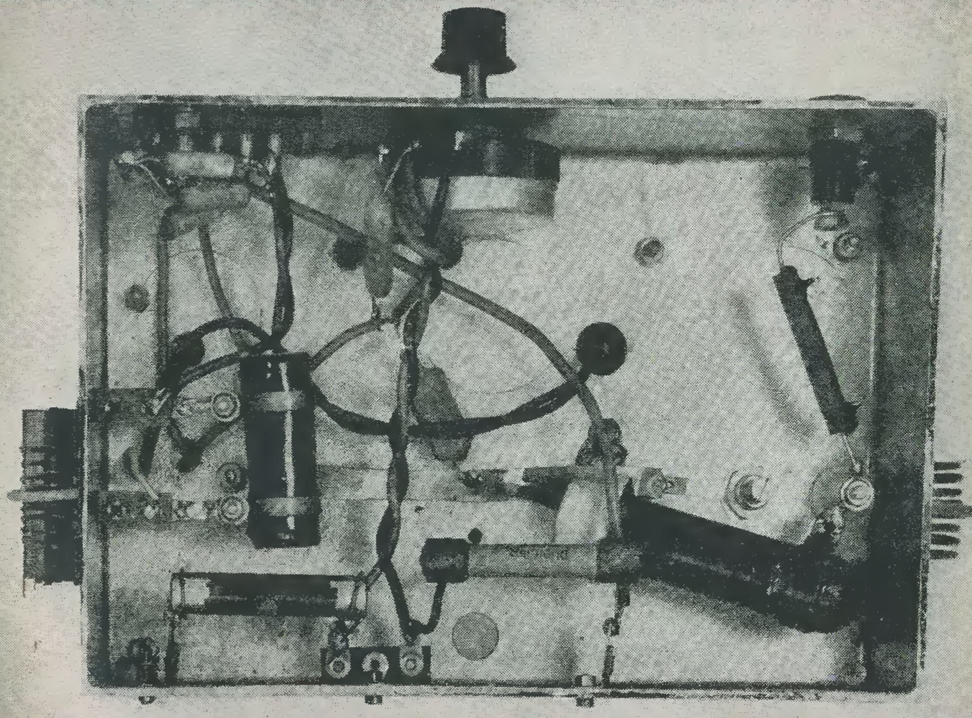
RADIO CONSTRUCTOR

for the Radio and Television Enthusiast



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A Signal Tracer · The Versatile Three · Harmonic Drive
Loudspeaker Baffles and Enclosures · Series Meter Resistors
Radio Control of Models · Query Corner

etc., etc.

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Radio Constructor

Vol. 5, No. 4 **Annual Subscription 18/-** **November, 1951**

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Edited by C. W. C. OVERLAND, G2ATV

Editorial

This month our exhibition takes place—the "our" referring not to this publication but to its readers, for this show is the one which caters most for the needs of the home radio enthusiast. Indeed, this year a special section will be devoted to the display of home constructed radio equipment.

The event is, of course, the Fifth Annual Radio Society of Great Britain Amateur Radio Exhibition, which will be held as usual at the Royal Hotel, Woburn Place, London W.C.1 over a period of four days.

The Exhibition will be opened by Mr. Charles Ian Orr-Ewing, O.B.E., at 12 noon, Wednesday, November 28th. Normal opening time is 11 a.m., and closing 9 p.m. The price of admission will be 6d.

Apart from the usual Trade stands, the Air Ministry, Admiralty, and the Television Society will be exhibiting.

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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.

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

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

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. 12: A High-Fidelity TRF Tuner Unit.

THIS month's circuit (Fig. 1) gives details of a TRF tuner unit intended for connection to a high-fidelity AF amplifier. The tuner unit covers both medium and long waves, a comprehensive control of variable selectivity being provided by a switching circuit which, as it is advanced, progressively loads each tuned circuit in turn. Detection is carried out by an infinite impedance detector. A "magic eye" tuning indicator can be included, if desired, this being used to show the state of tuning and also to give an indication of the magnitude of the RF voltages fed to the detector.

The RF Circuits

As may be seen from the diagram, the RF circuits are quite simple and straightforward. Wave-change switching is effected by S1 to S6 inclusive. RF amplification is carried out by V1 and V2, both of which are vari-mu RF pentodes. V2 feeds into V3, the infinite impedance detector, the demodulated output from this valve being built up across R17.

Variable selectivity is provided by the 3-wafer, 7-way switch S8, 9 and 10. When the arm of this switch is fully to the left (anti-clockwise in Fig. 1), the tuned circuits are unaffected and the unit is capable of giving its sharpest degree of selectivity. As the switch is turned clockwise through one contact, a 100 kΩ resistor, R3, is connected across the aerial tuned circuits (L3 or L4 and C4), causing these circuits to be slightly flattened. At the next contact a 10 kΩ resistor, R4, is connected across the tuned circuits, causing them therefore to be flattened still further. R4 remains connected across the aerial tuned circuits for the remainder of the variable selectivity switch positions; additional flattening being obtained by loading the tuned circuits L7, L8 and C10 in the same way, and, in the final two positions, the detector tuned circuits as well.

RF volume control is provided by R11, which varies the cathode bias of V1 and V2. This control may be ineffective when receiving very strong signals, whereupon it will be necessary to close switch S7. This switch causes the screen-grid voltage of V1 to be considerably reduced.

An AF volume control (R19) is also provided. This component may not be necessary in some installations, and it could be replaced by a fixed resistor of the same value. To prevent attenuation of the higher AF frequencies, it is *essential* that the output be fed to the subsequent AF amplifier through a screened lead whose self-capacitance is very small. If the use of a long screened lead (whose self-capacitance would therefore be high) cannot be avoided, it would be advisable to insert a cathode follower between the output of the detector and the screened lead. A suitable circuit is shown in Fig. 2. In cases where the self-capacitance in the connecting lead to the amplifier would not be higher than 100 pF or so, an easier course would consist of omitting R19 altogether and taking the output directly from C21 and chassis. However, should this course be adopted, care should be taken to see that the input impedance of the following AF amplifier is at least 500 kΩ. (If necessary, it should be altered to this value. Except for those cases where the input impedance consists of a volume control whose slider is *not* connected directly to the first grid, this should not cause any trouble since the total input impedance, so far as the amplifier is concerned, will be approximately 100 kΩ; this being occasioned by the presence of R17 in the tuner unit).

Stability

In order to prevent instability, careful attention has been paid in the design of the

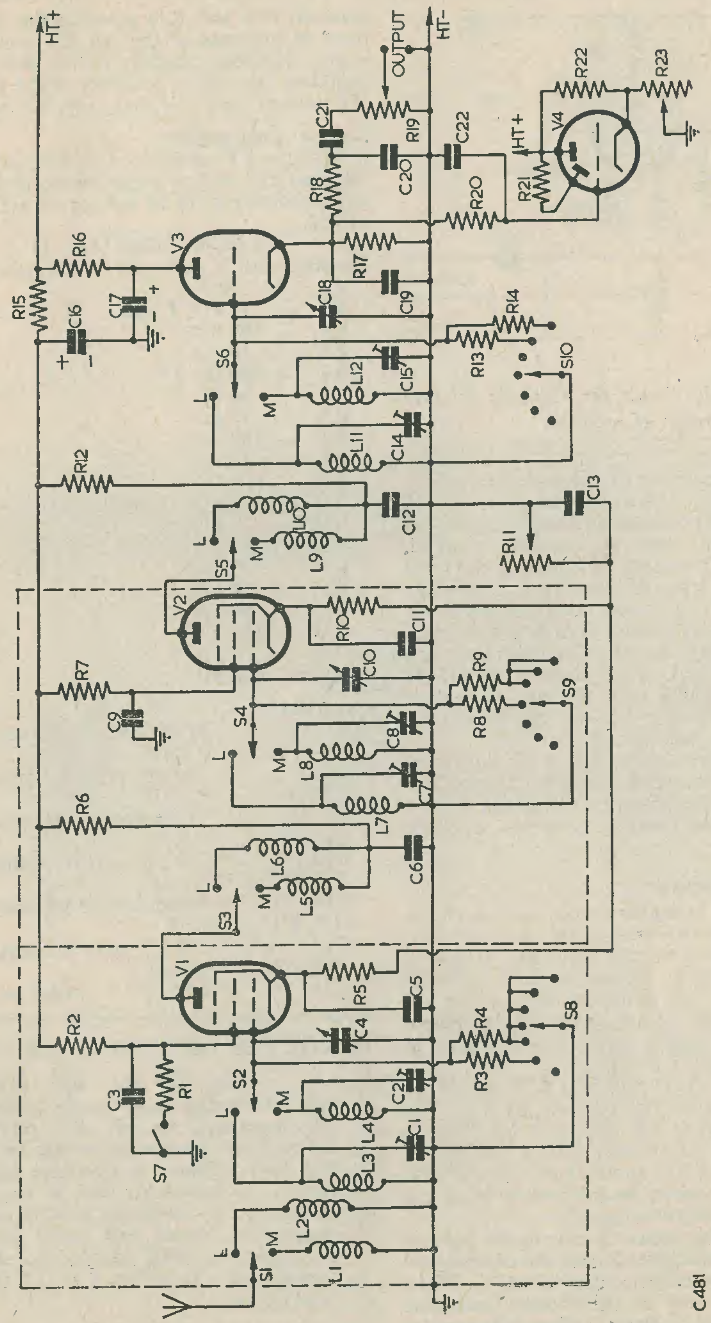


Fig. 1: Circuit diagram. For values, see P.124.

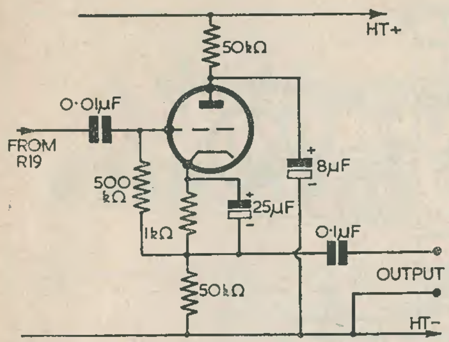


Fig. 2. Suitable circuit for Cathode follower stage, if required.

circuit to the inclusion of adequate decoupling. The provision of effective screening is also of considerable importance, and the layout should be planned with this point always in mind. The best policy consists of screening the three sets of tuned circuits (and their immediate wiring) away from each other as effectively as possible. The dashed lines in the diagram give a good idea of the points at which screening should be applied. (If instability should be persistent, it might help to have the anode leads from V1 and V2 to their respective switch contacts screened also).

It should be remembered that the individual wafers of both the wave-change and the variable selectivity switches must be connected to their respective tuned circuits by means of short wiring.

The Tuning Indicator

The tuning indicator shown in the circuit need not necessarily be fitted to the tuner unit, as its inclusion is entirely optional. It is used here in a different manner to that normally encountered. This is due to the fact that the DC voltage built up across the infinite impedance detector load is positive (with respect to chassis) instead of negative.

If they are used, R20 and C22 should be mounted close to the cathode of V3. The lead to the tuning indicator grid can then be made as long as is required by the layout. The positions of R22 and R23 are unimportant. R21 will, of course, be fitted directly to the indicator's valveholder tags.

To set up the indicator circuit, the resistor R23 should be adjusted until the shadow on the target of the indicator just "closes". When a station is tuned in the shadow will then "open". It will be seen that the potentiometer network R22 and R23 prevents the indicator from making use of the full HT voltage. It might, therefore, possibly not be worth while including the tuning indicator if the available HT voltage were less than, say, 225 volts.

Current Consumption

With the RF volume control fully advanced, the total HT current taken by the unit will be approximately 20 to 30 mA for an HT voltage of 250.

List of Values (Fig. 1)

Resistors (All ½ watt unless otherwise stated)

R1	— 5kΩ
R2	— 75 kΩ; 1 watt
R3	— 100 kΩ
R4	— 10 kΩ
R5	— 300 Ω
R6	— 10 kΩ
R7	— 75 kΩ
R8	— 100 kΩ
R9	— 10 kΩ
R10	— 600 Ω
R11	— 25 kΩ; 1 watt
R12	— 5 kΩ
R13	— 100 kΩ
R14	— 10 kΩ
R15	— 1 kΩ; 1 watt
R16	— 50 kΩ
R17	— 100 kΩ
R18	— 10 kΩ
R19	— 500 kΩ

Capacitors

C1, C2	Trimmers; 60 pF max.
C3	0.1 µF
C4	500 pF; part of 3-gang
C5, C6	0.1 µF
C7, C8	Trimmers; 60 pF max.
C9	0.1 µF
C10	500 pF; part of 3-gang
C11, C12, C13	0.1 µF
C14, C15	Trimmers; 60 pF max.
C16, C17	8 µF
C18	500 pF; part of 3-gang
C19, C20	200 pF
C21	0.01 µF

contd next page

Valves

V1, V2	Vari-Mu RF Pentodes
V3	Amplifier Triode (6J5, etc.)

Switches

S1 to S6	Wave-change (Ganged)
S7	Local station attenuating switch
S8, S9, S10	Variable selectivity (Ganged)

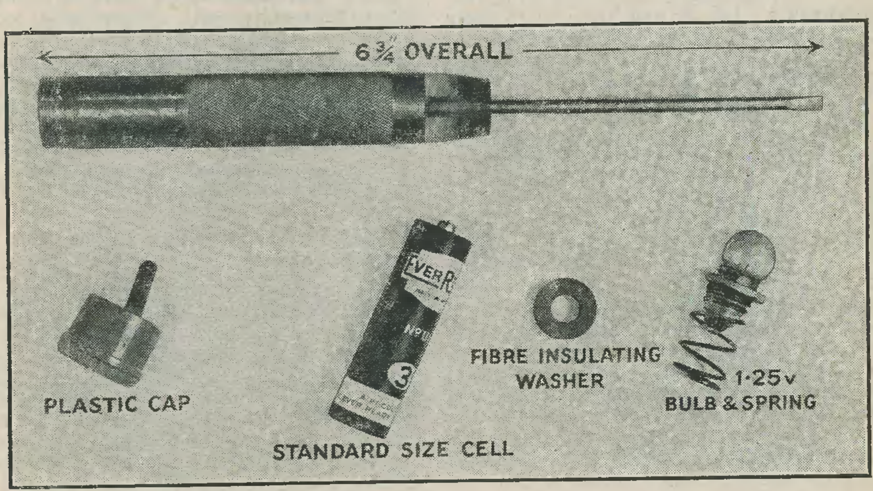
Inductors

L1, L5, L9	Coupling; medium waves
L2, L6, L10	Coupling; long waves
L3, L7, L11	Grid; long waves
L4, L8, L12	Grid; medium waves

When tuning indicator is used

R20	4 MegΩ; ½ watt
R21	1 MegΩ; ½ watt
R22	50 kΩ; 2 watts
R23	50kΩ; 2 watts. Pre-set
C22	0.01 µF
V4	Tuning Indicator

TRADE REVIEW



THE SPOTLIGHT SCREWDRIVER "MINOR".

