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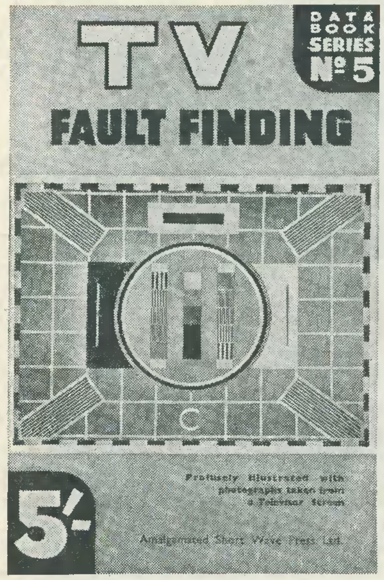

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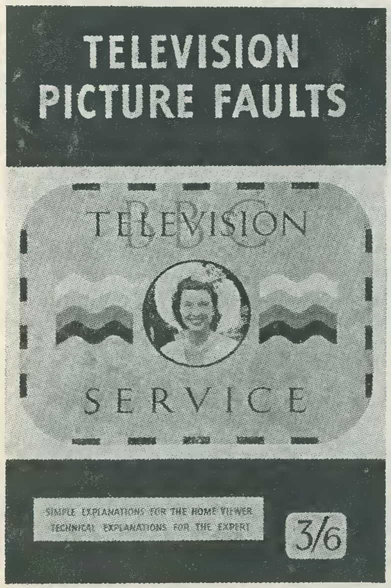

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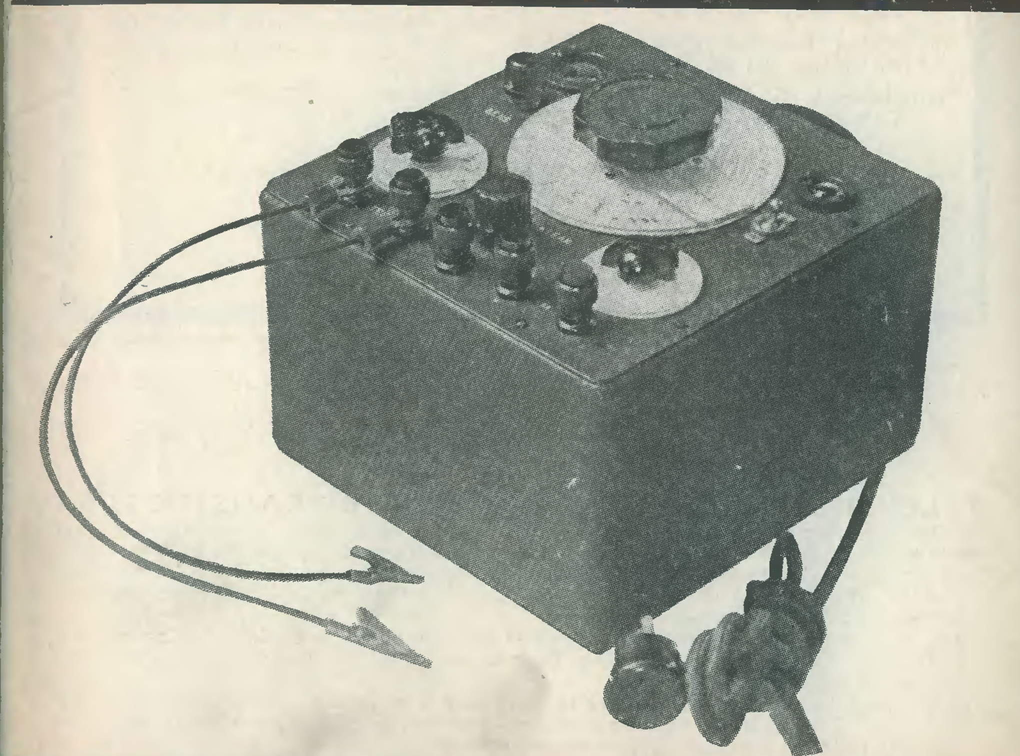
Volume 6
Number 11
JULY
1953