We have been favoured with a sample of the interesting screwdriver pictured above.

It very often happens, particularly when servicing, that work has to be undertaken where light is poor, if not absent. In addition, both hands are usually fully occupied, and a propped-up torch has an annoying habit of falling over just at the crucial moment. We have recently, for this reason, fitted a couple of spotlights to our 7-second soldering gun; now, along comes another useful tool to help us in such circumstances.

This screwdriver is of a suitable size for most radio work, and will comfortably handle 4 BA screws. The blade is well keyed into a plastic lens, and the handle is well knurled, affording a firm grip. The lighting arrangement is simple, yet positive. As will be seen from the above illustration, the bulb is normally held away from the battery by a spring. On rotating the cap, the battery is pressed inwards until contact with the bulb is made.

The "Minor" retails at 6s. 9d. and is now being introduced to Radio and Electrical shops throughout the country. Readers unable to obtain one locally may do so on forwarding 6s. 9d., direct to the makers, Messrs. John E. Buck and Co., 47 Brewer Street, Piccadilly, London, W.1.

Loudspeaker Baffles *and* Enclosures

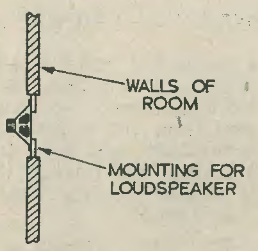
PART 2

By J. R. DAVIES

IN last month's article we dealt with the main theoretical points which are encountered in the design of baffles or enclosures for quality reproduction. Let us now pass on to more practical factors and see how the problem of providing a suitable housing for the loudspeaker may be actually obtained.

As we said last month, the simplest solution to the problem (and incidentally a very effective solution) is provided by the ordinary flat baffle. As was also pointed out, however, this baffle has a great disadvantage owing to the large size needed for adequate bass reproduction. We mentioned a diameter of about ten feet as being necessary for really adequate reproduction.

The large dimensions required, therefore, make the flat baffle too bulky for domestic purposes. Nevertheless, if the listening room should possess such a thing as a serving-hatch, it is possible to fit the loudspeaker in this, the walls of the room themselves forming the baffle. Fig. 4 shows the idea. Of course few constructors will be able to avail themselves of such a facility; and a considerable disadvantage is given by the fact that the loudspeaker radiates backwards into the room on the other side of the hatch as well. Nevertheless, such a mounting would give an almost ideal baffle and is therefore well worth consideration here.



C483

Fig. 4 An almost perfect baffle may be obtained if use is made of, say, a serving hatch: utilising the walls of the room themselves as a baffle.

The necessity of using a large baffle is sometimes overcome by mounting the speaker on a baffle of smaller dimensions and incorporating a little bass boost in the amplifier. However, this course is not recommended for those who want really good fidelity, as it is almost certain to give unsatisfactory and unbalanced reproduction.

Cabinet Baffles

The bulkiness of the flat baffle may be reduced somewhat by folding the edges over as illustrated in Fig. 5, where equal parts of two sides of the baffle are shown bent back. This certainly allows an effectively larger baffle to be made, provided that only two opposite sides of the baffle are so treated. If all four edges were bent back, thus forming a "cabinet", the loudspeaker would not give good reproduction owing to the reverberation induced by the air within the cabinet, and by the reflections from the sides. Some relief from this effect may be given if the sides are folded back through, say, 45 degrees or less (as shown in Fig. 6), but the baffle then begins to become as large as does the equivalent flat version.

Cabinets, as such, cannot really be recommended for high quality reproduction; and even the baffle of Fig. 5, with only two opposite sides bent back, is not quite so good as the equivalent flat baffle.

The Infinite Baffle

An early solution to the problem of providing an adequate baffle in a small space was suggested by the use of an "infinite baffle". This was made by mounting the loudspeaker in a totally enclosed cabinet, thus preventing any back-radiation whatsoever from reaching the front of the reproducer.

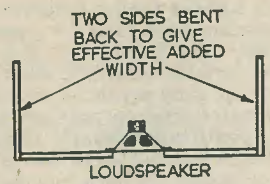


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Fig. 5 How two edges may be bent back to reduce the width or height of a flat baffle.

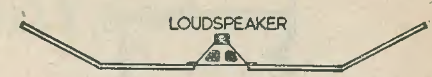

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Fig. 6 If all four sides of a square baffle are folded back as shown, cabinet resonance should be almost entirely eliminated and the effective size of the baffle can be increased.

Used in this form, the air imprisoned inside the cabinet very naturally had a highly resonant frequency. This effect was reduced by lining the inside of the cabinet with a heavy layer of rock-wool or similar sound-absorbent material, thus "absorbing" the back radiation and so preventing any cabinet resonance.

However, although this process was successful to a certain degree, the imprisoned volume of air inside the rock-wool itself was still sufficiently resonant to mar the reproduction. It must be remembered, of course, that the conditions at the back of the loudspeaker diaphragm have practically the same effect on reproduction as if they were at the front.

An interesting solution to the problem of absorbing the back radiation of the loudspeaker is provided commercially by the "True Bass Boffle" manufactured by Hartley Turner.[1] A typical cross-section of the Boffle is shown in Fig. 7. The sound from the back of the speaker is absorbed by the air pockets formed between the screens, these air pockets acting as a series of acoustic filters. The result is a completely non-resonant baffle which can be made quite small in size.

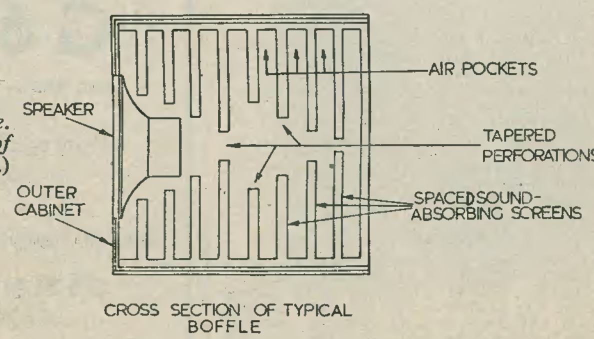
Bass Chambers and Labyrinths

Apart from the use of baffles, the low frequency radiation of the loudspeaker may be accentuated, or its frequency range may be extended or corrected, by means of bass chambers and labyrinths.

Bass chambers, although used occasionally to remedy defects such as resonances in the reproduction of the speaker, are designed mainly to load the diaphragm in such a fashion that the bass response is extended. This is done usually by making the chamber resonant at a certain frequency, the frequency being dependant upon the physical dimensions of the chamber. The resonance may be "flattened" by fitting the inside of the chamber with a layer of sound-absorbent material. Occasionally two chambers may be used, one "feeding" into another of different resonant frequency, in order to enlarge the bass response of the speaker over a wider frequency range. The chambers may be regarded as being acoustic filters, having something of the characteristics of flatly tuned circuits. They are not necessarily used to prevent back radiation reaching

1. The Boffle is supplied by H. A. Hartley Co. Ltd., London, either complete or in kit form. It is protected by Br. Patent No. 434563.

Fig. 7 The True-Bass Boffle. (Reproduced by courtesy of H. A. Hartley Co. Ltd.)



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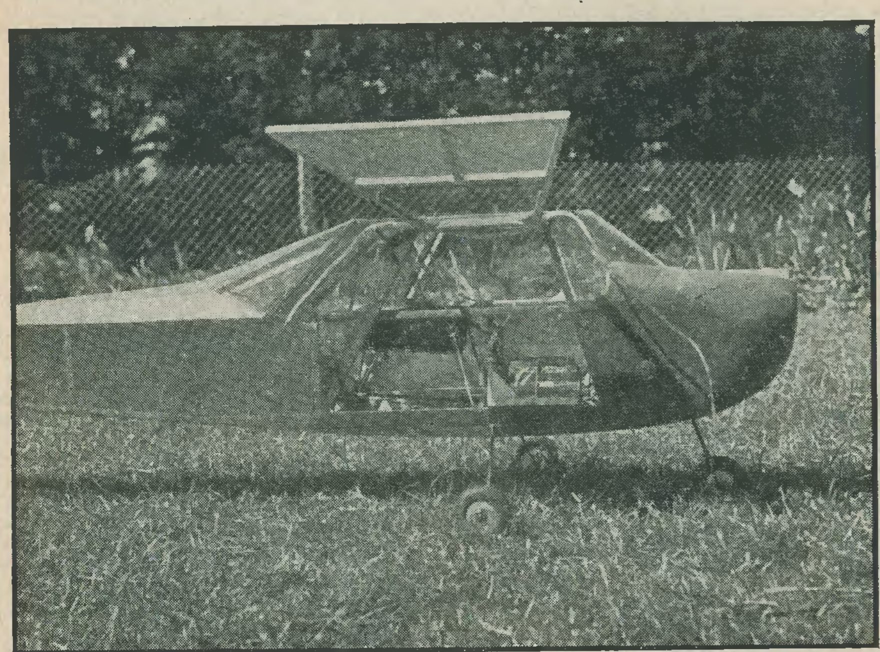


The Model Aircraft with cabin open to show receiver slung by rubber bands, and batteries fixed in forepart of cabin. The potentiometer adjusting screw can be seen just forward of the cabin door.

then left and back to centre again and so on. Due to inertia in the turning movement of the aircraft it is possible to flip the rudder through an unwanted position without adversely affecting the direction of the aircraft.

The escapement is a neat little unit supplied by E.D. It must be built into the fuselage during the construction of the model, together with the rudder control shaft, the rudder fittings and hooks, etc., for rubber skeins. So let your aeromodeller friends have this unit at an early stage in construction. There is a very simple and useful current saving switching device fitted to this escapement, which minimises the drain on the 4.5 volt battery which operates the electromagnetic escapement mechanism. This battery is made up of three cells taken from a pen torch battery, but more of this later. The rudder mechanism is well shown in one of the photographs.

The receiver itself uses one of the Hivac Type XGF1 valves in a super-regenerative circuit. It is constructed in a paxolin tube so as to be fully protected against damage in the event of a crash. The receiver is suspended by rubber bands inside the cabin of the model as shown in one of the accompanying photographs. The aeromodeller will fit the necessary hooks for its suspension when he builds the aircraft.

Terminal tags for aerial, battery and external controls are fitted to the rims of the paxolin tube housing the receiver. A small tuning control projects through the tube for fine adjustment of the receiver tuning.

The transmitter uses a DCC90 twin triode valve in a self-excited circuit working in the 27 Mcs model control frequency band. The transmitter is supplied in an attractive black crackle cabinet which will also accommodate the HT and LT batteries. Its aerial consists of a number of aluminium rods which fit into one another, and an earth pin is provided. A toggle switch controls the filament current; it can be seen on the front of the transmitter cabinet. There is a thumb switch on a length of flex by means of which the transmitter is operated and the aircraft controlled.

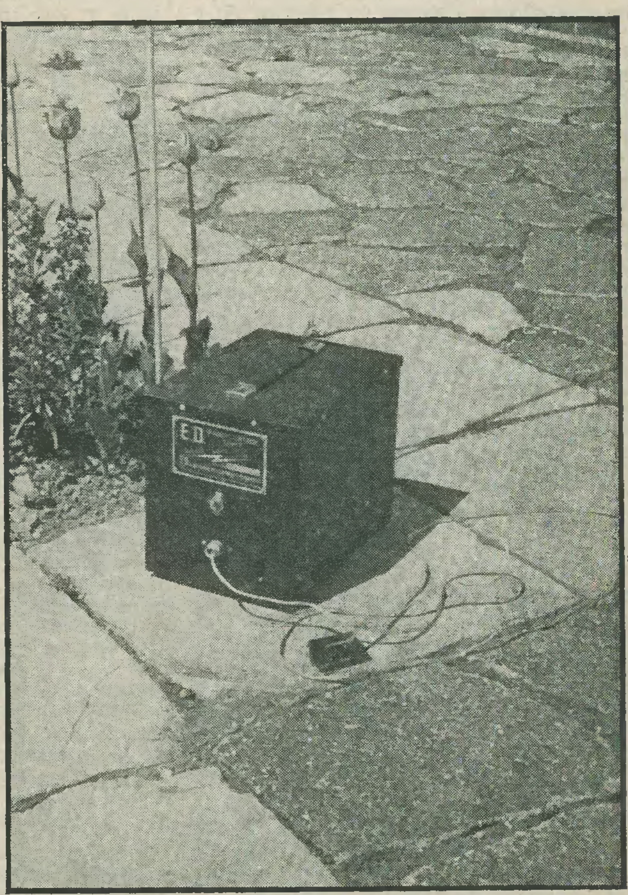
A number of external controls must be fitted to the aircraft. These are a main on/off switch, a potentiometer and a test meter socket. They are provided with the kit and must be fitted during the construction of the model. The potentiometer is of the miniature type and can be fitted on the wooden panel on one side of the cabin fuselage, and the microswitch and test socket can go in a similar position on the other side of the cabin. The control spindle of the potentiometer can be seen projecting from the side of the cabin in the photos.

The batteries required are all readily available and, in the case of those operating the receiver and escapement, must of necessity be chosen with a view to saving weight rather than providing long life. The escapement itself works on a voltage of 4.5 and this is obtained by using three cells taken from pen torch batteries and wiring them in series. In this way a 4.5 volt battery weighing no more than 1½ oz. is obtained. The receiver requires a filament voltage of 1.5 and an HT voltage of 45. One cell from a pen torch will provide the 1.5 V and will weigh no more than ½ oz., and two 22.5 volt hearing-aid batteries in series will provide the 45 V for a weight of just over 2½ oz. By using these small batteries, we can keep the total weight of the radio gear within the limited carrying capacity of the model.

The transmitter uses standard type batteries, 120 volt for HT and the 1.5 volt Ever-ready All Dry Type No. 1 for LT.

It is not a bad idea to wire the receiver up first on the bench and test it out before installing it in the aircraft, as this will enable one to get some inital experience of the way things should go. Full wiring instructions and a circuit diagram are provided with the kit, and little comment is necessary as the wiring is pretty straightforward and the tags on the receiver are clearly labelled. As the life of the hearing aid batteries is very short, and they are quite expensive, preliminary tests should be made from a standard sized battery. Be careful however to see that the voltages applied do not exceed the specified values.

Having wired up the receiver, potentiometer and switch, first check the filament current to make certain the valve is functioning. The filament current should read about 50 mA. Next connect a 0–5 mA test meter into the



The E.D. battery-operated 27 Mcs Radio Control Transmitter.

meter socket leads. A short length of wire—about 18 inches—should be connected to the "short aerial" tag on the receiver. Connect up HT. The test meter should now read some value between 1 to 2 mA. By adjusting the potentiometer it should be possible to get the receiver to draw approximately 1.8 mA.

At this stage, the radio enthusiast with a shortwave receiver covering the usual amateur bands can score heavily over his colleague not so equipped. Switch on your receiver and tune around the 27 Mcs mark. If the R/C receiver is functioning, you will soon come across the characteristic hiss emitted by its super-regeneration. If all is well, switch off the R/C receiver and turn your attention to the transmitter. Connect up batteries, fit a couple of the aerial rods together to make a short aerial, which is all that is required for these preliminary tests, and switch on. Press thumb switch and tune your shortwave receiver until you find the transmitter carrier. If your receiver is of the highly selective communications type, you will probably have to chase the transmitter carrier over a fairly wide range of frequencies until its frequency has settled, but this is nothing to worry about as the super-regen R/C receiver has very broad tuning. The transmitter, incidentally, is preset on the 27 Mcs model control frequency, so do not attempt to alter its frequency.

Having located the carrier on your shortwave receiver, switch off the transmitter, switch on the R/C receiver and by means of its tuning lever, bring its frequency on to that of the transmitter, using its super-regen "hiss" as an indication of its frequency.

Now switch on the transmitter; on operating the thumb switch there should be a drop in the receiver standing current sufficient to work the receiver relay. If all is well, the trials can be regarded as complete and the receiver and its external controls installed in the aircraft. Connect up the batteries and escapement, fit a piece of fine wire as an aerial between the tail fin and the cabin and test out with the transmitter.

We had little trouble with our first trials, except that the specimen of the XFG1 valve in our receiver appeared to draw 2 mA and not the 1.8 mA specified. As the makers' instructions contained a warning that exceeding the rated HT current of 1.8 mA would considerably shorten the life of the valve, we were loath to turn the potentiometer up to give a current exceeding this value. However, the drop in standing current was not sufficient to operate the relay unless the valve was run at 2 mA. When one comes to weigh up the matter, one can expect a certain amount of variation in circuit characteristics and meter readings which might well give rise to such a small difference. So it is worth while experimenting a little with slightly higher HT current if the relay does not work satisfactorily at first. Our receiver gave a 'no signal' current of 2 mA, dropping down to about 1 mA 'on signal', and this gave quite positive relay action. Final adjustments should be made with the model some thirty or so yards from the transmitter. One other point we noted was that the receiver HT must be at full voltage. A very small drop from the rated 45 volts will give sluggish or no relay action. So conserve the flying batteries carefully.

For those who have never seen radio controlled models before, the fascination of watching a model aircraft rudder clicking over at the touch of a switch on the transmitter, is quite unbelievable and has to be experienced to appreciate its peculiar thrill. Our model is now back in the hands of the local model aircraft club for flight tests and trimming up. At the time of writing this article they say they are awaiting suitable flying conditions, which to the writer appear to be as elusive as suitable ionospheric conditions have been recently for transmitting! However, at least the radio gear is working, and if initial flights are characterised by crash landings, the receiver should not come to much harm, judging from its robust construction.

In the next instalment in this series, we shall describe the fitting of an E.D. clockwork servo motor to the model launch we mentioned in our first article, and deal with some of the differences between the R/C of boats and that of flying models.

The VERSATILE THREE

A Powerful and Novel Gram-Radio for Battery Operation

By FRANK L. BAYLISS, A.M.I.E.T

Biased Buyers?

Despite the Editorial pun in this magazine some time back, anent the "bias against batteries"—the public displaying the "negative sign"—there is still a surprisingly large call for battery receivers for use in country districts, by caravan holiday-makers, and so forth.

The old type TRF3 has, however, largely been replaced by the highly efficient and powerful four or five valve superhet, usually having a built-in frame aerial, and being a miniature replica of its mains-operated big brother.

Such receivers are usually fairly economical in both HT and LT current drain, although some using 1.4V valves supplied from a "combination" HT and LT battery tend to run the LT part down first and so waste HT.

From the constructor's viewpoint, the main thing against the modern commercial battery superhet is its price—especially when there's an old TRF set or portable kicking around the house that, with a little labour and guidance, could be converted into a first-class receiver as good as—nay, better than—the commercial product.

It is with this latter idea in mind that the writer presents the "Versatile Three", a highly economical superhet designed around three pentode valves—the usual TRF3 line-up—thus enabling conversion from TRF to superhet working with very little more than two coil changes, i.e., the replacement of the usual tuned anode coil by an IF transformer and the addition of an oscillator coil.

The Circuit

Reference to Fig. 1 will show V1, an RF pentode operating as an oscillator-mixer, with the signal input fed to g1 and the oscillator section operating between g2 and g3.

L1 and L2 are normal aerial input and oscillator coils respectively, and may be of any suitable (for wavelength) types or make—or even home wound.

Trimmers have been omitted for the sake of clarity, and may indeed not need to be used, especially if L1 is the frame aerial of a portable which it is wished to modify.

The output from V1 is taken through a standard 465 kcs IF transformer to V2, another RF pentode functioning as a leaky-grid demodulator by virtue of C9 and R3.

Reaction is taken from the anode of V2 and via C8 to a supplementary winding on the secondary of the IF transformer. This winding must be put on by the constructor. Fifty turns of 36 swg enamelled wire on the coil former, close to the secondary winding on the side away from the primary winding, should prove ample in most cases.

The demodulated signal now passes via C12 to the primary of a 1 : 3 or 1 : 4 intervalve transformer, from the secondary of which it is fed to the grid of the output pentode.

Automatic gain control is effected from the suppressor grid of V2, which is given a slight positive potential by R7. The current to g3 of V2 should not exceed 10 μA, and the resistor R7 should not, therefore, be smaller than the value stated.

This current forms the basis upon which the signal voltage, via R8, is "ironed-out" by C5, C6 and R2 and fed back to the grid of V1. Variation of the values of R2 and R8 will vary the value of the AGC voltage.

To stabilize the receiver, and to make good deficiencies in the old, and therefore possibly indifferent, intervalve transformer that may be used in a conversion job, negative feedback has been incorporated.

The NFB—taken from the anode of V3—is led via C13 and R9 back to the grid circuit, thus cancelling parasitic oscillations at V3 grid and tending to level the transformer response.

Manual volume control is effected by varying

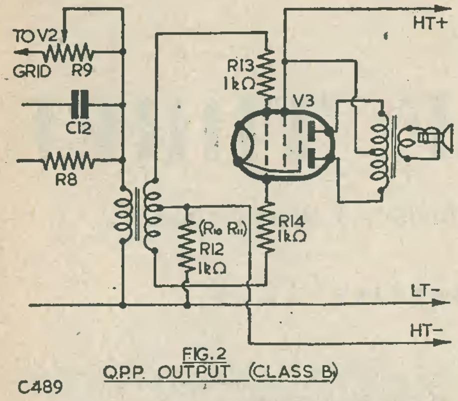


FIG. 2
QPP OUTPUT (CLASS B)

the value of the feedback resistor, R9, which may be a 2 MegΩ potentiometer. As

$$\text{NFB\%} = \frac{\text{T2 primary} \times 100}{\text{T2 primary} + 2\ \text{Meg}\Omega},$$

there will be a feedback of between 20% and 30% at full volume, even with a good transformer. Also, the quieter that one has the output, the better will be the reproduction.

Finally, automatic bias is provided for the gramophone input to V2 by R11, whilst V3 is biased by R10 and R11 in series.

Reaction

As the IF of 465 kcs remains unchanged, no matter what the station received, the setting of the preset feedback capacitor C8 will give uniform reaction over the whole of the wave-range. This capacitor should be set to give maximum reaction without actual oscillation or distortion resulting from near-oscillation, and once set need not be altered.

The additional gain given by reaction is very nearly as good as a complete IF stage, which it replaces, with a consequent saving in components, and HT and LT current.

Be sure, however, that the reaction winding is connected in phase with the IFT secondary, or you'll get NFB where it isn't wanted!

Variations

The experienced constructor will by now have noted the flexibility of the circuit, and its possibilities in respect of using many and varied valve types and line-ups.

V1, for instance, may be an ordinary triode-hexode or heptode of either the 2V or 1.4V types, or it may be a 2V variable-mu RF pentode of the Mullard KF35 or Mazda VP23 types; the only essential in the latter case is that g3 should not be internally connected to the filament (note that the 1T4 is unsuitable in this respect).

Similarly, either variable-mu or "straight" RF pentodes will do for V2 and, if the AGC circuit can be dispensed with, V2 may even be a triode. It may, in fact, also be a diode-triode or diode-pentode, with the diode demodulating the signal and the reaction taken from the anode of the other section. In this case, do not bypass RF after demodulation, but feed it with the signal straight to the control grid.

Whatever valves are chosen for V1 and V2, undoubtedly the greatest difference in output will be noticed by the variation of V3.

For those who like a good sturdy output either from radio or gram, there is no alternative but a class B valve.

With the double-pentode output of Fig. 2, one watt of undistorted audio is possible, using the Mullard KLL35. Even the old QP21 may be used, if 0.4A filament current is not objected to, and there are still numbers of these obtainable ex-WD for as little as 1s. 6d. each.

Perhaps the best and most economical arrangement of all, however, is the class B2 double-triode circuit of Fig. 3. For this arrangement use a Tungsram CB215. This valve will give a full 1.5 watts from local transmissions and gram. input.

When using class B or B2 output, note that NFB can no longer be applied as a *voltage* to the output stage. However, by dispensing with C13 and taking the now free end of R9 back to the grid of V2, NFB is still operative and fully effective.

Note, too, that special QPP or class B input and output transformers are required, although an ordinary *input* transformer *may* be used, as described in Query Corner in the March issue of this journal.

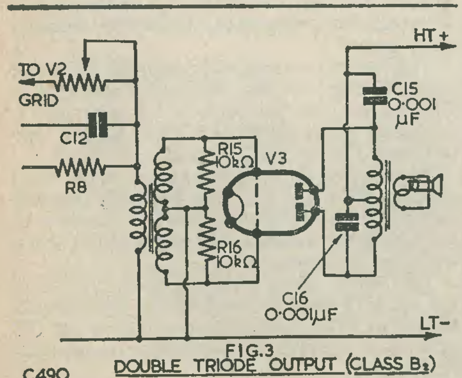


FIG.3
DOUBLE TRIODE OUTPUT (CLASS B2)

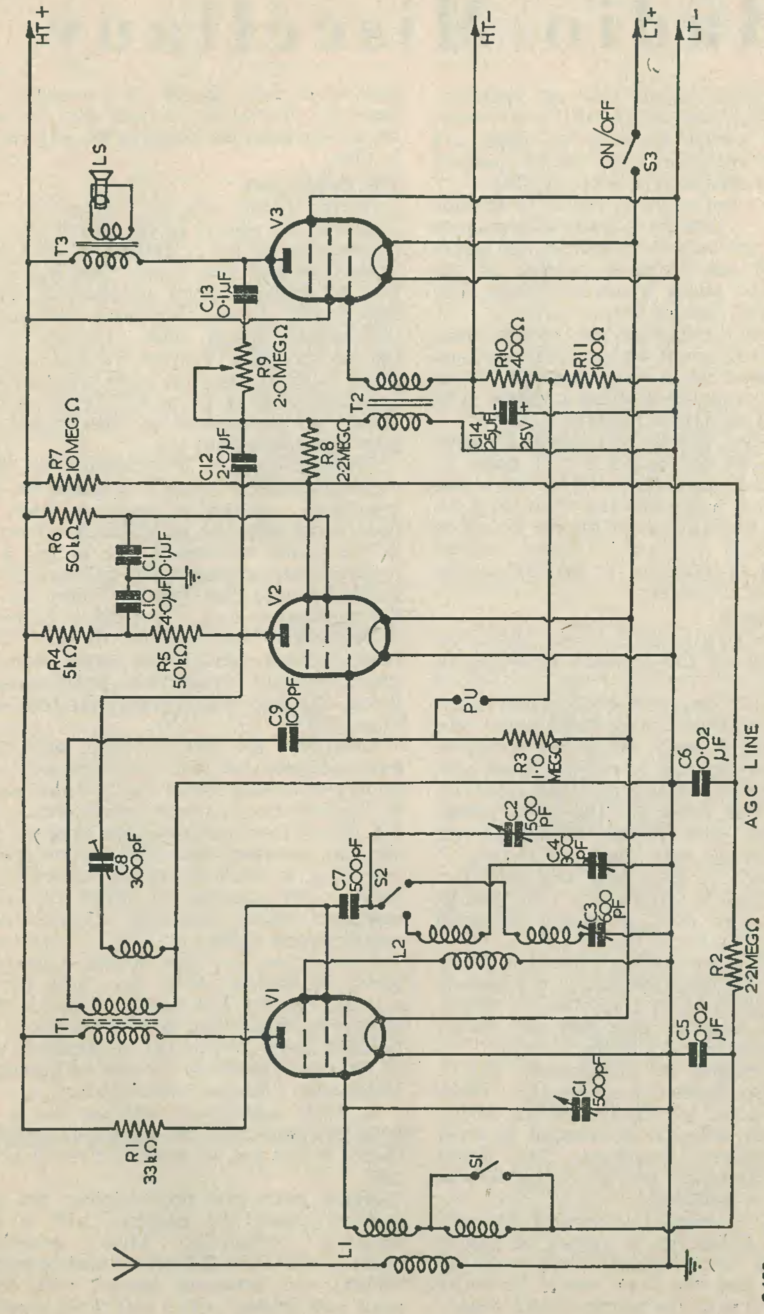


Fig. 1: Complete circuit diagram.

Radio Miscellany

According to no less an authority than the Minister of Fuel and Power, four million people switched on lights and radio in the wee small hours of the morning to listen to a broadcast of a prize-fight.

This little titbit of news ought to provide food for thought. Statistically-minded readers can get busy with pencils and paper working out the probable number of gas rings and hot plates which also went into service making cups of tea.

The cynical can ponder on the silly mass hysteria which seems so easily worked up by a few headlines in the sensational press, and on the empty-headedness of those who take no part in serious hobbies.

It is, however, not for the benefit of either of these classes of readers that I quote it. It is for those who might wish to cut it out and keep for a future defence when the XYL casts doubt on their sanity on the occasions when they stay up late o' nights because the prospect of working (or logging) a new country seems promising.

Hobson's Choice

Once or twice this column has had a few words to say on the question of wired, or relay, radio.

It gives, of course, freedom from interference as well as other advantages—the chief one, to my mind, being that it can be used as a very efficient check on those half-wits who persist in keeping their receivers running at full strength. The disadvantage that it might also further strengthen the B.B.C. monopoly was also considered. It is bad enough to have only one employer of broadcast talent, without the poor listener having the only door of escape slammed in his face.