The RADIO CONSTRUCTOR

for the Radio and Television Enthusiast



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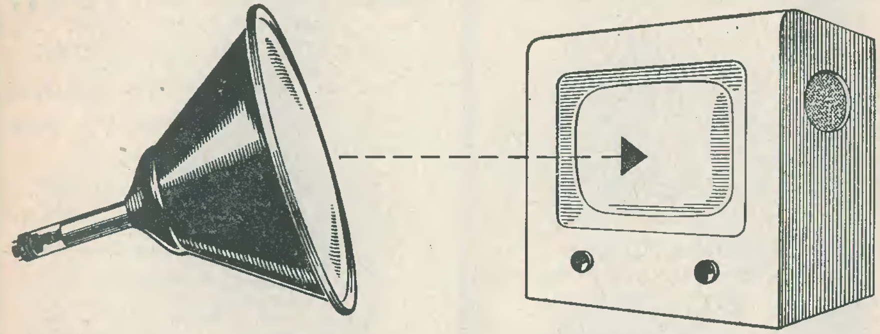

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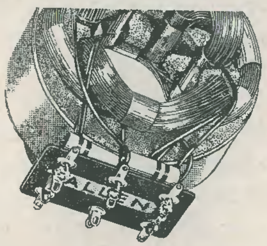

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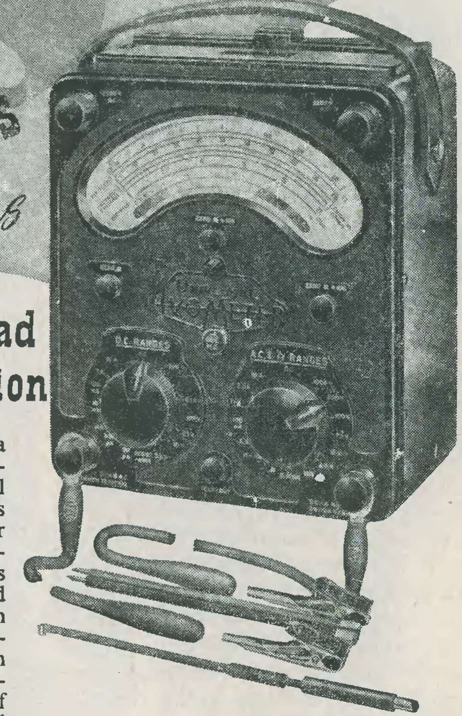

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The Radio Constructor

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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.

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

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A Companion Journal to THE RADIO AMATEUR

Suggested Circuits for the Experimenter

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

No. 31: A Hum-Free Pre-Amplifier for Low Level Inputs

One of the greatest difficulties encountered in the design of sensitive AF amplifiers consists of the elimination of hum. The points in the amplifier most likely to pick up hum lie in the grid circuit of the first valve and, to a much lesser extent, in its anode circuit and the grid circuit of the following valve.

If care has been taken in the design of the amplifier to obviate inductive and capacitive pick-up by means of careful screening and layout, hum may only be carried to the first stage or stages via the HT and heater wiring. Heavy smoothing can bring the hum on the HT line down to negligible proportions, but the heater wiring cannot be so easily treated. The use of top-grid valves, twisted heater leads, and centre-tapped heater windings (or humdingers), can reduce hum pick-up considerably; but, when the amplifier is intended for very low-level inputs, such measures are nòt always sufficient.

This month's circuit shows a pre-amplifier which may be used with most AF amplifiers and which should be capable of working on very small inputs with an extremely low hum level. It is shown here as a self-contained unit enclosed in its own screened case.

Circuit Description

Freedom from hum in the pre-amplifier is obtained by obviating AC heater leads altogether. A 1.4 volt valve is used, its filament supply being obtained from the HT line of the main amplifier. Smoothing for the filament supply is given by the voltage-dropping resistor R6 and by C4. R6, C4 also offer smoothing for the anode supply of the valve. In instances where the HT line of the main amplifier has a high ripple content, or if the pre-amplifier supply is taken from the rectifier cathode (see below), a large smoothing choke may be needed between R6 and the HT supply, an additional 16 µF capacitor being fitted between the junction of R6 and the choke, and chassis. The value of R6 should be sufficient to drop the amplifier HT voltage to 90 volts at a current of approximately 55 mA. It might be advisable to find the exact value for this resistor by experiment. R6 should be mounted on the main amplifier chassis.