Not that I have ever yet found anybody who listens to foreign broadcast propaganda —even to the Russian transmissions which, despite good reception over here, are deadly dull and pyschologically feeble.

I cannot imagine the audience for B.B.C. Russian transmissions is much bigger. Those who should know tell me that in the towns, at least, radio diffusion is installed in every block of workers' tenements. No doubt the local Commissar sees that any foreign propaganda is excluded.

According to recently published intimate close-ups of Hitler, he is quoted as having been anxious to introduce wired radio in Germany so that the State would be better able to control what the people should hear—and what they should be prevented from hearing! Apparently it was too big a job for the Propaganda Ministry to push through in time.

The Bright Side

During recent months I have had quite a number of visitors to the Shack who have commented on the brightness of all exposed aluminium and steel parts. Not that I have kept everything as spick and span as I should have liked. In fact, this year I missed out the annual Spring clean. Perhaps it was the un-Springlike weather we had this year which failed to start the surge that ordinarily animates most of us as the bright sunshine reveals the drabness of our Shacks and Dens after a winter's hard use.

Disregarding for a moment the Spring cleaning business—frankly I admit to being unhygienic enough to prefer a good old-fashioned warm fug as a Shack atmosphere in the winter months—I like to put a real finish on a job of construction as it is completed. Preferably one that will last until the next Spring clean at least. This one is guaranteed to withstand the thickest tobacco smoke haze. I have used it for some years and proved it not only durable, but finger-mark proof, although it is probably far from being original.

Dissolve a few strips of clear celluloid in amly acetate—the stuff with the pear drop odour—and keep dissolving it until you get a varnish like, syrupy consistency. (Yes, old timer, the same dope we used to paint on our stretched linen diaphragm speakers way back in 1926 before moving coils were thought of). And don't forget to keep it stoppered while dissolving. That is not a quick process either.

I could just say, then spread it on plated parts, aluminium dials, etc., and leave it at that, but the last time I discussed metal treatments (that time it was matt and satin finishes) quite a number of readers wrote in for more details to be sure of getting the best results. So here's the full story.

A single application will last for a very long time providing the surface is clean and that it is not put on when the metal is very cold.

Plated parts just need wiping, but plain surfaces should be polished with a non-abrasive preparation. Most proprietary polishes will do, but I prefer finely powdered whiting and ammonia applied with cotton wool, and finished with a soft cloth, especially with 'soft' metals.

Before you put the lacquer on, warm the object slightly to assist the mixture spreading smoothly. There is no need to heat it. Normal summer room temperatures are just about right. In the winter months no other warming is necessary if the metal has been in a warmed room for a few hours.

German TV

Regular TV transmissions have begun in Western Germany, from Hamburg. At least, at regular intervals of two-hour-programmes three times a week—the same basis as used in Holland for some time past. The definition is rather higher than that used by the B.B.C., although from what I have seen earlier this year of European higher definition systems, one cannot detect much difference between theirs and ours. In fact, whatever difference there was, the B.B.C. transmissions at their best leave a slight balance in our favour.

The Germans expect to have nightly programmes laid on this month, and three other stations—Hanover, Langenburg and Cologne —are scheduled for early operation.

Soon, maybe, some keen listener will report reception in England. It will be quite a feat as the wavelength used is only 1¼ metres, and this, incidentally, as far as I know, is the first serious attempt in the world to exploit so high a frequency for TV. No doubt other national systems are watching with close interest. TV, when it really gets into its stride, is going to cause many a headache in the matter of wavelength congestion if everybody wants to stick around five or six metres.

Does it Pay?

I have been asked about the patenting and marketing of a reader's invention. The only advice I can give is for him to put the matter in the hands of a reputable Patents Agent. It is a very tricky business, and an idea has to be something out of the ordinary not to be covered in some way by existing patents.

As to the marketing, that nowadays can be a disheartening job, whether you try to do it yourself or get someone else interested in it. The supply of materials is probably controlled, and the selling price will positively frighten you.

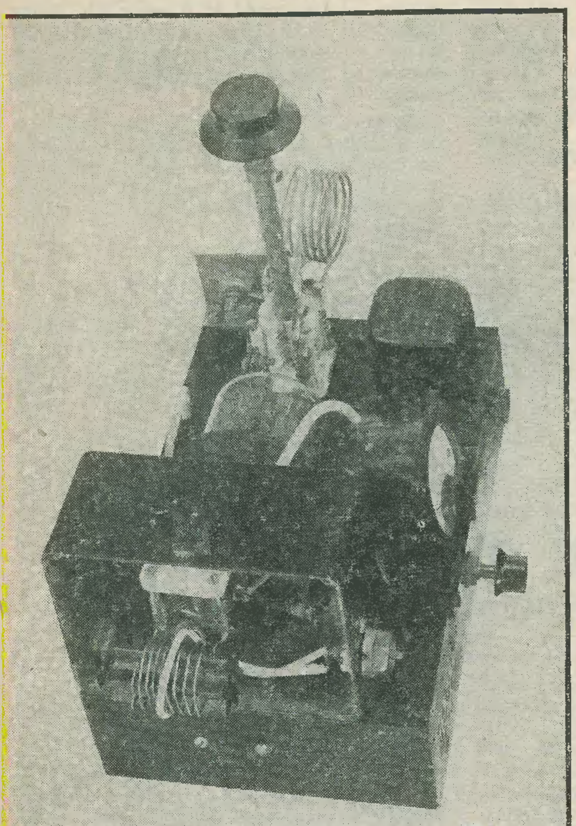
It is not generally realised what a big difference there is between the actual cost of the manufactured article and the price charged for it in the shops. Just after the War I took up the question of the possible marketing of an article designed by a friend and myself, primarily for our own use, but apparently of considerable interest to others.

To make it to a reasonably high standard of finish the cost came out to rather less than £4, disregarding the cost of tools which would have run into several hundreds. The selling price after allowing for tools, advertising, retailers' profits, etc., (plus a little for us) was very little short of fifteen pounds! Even comparatively large scale production would not have brought it down to a price which would have assured a wide sale, and a capital of many thousands would have been required to take a chance on that.

Without being discouraging, I can only give him my view. It is easier to invent things than to make a profit out of them! The Tax Authorities (who stand to lose nothing) get by far the largest whack. The man who passes it over the counter gets the next. The chap who makes it gets a modest sum, but the poor fellow who invented it is often lucky if he is not actually out of pocket after he has paid the patenting expenses.

CENTRE TAP *talks about*

WIRED RADIO – FINISH – GERMAN TV – INVENTIONS



POWER AMPLIFIER
FOR
28 Mcs.

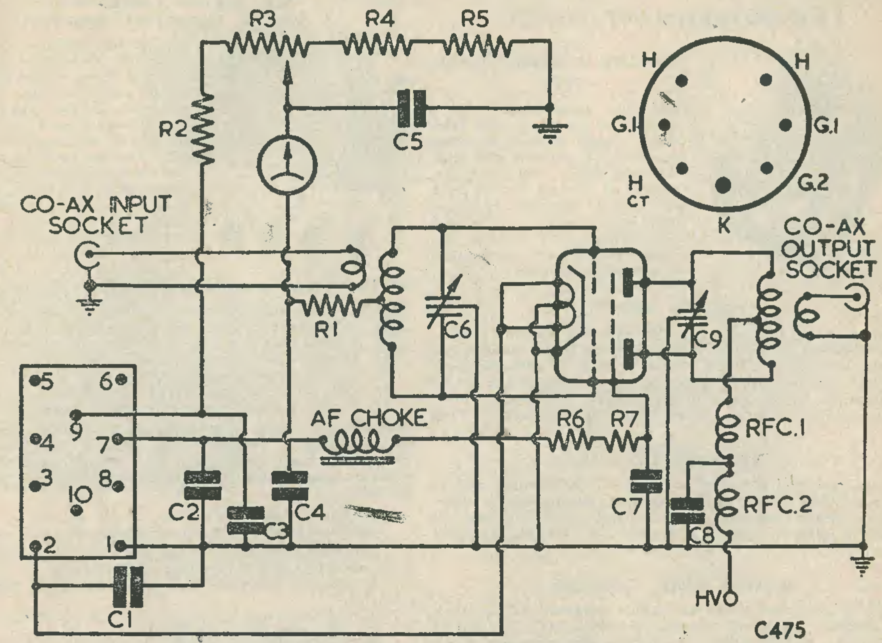
By
J. N. WALKER,
G5JU

THE small unit illustrated was built to meet a particular requirement, the circumstances f which, outlined below, have doubtless been ncountered by others. On the 14 Mc/s and 8 Mc/s bands the writer uses a VFO which ives sufficient direct output to drive an 813 ype of PA valve-at least, it gives ample output or high efficiency on 14 Mc/s but only enough o drive the 813 to about 80 watts on 28 Mc/s. At this frequency also the efficiency of a single-nded 813 leaves something to be desired.

The VFO is self-contained unit situated near he operating position. It is connected by a ength of coaxial cable to the PA which is on a eparate chassis some feet away. It was not easible either to increase the output from the VFO or to add a buffer amplifier on the PA chassis. It was therefore decided to construct a second separate PA solely for 28 Mc/s using a valve which called for comparatively small driving power, operated at high efficiency and which was capable of a reasonable power output. The *Mullard* QQV07/40 is an obvious choice and has been incorporated in the unit. In practice results have been found superior to those obtained when using the 813. More output (and it is RF output which counts) is obtained from the QQV07/40 with 600 volts on the anodes than from the 813 with 1000 volts.

Special Points

The unit has been made to permit rapid substitution for the 14 Mc/s PA and therefore the plugs and sockets are identical in each case. The Eddystone type shown in the photograph may of course require changing to meet individual requirements. A separate grid current meter is fitted and also a potentiometer for adjusting the amount of fixed bias (a stabilised 150 volt bias supply forms part of the main power supplies). A small low frequency choke is placed in series with the screen grid of the PA valve which is fed with 300 volts. By this means the audio potential of the screen grid automatically follows the modulating voltage



28 Mc/s Power Amplifier
List of Parts and Component Values

1 Diecast Chassis Cat. No. 643 Eddystone
1 Diecast Box Cat. No. 650 Eddystone
1 Microdenser 34 × 34 pF (C6) Cat. No. 584 Eddystone
1 Microdenser 15 × 15 pF (C9) Cat. No. 587 Eddystone
2 RF. Chokes Cat. No. 1011 Eddystone
2 Knobs Cat. No. 592 Eddystone
1 Knob Cat. No. 1044 Eddystone
1 Coil Former Cat. No. 646 Eddystone
1 10 way Socket Cat. No. 535 Eddystone
1 10 way Plug Cat. No. 534 Eddystone
1 Extension Control Cat. No. 1008 Eddystone
1 Lead through Insulator Cat. No. 695 Eddystone
1 Ceramic Valveholder, 829 type. Webb's Radio
1 Valve type QQV07/40 Mullard
1 A.F. Choke 20H. 30 mA
2 Coaxial Plugs and Sockets
1 Insulated Plug and Socket
1 M/c Meter 0-20 or 0-25 mA. 2" diam.

Resistors
R1 1000 ohms ½ watt
R2 3000 ohms 3 watt
R3 1000 ohms (or 2000 ohms) w.w. Potentiometer
R4, R5 1000 ohms 1 or 2 watt
R6 3000 ohms 10. w. w.w.
R7 200 ohms ½ watt

Condensers
C1, C3, C4, C5 100 pF Ceramic or Silver Mica 350 volt.
C2, C7 100 pF Ceramic or Silver Mica 500 volt.
C8 100 pF Pot type Transmitting.

applied to the anodes. This system is used in a number of transmitters and has been found equal to, and more convenient than, the method of applying the modulating voltage to both anodes and screens. Since the current capacity of the choke need be only 30 mA., the primary of a standard output transformer serves the purpose and is used in the present instance.

With a valve of the QQV07/40 type, possessing a high power gain, great care must be exercised to prevent feedback from the anode circuit to the grid circuit, otherwise instability is inevitable and will be found difficult to eradicate. Hence the use in the present design of a

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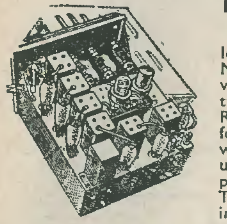
ELPREQ PAGES

EX-GOVERNMENT UNITS



10 VALVE 1½ METRE SUPER-HET.

Ideal for conversion into a Midlands or London region Televisor. These contain 6 valves type 2—SP61, and one each RL7, RL16 and EA50. Six I.F. Transformers of 12 mc/s, 4 mc/s band width, and hundreds of other useful components. Price 59/6 plus carriage and packing 5/–. These receivers are unused and in original wrappings.

RECEIVER 3457.

These cost over £100 each to build, and they contain 15 valves type EF50 and one each of VR55, VR56, VR92 and two of types VR116 and VR54. These contain a host of valuable post' meters, motors, relays, gear box and components of all descriptions, and in addition they contain the famous "Pye" 45 mc/s television strip. Brand new in transit boxes £5 19 6.

RECEIVER TYPE 21.

Battery operated superhet covering 4.2 to 7.5 mc/s and 19 to 31 mc/s, on 10 metre band, this operates as a double superhet. In brand new condition, complete with 9 valves and circuit diagram. Price £2 5 0, plus 7/6 carriage, insurance and packing.

POWER PACK TYPE 392.

This is an extremely useful unit which works off A.C. without modification giving an output of 700v D.C. adequately smoothed. Here is a list of the components contained in the power unit:—Mains Transformers for 200–250v 50 cycle with secondaries of 700–0–700v at 70 m.A., 4v at 2.5 amps., 12.5v at 1 amp. (Note these are Admiralty ratings, the transformers will stand at least twice these figures). Also two rectifier valves type CV54, 10 watt resistors, three 4 mfd 700v condensers, L.F. choke, 10 henry 100 m.A., 2 slydlok fuses. The power pack is unused and is contained in a louvred case size 12" x 5½" x 8½". Price 67/6.

RECEIVER TYPE 78.

This covers the wave band 2.4 to 13 mc/s and it is also fitted with a 100 kc/s crystal with an internal arrangement whereby its oscillator can be accurately checked with the crystal, the sets are complete with 5 valves, and they are brand new and unused. Size is 6½" x 8½" x 10" approx. Price £4 10 0, plus 7/6 carriage, etc.

AMERICAN TYPE 6 INDICATOR.

This indicator known as A.S.B. uses the same circuit and the same equivalent parts as our famous type 6. For instance, it uses tube type 5BP1 which is the American equivalent of the VCR.97, it uses valves type 6AC7 which are the American equivalents of the EF50, and, of course, it is packed full of very useful components. This unit can be made into an excellent 'scope and the "Wireless World" data (available price 9d.) will be an excellent guide. Price for the indicator unit is £4 10 0, carriage 10/– extra.

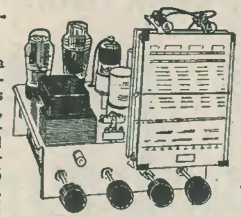
UNIT TYPE RDFI.

As suggested by 'Practical Television' October as suitable for a home built Televisor, but with the complete set of 14 valves instead of 11, e.g., 5 of SP61, 2 of P61, 3 of EA50 and 1 each of CV63, EB34, EC53, 5Z4. Price 49/6 plus 5/– post.

194 STRIP.

Also described in October 'Practical Television', contains 8 valves and really does give superior results. Price 45/– plus 2/6 postage.

A.C. MAINS OPERATED 5 VALVE SUPERHET CHASSIS.



Completely wired, al ready for immediate covering three wave-b shorts and medium). excellent receiver idea installations or as a re chassis in existing r etc. The set employs line up either internati valves 6K8, 6K7, 6Q7, 5Y3 or "E" types ECH EBC33, EL33 and 5Y3 The overall size is 8½ i 11½ in. wide and 11½ the dial size is 6 in. x

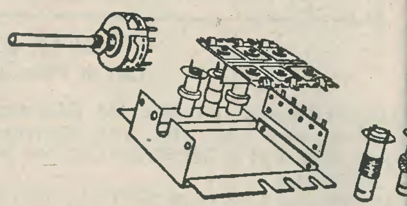
NOTE THESE POINTS:—

(1) Coil assembly can be removed as one unit.
(2) Wave-band indicator shows through glass sca
(3) 4 watts output will work 10 in. or 12 in. spe
(4) Negative feed back and tone control.
(5) Flywheel tuning and large clear dial.
(6) Dust cored coils and I.F. transformers.
(7) Sockets for pick-ups and extension speaker.

Only first-class parts have been used, e.g., mains tr by "Parmeko", resistors by "Erie", "Welw "Morgan", fixed condensers by "Hunts" and trimmers and tuning condensers by "Wingrove etc., etc.

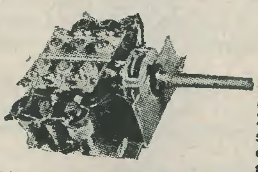
Complete chassis less valves £9 10 0.
Complete chassis with valves £11 10 0.
Complete chassis with valves and 10 in. speaker

If not collecting add 5/– carriage and insurance. Circuit diagram supplied free with chassis or s price 1/6.



WHY PAY HIGH PRICES FOR COIL P

If you use our parts these literally fall together, publication "Making Coil Packs" (price 1/6) des simple method of alignment without using a signal g and also gives circuits of typical receivers compl gram arrangements.



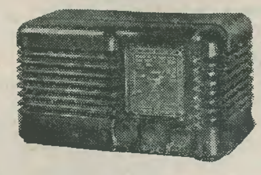
PRICE LIST OF

Set of 6 coils cove three standard long, and short wave ba Punched metal chas 6 Bank Trimmer a 3/–; Midget wave switch, 4/–; Tag pa densers and other to complete L.M.S.C 1/9. When completed your Elpreq will look like t

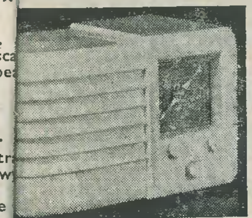
MULTI-SPEED MOTORS

You can adjust this motor to almost any speed you want, it will work directly off A.C. mains, or if you require greater power or greater speed work it through a metal rectifier. This motor is fitted with a gear box enabling speeds down as low as 1 r.p.m. to be obtained. Price 14/6, postage and packing 1/6 extra.

R XMAS GIFT—WHY NOT GIVE A RADIO VE MADE?



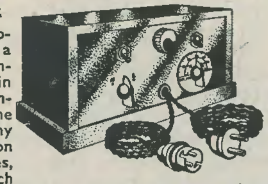
nd that the our all mains vers is simpli- and the more the less time s, everything e last nut and upplied, and fits together sional manner. ished the receiver looks and plays as well being offered in radio shops at anything between 14, so why not give one as a present to someone u this Christmas. The one illustrated we call our 'Occasional T.R.F.' in a choice of colours, Ivory, Walnut or Green, and costs just less than £6 to make. The one below we call "The White Lady," this is an extra fine cabinet of pure white. The complete receiver costs about £6 5 0 to build. Constructional data for either set is available at 1/6 post free.



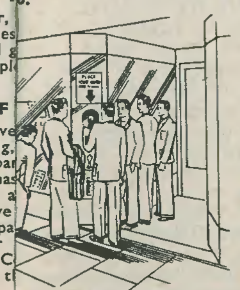
AL ALIGNMENT SIGNAL GENERATOR.

kit of parts to construct this item as described in r issue is available, price £5, post paid.

RONIC TIMER



s instrument pro- ich operate over a time can be con- tomatically, e.g., in phy use it to con- exposures, etc. The nt can be set to any time from a fraction nd up to 3 minutes, n be made to switch iance on or off. Circuit diagram and instructions mplete kit of parts including valves, mains trans- power pack sensitive relay, potentiometer and metal s.



HOW DOES IT WORK?

A device which enables passers-by to switch on lamps, models, motors, etc., without actually touching anything, is always a crowd attractor and is one of the cheapest methods of advertising. The device is known as an Electronic Switch, it is almost fool proof in operation and we can supply it either in the made up form at as a kit of parts at 69/6 (add 2/6 for post and packing). nstructional data and circuit diagram is available ly at 2/3 post free.

BOOKLETS AND PUBLICATIONS

DEMOBBED VALVES.

Gives the commercial equivalents of many thousands of service valves and conversely gives the service equivalent of many thousands of commercial type valves, an invaluable publication recently revised. Price 2/3.

AN ELECTRONIC TIMER.

Shows how to build a device for controlling timed operations. The timer can be set to any timing up to 3 minutes. Price. 2/3.

THE ELECTRONIC SWITCH.

Shows how to make a device for switching without mechanical contact. Price 2/3.

THE IMPLUSE RELAY.

Explains the working of an ingenious relay, and gives several circuits including radio control. Price 1/9.

3½ WATT CONVERTIBLE AMPLIFIER.

Shows how to construct a 3-stage amplifier with an output of 3½ watts. A unique feature is that this amplifier fits into our 'Occasional' cabinet. Price 1/6.

THE I.F. AMPLIFIER.

Gives details of a 465 kc/s amplifier with A.V.C. detector and power output stage. Designed to fit into our 'Occasional' cabinet, it is useful for aligning coil packs and for use as a signal tracer in radio servicing etc. Price 1/6.

THE 'OCCASIONAL T.R.F.'

Shows how to build a T.R.F. Receiver for medium and long wave reception, of looks and quality output, comparable with sets priced between £10 and £14. This costs less than £6 to build including cabinet. Price 1/6.

THE 'OCCASIONAL SUPERHET'.

In areas where field strength is low and interference is high, a superhet receiver is essential. For less than £8 one can be built into our 'Occasional' cabinet. This publication gives all details. Price 1/6.

VALVE EQUIVALENTS.

These are the best equivalents charts available to-day. Also the booklet can be used for keeping records of valve stocks. Price 2/6.

I.F. ALIGNMENTS PEAKS.

This booklet gives the I.F. frequencies of more than 4,700 receivers, British, American and Continental. A very popular British set is covered, and hints on finding the frequencies of unknown British sets are also given. Price 4/6.

FOUR INTERESTING LEAFLETS.

(1) The Infra-Red Cell; (2) A millibar barometer from a sensitive altimeter; (3) A V.F.O. from unit type TU5B; (4) The circuit for light operated relay. These are free with all orders for publications this month.

1000 BVA VALVES AT PREBUDGET PRICES

Orders by post are dealt with by our RUISLIP depot. To avoid delay address to:—E.P.E. Ltd., Dept. 3. Windmill Hill, Ruislip, Middlesex.

Orders under £2 add 2/6, under £1 add 1/9. Postable items can be sent C.O.D., additional charge approx. 2/6. List 6d. Early closing, Wednesday–Ruislip, Saturday–City.

RONIC
PRECISION EQUIPMENT

152-153, FLEET STREET, E.C.4.
WINDMILL HILL, RUISLIP, MIDDLESEX.

cast metal box to screen the grid circuit, and of a substantial metal chassis. It was hoped that neutralisation could be dispensed with but although the unit would function in a stable fashion with the grid bias set well beyond cut-off, self-oscillation occurred when the grid bias was reduced below cut-off and neutralising wires were therefore added.

The small by-pass condensers grouped around the power socket are also important. It was found that radiated RF was being picked up by the cable connecting the chassis to the power supplies and was reaching the grid circuit. The by-pass condensers connected from each incoming lead to earth act as a short-circuit to this stray RF. Probably a screened cable would also be effective but multi-way screened cable is not easy to obtain.

R7 is merely a small decoupling resistor fitted close to the valve-holder. The value specified for the screen dropping resistor R6 is based on an applied voltage of 300 and strictly the combined resistance of R6, R7 and the series choke should total 3,300 ohms, so that a drop of 100 volts occurs (the screen is rated to operate at 200 volts, 30 mA). If the applied voltage is appreciably different from 300, adjustment to the value of R6 will be necessary.

Construction

The construction of the unit is fairly straightforward and drawings are hardly necessary. The photographs give a good idea of the positions occupied by the various components—the layout is not particularly critical but the general scheme should be followed as closely as possible. The grid tuning condenser is fitted to the top of the screening box and the anode tuning condenser to the "floor" of the chassis. To prevent the hand coming in contact with high voltage, an extension spindle is desirable on C9. All wiring should be kept as short as possible and leads carrying RF should preferably be of thin copper foil strips, to minimise inductance and RF resistance.

Coils

The coils are soldered directly to tags on the butterfly tuning condensers. The grid coil L1 consists of 9 turns of 18 gauge enamelled copper wire on a 1″ diameter former, giving a value of inductance which permits a fair amount of C6 being used to reach resonance —a moderate L/C ratio is desirable in the grid circuit.

The anode coil L2 consists of 8 turns 14 gauge bare copper wire, 1¾″ diameter, with fairly close spacing and self-supporting. Resonance at the band edge—28,000 Kc/s—should occur with C9 at practically full capacity and the turns spacing may call for some adjustment to achieve this. The resulting L/C ratio is correct for efficient operation of the QQV07/40 running at 600 volts, 150 mA., and gives a tuned circuit "Q" of 12 with proper aerial loading.

Neutralisation

The neutralising condensers are simple enough. They consist of two five inch lengths of 16 gauge wire enclosed in polythene sleeving. Crossover connections to the tags of C6 are made inside the screening box and the wires brought out through ¼″ holes in the box. The wires are bent to run each side of the valve, the spacing being adjusted until no trace of self-oscillation is evident when C6 and C9 are rotated. For this adjustment, the bias should be set to give a standing anode current in the region of 45 mA.

As shown in the circuit, the bias system allows a variation from 50 to 75 volts, since the supply voltage of 150 drives 25 mA through the series resistors. To reduce the bias below cut-off will necessitate the temporary connection externally of an additional series resistor of about 3000 ohms.

Setting U

For CW work a bias of 50 volts is approximately correct and the input from the VFO should be sufficient to give a grid current of about 10 mA at this bias. The manufacturers' data sheet mentions 12 mA total grid current but 10 mA gives entirely satisfactory results.

The anode current will rise to a high value with C9/L2 off resonance and should drop to about 40 mA at resonance. It is dangerous to the valve to run it in an unloaded condition and a lamp of 60 watts rating (ordinary mains voltage) should be connected across the output loop during initial adjustments. When the transmitter is operating correctly the lamp should light to practically full brilliancy.

For telephony work the modulator should be capable of giving an output of about 50 watts, the output transformer being arranged to work into an impedance of 4000 ohms (assuming an input of 600 volts, 150 mA). The bias should be increased to 70 volts and if possible the drive also increased to restore the grid current to 10 mA.

Aerial Coupling

In the majority of cases, a low impedance feeder cable will be used to transfer power to the aerial and the single turn loop shown in the photograph will provide adequate coupling. With a long wire, Windom or other type of aerial, a separate aerial tuning circuit should be employed' It can well consist of an *Eddystone* Cat. No. 580 Microdenser in parallel with a self-supporting coil having five turns 14 gauge wire, 2″ diameter, with connecting tags soldered to the top of each turn. One end of the aerial circuit is earthed by a short heavy lead

Continued at foot of next page

SERIES METER RESISTORS

By **N. T. M. CHIVERS**

MANY people who would otherwise have saved themselves a large amount of money by building their own multi-testmeters instead of buying them, have been discouraged from so doing by what they consider to be the necessity of obtaining accurately-valued series resistors for the voltage ranges. However, it is possible to obtain very accurate series resistors with ordinary large-tolerance components (up to ± 20%), this being done simply by connecting these resistors in parallel. Also required to carry out such a process is a separate voltmeter to check the readings obtained.

The procedure will be simpler to explain if we take an example, so let us imagine that we wish to fit a resistor to a basic 1 mA meter movement to enable it to read 10 volts full-scale deflection. The resistance of the movement is 50 ohms. The series resistor we require would then need to have a value of 10,000 minus 50 ohms, that is, 9,950 ohms. Let us see how, by using a basic stock of resistors such as is held by most constructors, we may obtain this value.

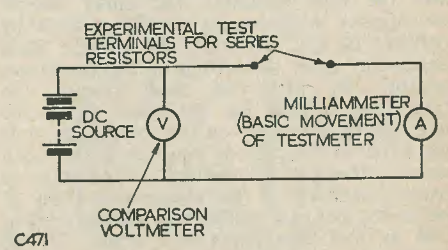
The milliammeter and the voltmeter which we are using for comparison purposes should be connected up to a source of DC in the manner shown in the diagram. This source of DC could, quite conveniently for this example, be a 9-volt grid bias battery. We check the reading of the voltmeter and find that, in this case, it happens to be exactly 9 volts.

Our next step consists of finding a combination of resistors which will cause the milliammeter to read exactly 0.9 mA. (This will, of course, correspond to a reading of 10 volts full-scale deflection). We mentioned above that the exact value of series resistor needed is 9,950 ohms. We almost definitely would not have a resistor of this value in stock, although we are pretty certain to have several large-tolerance components which are nominally 10 kΩ. We begin therefore by trying each of our 10 kΩ resistors in turn, observing the reading we get in the milliammeter with each. We would be very fortunate indeed if we found a resistor which caused the milliammeter to read 0.9 mA exactly, and so instead we choose one which makes it read just slightly below that figure.

This resistor will then have a value slightly higher than the 9,950 ohms required. What we next propose to do is to effectively alter the total series resistance by connecting other, high-value resistors across that already fitted. The process is rather similar to that of trimming a large capacitance with a low-value trimmer.

Working empirically, we may find that a 500 kΩ resistor shunted temporarily across the existing 10 kΩ resistor causes the meter to read slightly higher than the required 0.9 mA. On the other hand, a 2 Meg Ω resistor may cause it to remain still slightly below. We would then probably find that a parallel resistor of 1 Meg Ω would give the exact series resistance required. The series resistance needed for the 10 volt range in this example would, therefore, consist of the 10 kΩ resistor originally chosen, paralleled by a 1 Meg Ω resistor.

It will be seen that this method of working is very simple, and ensures accurate results without attempting to modify the individual resistors in any way, and without the necessity of using expensive components. With one or two "awkward" ranges it may be necessary to connect *three* resistors in a series-parallel network in order to arrive at the exact value; but it will usually be found that the average stocks held by most constructors are sufficiently comprehensive to satisfy the requirements of all ranges, using just the two resistors for each.



Circuit used for experimentally determining the value of meter series resistors, using the process described in the text.

PA for 28 Mcs, continued.

to the transmitter chassis or other "dead" point. Direct inductive coupling is recommended but link coupling may also be used, the aerial circuit in this case being also provided with a single turn coupling loop. The aerial lead should be clipped to one of the tags—near the "earthy" end to start with. Adjustment of tap and coupling is then made, the aim being to obtain a smooth rise of anode current not too sharp nor yet too sluggish—as the aerial circuit is brought into resonance.

QUERY CORNER

A "Radio Constructor" Service for Readers

Picture Tube Fault

About a year ago I completed my first television receiver, which after some initial fiddling, was coaxed into providing what I consider to be an excellent picture. Unfortunately, during the past week or so, an intermittent fault has developed; when first switched on the receiver may operate satisfactorily for about an hour, when suddenly the screen becomes white and all traces of the picture disappears. No amount of juggling with the controls will restore the picture, and the only cure is to allow the set to cool down, whereupon normal operation is resumed when it is once again switched on.

Before pulling the chassis out of the cabinet and hunting for a faulty component, I would like your suggestions as to the most likely cause of the trouble. *D. Owens, Catford.*

This fault is unfortunately all too common in television receivers and can usually be traced to either the picture tube, the video stage or brightness control circuit. The latter is easily checked by connecting a 250V voltmeter between the slider of the brightness control and the tube cathode. The slider should be negative with respect to the cathode by between 20 and 100 volts, this voltage being dependent upon the setting of the brightness control. If, when the fault occurs, the brightness control has no effect upon the intensity of the raster on the screen, the fault lies either in the cathode ray tube or the video stage. The grid to cathode or cathode to heater insulation of the tube is most likely to be faulty, and can exhibit intermittent tendencies as the tube heats and cools. If the trouble occurs because of poor heater to cathode insulation a cure can often be effected by feeding the tube heater from a separate winding on the mains transformer, so that the potential between the heater and cathode is reduced to a minimum, thus reducing the leaking current. In the AC/DC type of receiver the tube heater can only be isolated by the addition of a small transformer, and then only if the set is to operate from AC mains. However, in a receiver already fitted with a transformer an additional winding can often be fitted to supply the tube heater. Most transformers are wound with four or five turns per volt, so for a tube having a 2 volt heater between 8 and 10 turns will be required. A reliable AC voltmeter is essential to check the heater voltage, which must be within 5 per cent. of the nominal value when the correct mains voltage is applied to the receiver. To ensure that the heater remains at approximately the potential of the cathode, a 0.5 MegΩ resistor must be connected between the two as shown in Fig. 1. It has been found that even in receivers in which the tube is cathode modulated, a separate heater winding has permitted the use of a tube which had poor heater to cathode insulation. This may at first seem a little surprising, because if the heater were joined directly to the cathode the additional load on the video stage would seriously impair the definition. This is correct, of course, but a tube which has very bad heater to cathode leakage when the potential between these two components is fairly high may have quite good insulation if the voltage is reduced to something approaching zero. In any case, if the addition of another winding to the mains transformer, or perhaps the addition of another transformer, can enable an appreciably extended life to be obtained from an expensive cathode ray tube then surely it is worth trying.

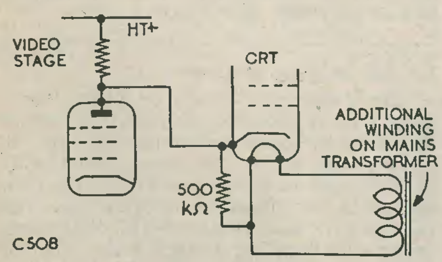


Fig. 1: Isolating the tube heater by means of a separate winding on the mains transformer.

Should the tube have faulty grid to cathode insulation the matter is more serious. The leakage may be caused by a piece of screen or cathode material becoming lodged between the grid and cathode, and can in some instances be shaken clear of these electrodes. However, if all else fails and the tube is outside the maker's guarantee it is worth attempting to burn away the shorting particle by sparking the tube. This is done by applying the high voltage output from an ignition type coil between the grid and cathode. This remedy is a little drastic and should not be continued for longer than is necessary, but it can be most effective if carefully applied. Ignition coils are usually obtainable with either 6 or 12 volt primaries, and the primary circuit may be interrupted either by hand or by means of buzzer contacts. If the latter arrangement is used a continuous spark will be obtained whilst the buzzer is in operation. The sparking method of improving insulation is equally applicable to radio valves, but care is necessary in its application as an overdose may cause further damage to the valve.

The insulation of a cathode ray tube should be measured with the heater alight by the method shown in Fig. 2. The leakage may be calculated by Ohms Law, and should be better than 1 MegΩ between grid and cathode and better than 100 kΩ between heater and cathode. When making this calculation, 1 MegΩ must be subtracted from the answer to allow for the meter safety resistor added in one of the test leads.

Finally it is just possible that the receiver fault mentioned by our correspondent is due to one of the components in the video amplifier stage; this may be ascertained by examining the anode load resistor, the cathode resistor and capacitor, and the valve when the fault actually occurs in the receiver.

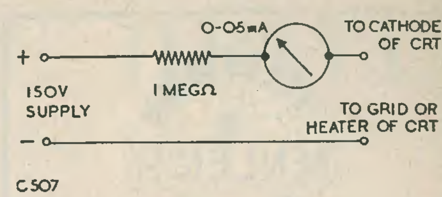


Fig. 2: Circuit for measuring grid to cathode or cathode to heater insulation of CRT. Tests made with the tube heater alight.

'H' Aerial for Holme Moss

Can you please supply me with the major dimensions of an "H" type aerial for use on the Holme Moss Transmission? R. Keally, Bradford.

The dimensions of such an aerial were discussed in the February 1951 issue, and figures were given for operation on either the London or the Birmingham television transmissions. We are now bringing this information up to date by reprinting the diagram (Fig. 3) and the table with the addition of the dimensions for use in the Holme Moss service

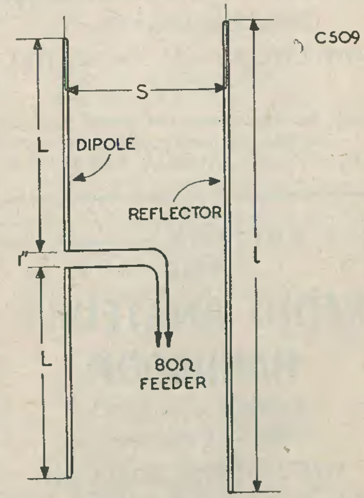


Fig. 3: Dimensions of dipole and reflector (for figures see text).

QUERY CORNER "Rules"

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

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

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

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

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

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

area. This aerial uses 1/8 wavelength spacing between dipole and reflector as this has been found to give a more even gain over the required bandwidth, whilst at the same time permitting better mechanical rigidity to be obtained. Either a balanced or an unbalanced 70–80 ohm feeder may be employed.

Transmission	*London*	*Birmingham*	*Holme Moss*
Length of each limb of dipole (L)	64″	47″	59″
Total length of reflector (l)	139″	100″	124″
Spacing between dipole and reflector (s)	33″	24″	29½″

from our Mailbag

Radio Control of Models

Dear Sir,—I should like to congratulate you on the new series of articles recently initiated by you on the radio control of models, and on your intelligent approach to the subject.

Radio control of models was, of course, pioneered in this country by members of the S.M.A.E., and various contests are held throughout the year and in all parts of the country for this type of model flying. Even with apparently limited control, almost any standard manoeuvre can be carried out by a skilful "pilot".

As you will have found, whilst the control of ground- or water-borne vehicles offers greater scope for complicated gadgetry and circuitry (often for its own sake), radio control of model aircraft presents the greater challenge because of the need for maximum efficiency coupled with high sensitivity, absolute reliability and the lowest possible weight. In this last connection, it seems that the Venner lightweight accumulators based on the silver-zinc reaction will be extremely useful.

There is little I need say about Dr. Gee's article, except that he is obviously tackling the subject with the right attitude and with an open mind.

I look forward to the next of Dr. Gee's articles and am, of course, happy to be of service at any time. Yours sincerely, Kenneth J. A. Brookes, Press and Public Relations Officer, Society of Model Aeronautical Engineers.

HARMONIC DRIVE

Part Two

By P. TURNER

It's That Frenchman Again

WHEN I first started looking into this harmonics business I kept coming face to face with something that rather put me off. It frightened me away, if you follow what I mean. Every so often some mathematical blighter would mention, with an airy fol-de-rol and a pie-ar-squared, Fourier's Analysis, and follow up with a lot of baffling symbols. (The really funny part is that these chaps sometimes baffle themselves as well as the others. It gets very humorous, then). Don't let old Monsieur Fourier put you off. He was a rather ducky old Frenchman who went to Egypt with Napoleon Bonaparte as chief of supplies to Napoleon's army. He did a lot of mathematics in his spare time and wrote a book about the way heat is absorbed and given off again. For instance, the heat from the sun is absorbed into the surface of the earth during the day and during the summer, and is given off again during the night and during the winter. The graph of that, plotted with time as the horizontal part of the graph, would be a waveform with a frequency of one cycle per year and a ripple superimposed on it. The ripple frequency would be 365 cycles per year. I am not sure exactly how much ground Monsieur Fourier covered, but his book was called Théorie Analytique de la Chaleur, or in English, Analytical Theory of Heat. Now M. Fourier was a good mathematician, and he was also a good see-er. When he looked at something he really took notice, and he found out that a certain kind of mathematical phrase was very helpful in working out things which were connected with varying quantities when the variations kept on repeating, like heat soaking into and out of the earth. A bit later on, about 1840, Herr Georg Simon Ohm, who was a physicist and gave his name to a certain electrical law, realized that much faster varying quantities could also be investigated by this method. He pointed out that a violin note waveform could be worked upon. Herr Ohm did not have a cathode ray oscillograph to use, of course. He must have used some kind of mechanical device employing very small mirrors and a narrow beam of light. This method depends upon a beam of light being reflected from two mirrors in turn. The first one swings rhythmically, to provide a "time base", and the second one moves at right angles and is driven by the thing under investigation. The spot of light moves over a white screen and by persistance of vision produces a waveform. Nowadays we make great use of M. Fourier's discovery to describe and to investigate the variations of voltage and current waveforms in electrical circuits.

M. Fourier's discovery is very simple really, although the mathematics is a bit complicated. It is just this: if you have a varying waveform, no matter what its shape is, and providing that it keeps on repeating the same variations over and over again, you can represent it *for mathematical purposes* by a lot of other waveforms of different sizes and phase relationships, all of them being sine waves. All the sine waves are exact multiples of the original wave frequency, that is, they are one or two or three or four times the frequency up to as many as you like. These higher frequencies are called the 'harmonic frequencies' of the original one. The use of the word harmonic comes from the world of music, as one might suspect. The word originally came to us from a Greek word, harmos, a fitting. The Roman version was 'harmonia' and the Old French word was 'armonie'. When music came to be studied scientifically, the especial meaning which the word was given was this: an overtone, especially one produced by a vibration frequency which is an integral multiple of the vibration frequency producing the fundamental. That is just the meaning with which we use the word in our application of it to radio and audio frequencies.

Note the phrase "for mathematical purposes". This Fourier Analysis is just another mathematical TRICK.

It is a very useful one because sine waves can be worked with by using mathematical formulas, whereas just any old waveform cannot. The sine waves which are used to represent the main waveform are called, as we saw, harmonic frequencies and it is here that a certain little misunderstanding creeps in.

When some people use a tuned circuit to get a multiple of a frequency they say that they have 'extracted a harmonic' *and they imagine it just like that.* Certainly there is a connection between the two things, but getting harmonic frequencies is not like extracting toffees from a paper bag. If you really 'extracted the harmonic' you would alter the original wave form drastically, and this does not happen. If you had a two foot rule and a pencil and you used them to draw a line three inches long on a piece of paper, and somebody came up and said that you had 'extracted three inches from the fundamental rule' you would probably either screech with laughter or sock him over the bonce with a bottle, according to your temperament (I prefer the bottle technique, I think), and yet it is just the same thing as to say that you have 'extracted a harmonic from the fundamental frequency'.

What is really meant by that statement is this: the varying current (or voltage, or magnetic or electric field) has been used to drive a circuit which resonates at exactly a certain number of times the original waveform frequency. If it is twice, you say it is the second harmonic frequency, and so on. Now in order to use the current indicated by the original waveform to do this it cannot have a sine wave variation. It must be distorted, otherwise it will not work. If it is distorted relative to a sine wave, and if its wave form is investigated by Fourier's method, it will give smaller amplitude—higher frequency sine waves *on paper*, and its efficiency as a driver of higher frequency tuned circuits can be judged from the results of the investigation. This is the connection. This is also the clue to a useful dodge which we shall come to in a little while. You will see from this that the talk about the 'harmonic content' of a waveform is all right so long as you understand that it only means on paper. In practice, the apparent harmonic drive from an oscillator may vary considerably due to the amount and character of the coupling between the driver and the driven circuit, or due to the damping present in the driven circuit or the strays present in the driven circuit. It becomes rather difficult to say just how much harmonic drive will be obtained from any given oscillator feeding into a specified circuit.

What we have found out so far

Before we go poking our noses into any more whys and wherefores, let us have a look at what we have found out.

1. We have found out that a vector is not a very fierce animal and does what we tell it.

2. We have found out what a sine wave is and why it does such useful things.

3. We have found out what M. Fourier did and how his idea works.

4. We have found out what 'extracting a harmonic' really means and why it is not quite right to use that phrase.

Now if we get all those things into the right perspective and see how they fit in, we have in our hands the key to a very useful box of tricks. This box of tricks gives us the ability, to a great extent, to order about the shape of a distorted waveform just as we like, and thus to change its efficiency as a driver of higher frequency tuned circuits to suit our own needs. It also gives us an understanding of why a waveform from an oscillator is distorted. This is very useful because it helps us to choose the right methods for driving our other circuits.

Why a Crystal does not give any 'Harmonics'

First of all we must have a look at another thing which often led me astray until I 'rumbled it'. I mean this business of crystal oscillators. A crystal as used for frequency standards is usually made of quartz. This is the same substance as sand, only sand has been ground to a fine grit by Mother Nature and usually contains some impurities as well. The most common one is iron oxide, which gives the familiar red or yellow colour. A quartz crystal resonator is one of the links between electrical and mechanical vibrations and it has a similar sort of action to a pendulum, only much faster. The force which provides the 'swinging back' action is not the force of gravity, as in the case of the pendulum, but is the natural elasticity of the quartz. A quartz crystal can be likened to a very good, low loss, and therefore high 'Q' value tuned circuit, having a natural frequency of oscillation which is very nearly equal to the natural mechanical frequency of the crystal. Many text books will tell you this and then almost in the same paragraph will mention that "*such and such a crystal was a good generator of harmonics*".

Now a high Q value circuit when oscillating at its fundamental frequency gives a very good approximation to a sine wave, so a crystal does not give any harmonic drive at all. What is meant, then, when it is said that a crystal is a good generator of harmonics is this: the valve circuits and external circuits (external to the valve), are good generators of harmonics when they are controlled at the frequency of the particular crystal in use. If another crystal is used there will be a different percentage of harmonic distortion present in the waveform of the voltage at the anode of the valve, if the frequency of the crystal is different from the first one. If the first crystal is used but the anode circuit is changed a little in layout or values, the waveform will be different again. So we see that it is not the crystal itself that determines the amount of harmonic drive that you can get from a fundamental circuit, but the circuit elements themselves and the manner in which they are disposed in the circuit. Now you see where the box of tricks comes in. If we can make it possible to push the waveform about just as we like, we can arrange for any amount of harmonic drive we need, up to a point.

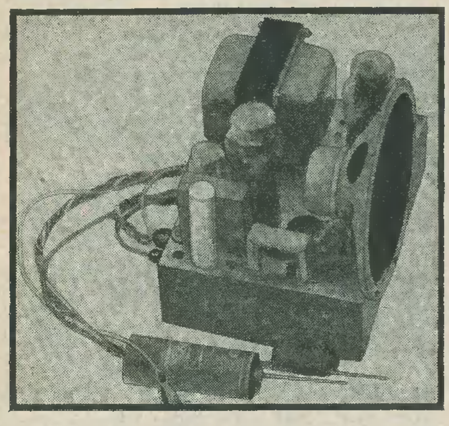
(*To be continued*).

MISCELLANY

System Schultz.—We have been favoured with samples and details of this new method of panel building, which is advertised elsewhere in this issue. Our first reaction is that this system definitely has possibilities, particularly for the experimenter and practical radio instructors. We hope to go into greater detail in our next number.

Next Month:

Converting the 21 Receiver.



A SIGNAL TRACER

By

J. GLAZER

THE average radio amateur when building equipment, chooses the design which is not complicated in circuit or construction and which also offers several uses. When I first decided that I needed a piece of equipment for testing radio receivers, I realised that a signal generator would be the ideal thing; but looking through circuits of the latter I found that to build one would be a little too risky. Firstly getting suitable coils for it and then getting it to oscillate.

Now what we radio amateurs really want is a radio receiver without any COILS ! ! How absolutely Super ! ! If it were only possible. It's those beastly "squiggles" in the circuit diagrams (meaning coils) that have stopped many an enthusiastic "ham" from building some Super-duper 15 valve communication receiver.

Back to the point, the signal generator is really a transmitter and the signal from it is injected into a radio receiver. So why not have an instrument which is really a receiver (with no coils, of course) and EXTRACT the signal from the radio receiver on test.

Well, after years of scientific research in my "shack", I eventually managed after rebuilding it six times, to perfect it to the standard of Radio Amateurs (NO COMMENT, PLEASE). I called it a SIGNAL TRACER, christened it with a bottle of "pop", and rebuilt it again.

The signal tracer is very sensitive. With the volume control well up, hum is produced from the speaker when the R.F. probe comes near mains wires or your finger. If the probe is placed near the wires joining a working receiver to its speaker, the signal is picked up from the wires and produced in the tracer speaker. The tracer is really a radio receiver without any tuned circuits. If the R.F. probe is connected to a simple tuned circuit with an aerial, it will act as a rather unselective radio; which is rather useful when it is not being used for servicing.

I built it (after its christening) on the chassis of an RF25 unit which I purchased rather cheaply. The RF25 unit contains two 460 kcs transformers, with iron dust cores, four 75μμF preset capacitors, four capacitors containing three 0.1μF in each with a common earth connection (these capacitors are extremely useful for mounting near valves to be used for decoupling) and a good many resistors. The RF25 unit is encased in black enamelled steel (tinplated). Don't let me dishearten some of our not so energetic readers, the steel is as easy to drill and file as aluminium. The valve line up is RF detector (Mullard EF91, acorn pentode), this is contained in the probe head. The A.F. valve is a 6J5 and an EL33 is used as O/P, a 5Z4G is rectifier.

The RF probe head is made of a U2 battery case, with the inside scraped out. Three holes are drilled in the end of the battery case, one to take a screwdriver, the other two holes are for the bolts that hold the screwdriver

CIRCUIT AND COMPONENT LIST.

C1	100μμF
C2, 4	0.01—0.1μF
C3	0.005μF
C5, 8	25μF, 25v. wkg.
C6, 10	8μF 350v. wkg.
C7, 12	0.1μF ,, ,,
C9	16μF ,, ,,
C11	1μF ,, ,,
1—2 pin plug and socket	
1—5 pin plug and socket	
6″ speaker	
R1, 4, 9	500kΩ ½watt
R2	470Ω ½watt
R3	250kΩ variable
R5	220kΩ ½watt
R6, 11	47kΩ ½watt
R7	2.2kΩ ½ watt
R8	100kΩ ½watt
R10	150Ω ½watt
CH	Smoothing choke, 50mA
T1	O/P transformer 35mA 40:1
T2	Mains transformer 250-0-250v, 75mA 5v, 2A 6.3v, 3A.
Earthing clip	

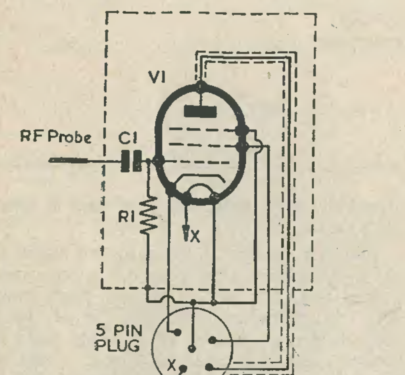
Base Connections

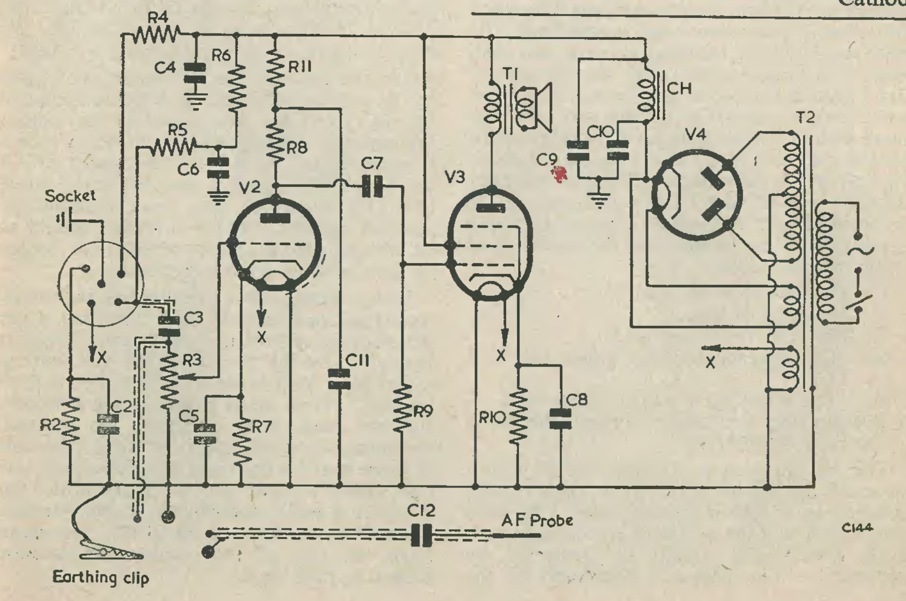
EF91—B7G
1 Control grid
2 Cathode
3 Heater
4 Heater
5 Anode
6 Suppressor grid
7 Screen grid

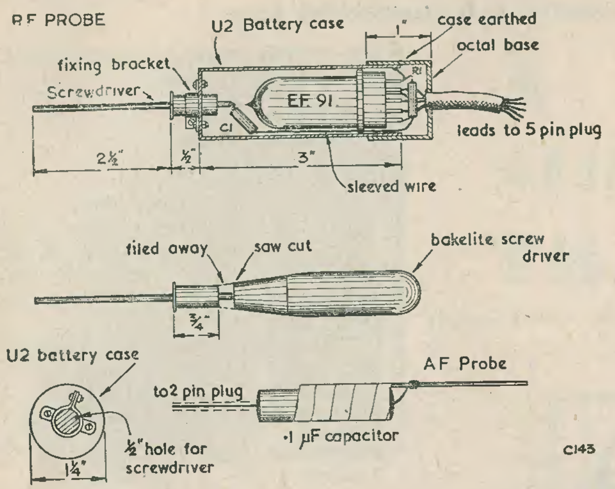
6J5 I. OCTAL
1 Earth
2 Heater
3 Anode
4 N.C.
5 Grid
6 N.C.
7 Heater
8 Cathode

EL33—I.O.
1 N.C.
2 Heater
3 Anode
4 Screen grid
5 Control grid
6 N.C.
7 Heater
8 Cathode

5Z4G—I.O.
1 N.C.
2 Heater
3 N.C.
4 Anode
5 N.C.
6 Anode
7 N.C.
8 Heater and Cathode







Constructional details of RF and AF Probes.

fixing bracket. The fixing bracket is the same design as the type used to fix large round capacitors to the chassis. The screwdriver is of the bakelite type, this is cut and filed as shown in the diagram.

C1 is soldered to the end of the screwdriver and brought out to the grid pin of the EF91 valve holder. The acorn valve with its B7G valve holder fits into the battery case, which is padded with cotton wool to prevent damage to the valve if the probe head is knocked. To hold the valve in the battery case, an octal base (of a broken valve) with its pins cut off and a hole drilled where the " peg " is, is fitted over the open end of the battery case and later glued with Durofix. The wires from the probe head to the main amplifier are brought through the hole in the octal base. The grid capacitor and grid leak C1 and R1 are contained in the probe head with the valve. The battery case is earthed. Four wires join the probe head to the main amplifier.

1. The 6.3 volt heater lead
2. The cathode lead
3. The H.T. for screen grid

4a. The screened lead for anode O/P and H.T.

4b. The screening is used as earth lead.

A five pin plug and socket connect the probe to the main amplifier.

The AF probe is a capacitor (C12) with a piece of thick wire about four inches long, fastened to it with insulating tape. The lead from one end of the capacitor is soldered to the thick wire which should be protected by sleeving it. The probe is connected to the amplifier by a screened lead and a two pin plug and socket.

The A.F. probe is fed into the audio valve (6J5) just before the volume control, which is placed near the 6J5 to prevent hum pick up. The O/P transformer should be of the ratio 40:1 (with a speaker of 3 ohms impedance speech coil) and rated at 35mA. The mains transformer should have a primary of 200-250v, and secondaries capable of providing 250-0-250v at 75mA, 6.3v at 3A and 5v at 2A. The smoothing choke should be rated at 75mA.

The signal enters the RF probe, is amplified by V1 which is biased by R2 and decoupled by C4, C2, C6. The signal is then passed through the volume control, to V2, which is, in turn, biased by R7 and decoupled by C11 and C5. The signal is coupled to V3 by C7 (0.1 μF), amplified, then made audible by a six inch speaker. The two probes should not be both plugged in at once when in use, because of hum pick up from either one.

Unless some idiotic mistake has been made, the signal tracer should work first time. Turn the volume control up and place a finger on the end of the RF probe. (No, you don't get a shock), a loud noise should be heard in the speaker. Then apart from placing it in some suitable case, it is finished. No adjusting trimmers, variable capacitors, iron dust cores in those horrible coils and no calibrating. Just one simple volume control, marvellous ! and if you're a really enthusiastic Radio Amateur, apart from the cost of the EF91, you should have the rest of the components in some forgotten junk box.

If you have a radio receiver that you have just built, here is your chance to use the tracer. Inject a signal into the aerial socket of the receiver from an aerial or a signal generator, connect the tracer's earthing clip to the receiver chassis. Assuming the first stage to be the RF stage, place the RF probe onto the grid of the RF valve and tune in the Home Service on medium waves (I know some receivers with the Home Service on all three bands). This should be easy, unless there is something wrong with those wretched coils. Now place the probe onto the anode of the RF valve, the signal should have increased in strength, if not, there is something wrong with this stage.

1. Too little or no H.T. on the anode or screen grid
2. Cathode resistor or bypass capacitor faulty
3. Valve faulty.

In this way the faulty stage(s) may be isolated. Place the probe on the control grid of the frequency changer, tune in trimmers and/or iron dust cores in the previous circuits for maximum gain. Place the probe on the frequency changer anode, adjust trimmers, padders and the I.F. transformer. Transfer the probe to the grid of the IF amplifier valve, adjust the I.F. transformer connected to this stage for maximum gain. Apply the same method to the anode of the I.F. amplifier and diode detector, adjusting the I.F. transformers. Use that A.F. probe from the first A.F. valve to the O/P, checking for signal continuity. The R.F. probe may be used for A.F. but without good reproduction.

A hint to beginners; do not try to make testing equipment A.C.-D.C. because when working on an A.C.-D.C. receiver, it is easy (with the mains plugs in the wrong way) to have one chassis alive and the other neutral and on joining the chassis together, the mains will be short circuited and a severe shock is liable to be given.

" What's that you say ? The signal tracer has blown up. Oh, well, perhaps those coils aren't so bad after all ! ! ! "

A LIST OF EX-GOVT. COMPONENTS (TR1196) FROM THE RF25 CHASSIS

Resistors:

10C/ 1847=2.2K Ohms
„ 1850=4.7K „
„ 6081=47K „
„ 6320=470K „
„ 6322=1Meg „
„ 6471=220K „
„ 6840=100K „
„ 6842=68K „
„ 6927=470K „
„ 8195=220K „
„ 8197=100K „
„ 8435=500K „
„ 8652=2.2K „
„ 8678=470K „
„ 8961=1Meg „

Capacitors:

10/C 3399=0.1+0.1+0.1μF
„ 4321=75μμF variable
„ 4325=500 μμF fixed
„ 4326=200 „ „
„ 4327=200 „ „
„ 4328=150 „ „
„ 4329=100 „ „
„ 4568=2μF 250v. wkg.
„ 5469 1μF
„ 4570=0.5μF 400v. wkg.
„ 9755=0.01μF 450v. wkg.
„ 11126=0.1μF 350v. wkg.
„ 11138=0.01μF 375v. wkg.

Transformers and Coil:

10K/245=Microphone Transformer
10K/246=O/P Transformer
10K/241=I.F. 460kcs. Transformer
10K/242=I.F. 460kcs. Transformer
10K/3425=H.F. Choke

IN YOUR WORKSHOP

In this month's article J.R.D. continues his discussion on a subject which has proved to be of interest to many readers—that of Modernising Old Receivers.

LAST month "In Your Workshop" concerned itself with the various procedures needed in order to modernise old receivers of different types. Some time was also spent particularising on the treatment

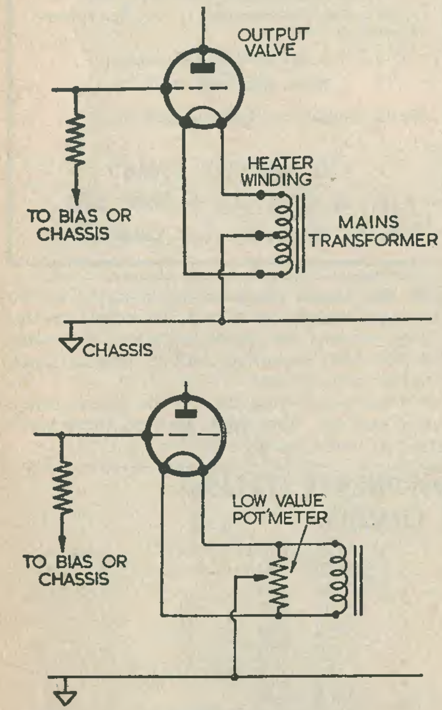


Fig. 1 (a): To reduce hum, directly-heated valves may be heated from a centre-tapped transformer winding, as shown here.

Fig. 1 (b): An alternative circuit which uses an adjustable potentiometer connected across the heater supply instead of the centre-tap of (a).

required for various sections of the receiver circuit, starting with the power pack and the loudspeaker. We shall now carry on to the output and AF stages.

The Output Stage

Unless the receiver being modernised is a fairly early model, the original output stage will usually be found to consist of an indirectly-heated output pentode or tetrode. Let us commence therefore by considering a case of this type.

Ignoring the possible necessity of altering the heater voltage or the valveholder, the output valve used in such a receiver will nearly always permit of direct substitution by a more modern type. Some output valves have substitutes recommended in the manufacturer's valve lists. It will also be found that quite a number of output pentodes and tetrodes are of types which are still being manufactured today.

It will nearly always be worth while replacing the output valve in a receiver undergoing modernisation, as this valve is one of the first to wear out with time. A replacement will very often be required in any case, owing to the necessity of replacing obsolete valveholders, of altering heater voltages, and so on. When such a replacement is carried out, care should be taken to see that the new valve is designed to work into the same impedance as the old.

In some of the earlier receivers it will be found that a directly-heated valve is used in the output stage, this valve sometimes being a triode. These directly-heated valves were usually heated as shown in Figs. 1 (a) or (b). In Fig. 1 (b), the potentiometer connected across the valve heater was pre-adjusted to give minimum hum in the speaker output. Bias was either supplied to the grid by means of a negative bias network, or to the filament by a resistor connected between chassis and the heater supply centre-tap.

When a directly-heated output valve is used by itself, its replacement by a modern indirectly-heated type will almost certainly result in a considerable improvement. Sometimes, however, and especially when, say,

two triodes are used in push-pull (as could be met in the more expensive type of receiver), replacement with tetrodes or pentodes may not necessarily give better results. If the particular valves used, or recommended substitutes, are still available, it might in this case be a good plan to leave the circuit as it is. Especially is this true if the circuit is capable of giving really good quality and seems to be trouble-free in operation. A decision on this point is best left to the individual constructor.

Replacing directly-heated output triodes by modern pentodes or tetrodes will, of course, result in a noticeable increase in gain and volume. This extra gain may be undesirable, and it can be reduced by the judicious use of negative feedback. This point will be discussed later.

Output Tone Controls

It will be found that some receivers use the top-cut tone control circuit which is shown in Fig. 2 (a). This circuit has certain advantages for the manufacturer, insofar that it is simple to instal, that it does not necessitate the use of screened leads, and that it may be fitted, if desired, directly to the inside of the cabinet without affecting the chassis. It has the further advantage of being able to remove the shrillness inherent in a pentode output stage by an adjustable amount. It suffers, however, from the disadvantages that it may sometimes cause the output transformer primary circuit to become resonant, and that the audio power present may cause arcing in the potentiometer at the "full-cut" end (with the result that this component becomes worn and "crackly"). If it is intended to retain a tone control in this circuit position, an improvement would be obtained by using a switch, as shown in Fig. 2 (b). If possible, the switch chosen should be of the type which has a wiper arm. (As it is turned, this type of arm causes one contact to be made before the preceding one is broken).

The Detector and AF Section

We mentioned last month that it was possible to encounter many "freak" and out-of-date circuits in the detector stages of old receivers. So far as straight receivers are concerned, it was recommended that an infinite impedance detector be used instead of that originally fitted, the straight receiver then being used for high-quality local reception only. This recommendation was made on the presumptions that the receiver had a sufficient amount of tuned circuits and of RF amplification to make such a course

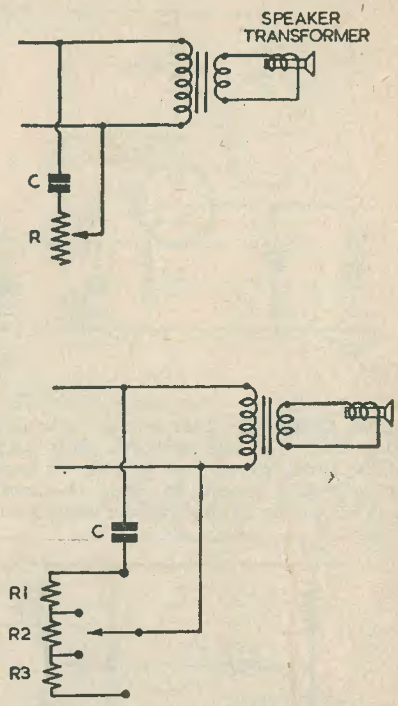


Fig. 2 (a): A simple top-cut tone control. The value of C may lie between .01 and .05 μF: and that of R between 10 and 50 kΩ.

Fig. 2 (b): A suggested alternative, using a switch. The switch may have more than four contacts, if desired. The values of resistance can be found by experiment.

practicable; and that it was not intended to convert the receiver to a superhet.

The circuit of a practical infinite impedance detector is given in Fig. 3. It would be difficult to say, without handling the actual receiver being modified, how much AF amplification would be required after such a detector. In some cases, it may be sufficient to feed the detector output straight to the output valve; whereas in others it would be necessary to employ a triode amplifier between the two. If a leaky-grid or anode-bend detector is being replaced by the infinite impedance detector (which gives, of course, no amplification) then the AF triode will most probably be required.

The situation is a little more complicated when we come to consider the second detector of a superhet. If the original design used

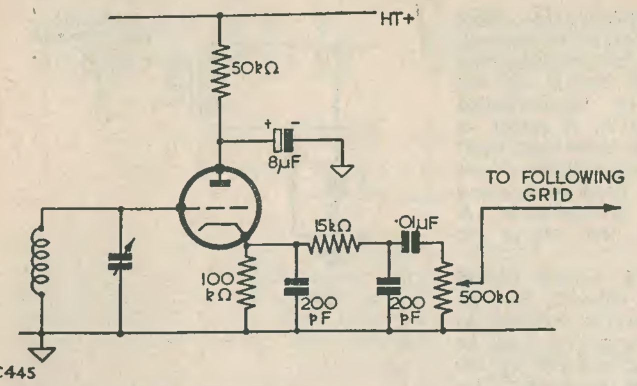
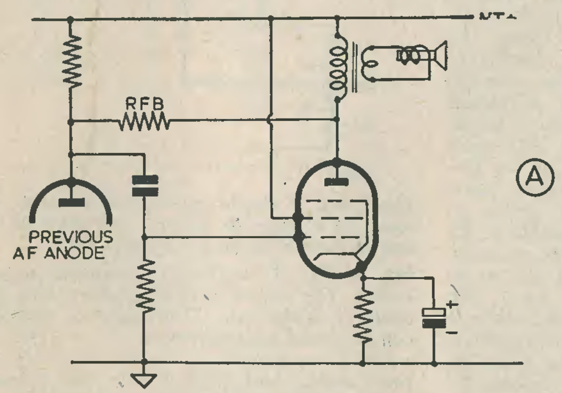


Fig. 3 An infinite impedance detector.

a diode detector (perhaps as part of a diode-triode, etc.,) it would be worth while tracing out the circuit to see how it looks on paper. Particular care should be taken to examine the AVC circuit, as this may be unnecessarily complex. Amplified AVC was occasionally used in old receivers, and can usually be removed with advantage. Modern frequency-changers and IF amplifying valves are capable of being adequately controlled with ordinary simple AVC circuits; and the added complications of amplified AVC do not make its retention worth the trouble. Some sets which boasted "quiescent AVC" carried this out by the simple process of applying little or no bias to one (or more) of the pre-detector amplifiying valves. Until an AVC voltage appeared on the reception of a carrier, this valve then passed grid current, damping its grid tuned circuit and consequently reducing inter-station noise.



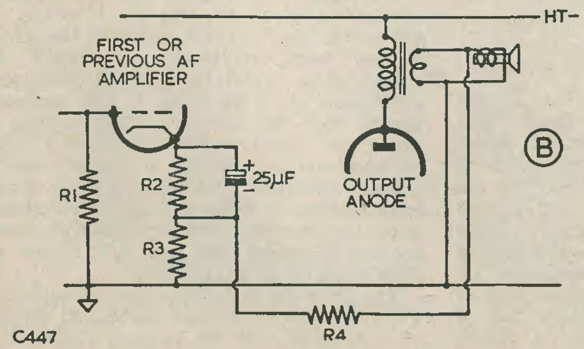


Fig. 5 (a): Obtaining voltage feedback over the output stage.

Fig. 5 (b): Negative feedback applied over several AF Stages. (R2 and R3 add up to the value of bias resistor normally used).

If the constructor intends fitting a new second detector circuit the writer suggests the use of that shown in Fig. 4 (a); (this is an "old faithful" which has been well-tried in practice). The value of R_K in this diagram corresponds to that needed to give correct cathode bias for the triode section. If the volume control is mounted some distance away from the second detector valveholder, this circuit allows it to be connected via screened wire. All the other components must, however, be mounted close to the second detector. (It should be pointed out that the AVC voltage obtained from the circuit of Fig. 4 (a) has a standing voltage equal to the cathode bias of the triode section. The cathode bias of the AVC-controlled valves must, therefore, be increased in order to allow for this).

In the circuit of Fig. 4 (a) AVC is undelayed. Should delayed AVC be required, the circuits of Figs. 4 (b) and (c) can be used instead. These last two circuits can be utilised in conjunction with that shown in (a); one diode instead of two strapped together then being used for AF detection, whilst the other is freed for the AVC circuit. (The 2 MΩ resistor of Fig. 4 (a) would, of course, be removed). In both cases, the AVC delay is provided by the cathode bias of the triode. A smaller delay could be obtained by tapping the bottom end of the 1 MΩ resistor into the bias resistor. The circuit of Fig. 4 (c) is fairly popular, although it does not allow the AVC to follow the response curve of the IF transformer *quite* as accurately as that of Fig. 4 (b). This point is of some slight importance, particularly when AVC-operated tuning indicators are used; and it necessitates then that the alignment of the IF transformers is carried out with care.

It is conventional to follow a diode second detector with an AF triode and the output valve. Unless a complicated or ambitious AF section is being considered, this line-up is more than sufficient for normal purposes and may be used with confidence. In many cases there should be sufficient gain with such a circuit to allow a small amount of negative feedback to be employed. A higher degree of negative feedback would be feasible if the AF triode were replaced by a pentode.

A simple and fairly effective method of obtaining negative feedback consists of omitting the capacitor across the cathode resistor of the output valve. Alternatively, voltage feedback over the output stage can be obtained by using the circuit of Fig. 5 (a). (The value of R_{FB} may be determined experimentally). Feedback over all the AF stages is provided by the circuit of Fig. 5 (b), in which the ratio of R3 to R3 + R4 determines the amount of feedback applied. Tone control circuits should be connected outside the feedback loop. (My colleague, G. A. French, has had some words to say recently on this point!)

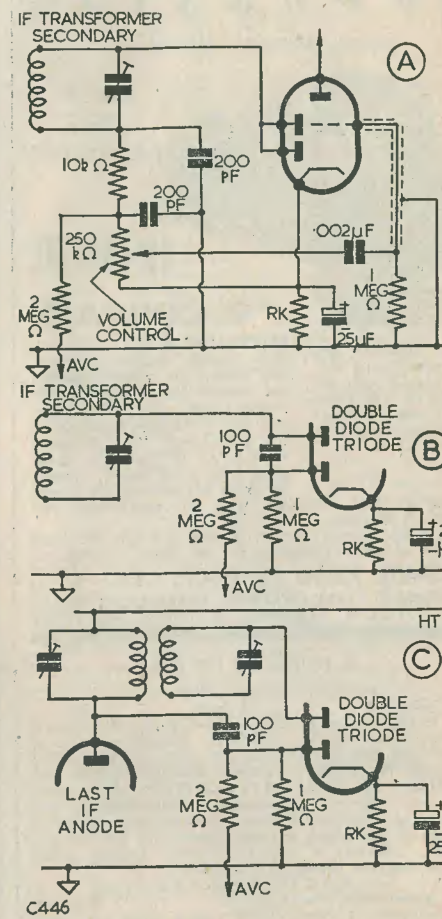


Fig. 4 (a): A useful second detector circuit.

Fig. 4 (b) and (c): Two different methods of obtaining delayed AVC in conjunction with the circuit of (a).

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