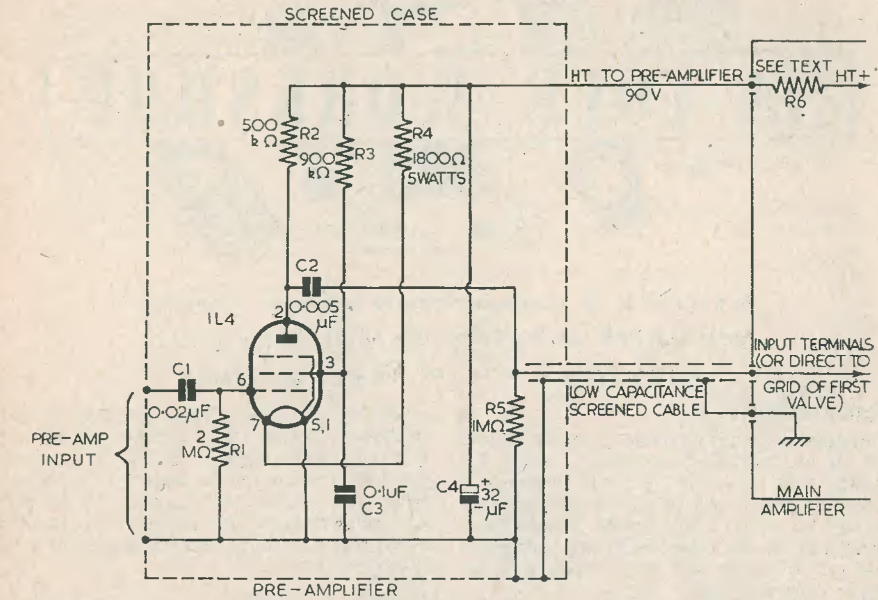
The output of the pre-amplifier is at high impedance and its output lead to the grid of the first valve in the main amplifier, or to its input terminals, should be kept fairly short. It will be noticed that the grid leak for the following valve is mounted in the screened case of the pre-amplifier. This is by no means essential, but it allows the output lead to be taken direct to a top-grid with complete screening all the way. When such a course is followed the pre-amplifier chassis connection should be taken, via the outside conductor of the output lead, from the chassis point on the main amplifier to which the cathode decoupling capacitor of the first valve is connected.

Such precautions are intended to reduce hum pick-up in the anode circuit of the pre-amplifier valve. In most cases it will be possible to connect the pre-amplifier output direct to the input terminals of the main amplifier in the normal manner. R5 will not then be needed. The input impedance of the main amplifier should be 1 MΩ; if it is lower, say 250 kΩ, the value of C2 should be increased to 0.01 µF.

The circuit constants shown are suitable for a valve type 1L4. Valves type 1S5 or 1U5 can be used instead, in which case R3 should be increased to 1.5 MΩ.

HT Supply

It will be found that some amplifiers may not be able to supply the extra 55 mA needed for the pre-amplifier without over-running the power supply circuits. Most amplifiers, however, which are designed to supply HT for a radio feeder unit should be capable of giving the extra current; although this point should be carefully checked. To prevent overloading the smoothing choke or chokes in the main amplifier, it might occasionally be worth while taking the pre-amplifier tap from the rectifier cathode, as was mentioned above.



RC 201

From our Mailbag

Valves and Their Power Supplies

Dear Sir, In the article "Valves and their Power Supplies," Part 7 (June issue) there is a mistake in Fig. 19 and the author's remarks concerning this circuit. He states, and the circuit shows, that the junction of MR1 and MR2 is fed via C5 from the cathode of the rectifier whereas the correct feed point should be from one anode (or end of HT secondary winding).

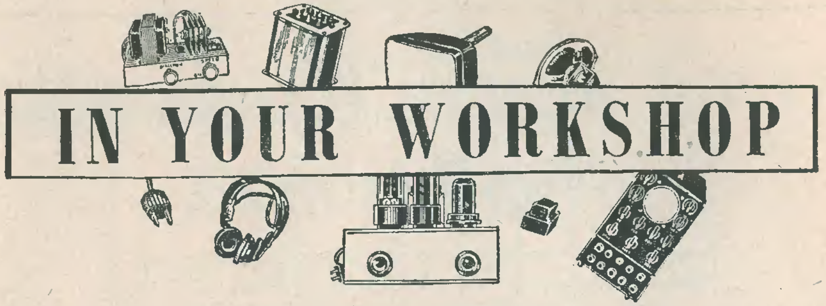
With the circuit as shown the ripple voltage component at the cathode of the rectifier is about 30V rms, from which it would be impossible for MR1 and MR2 to "double" to 500V.

In the form of doubler circuit shown, fed with 250V rms via C5, about 500V will be developed across MR2, the negative peaks being at earth potential and the positive peaks approximately $2\sqrt{2}\times250$V above earth. This "doubled" voltage is rectified by MR1 and reservoir capacitor C4 to provide the 500V DC output. It is therefore necessary that MR1 and MR2 should be rated for at least 500V, and not 250V as stated by the author.

It is specified that the smoothing capacitor C3 should be rated at 750V DC working at least; this, of course, also applies to the reservoir C4, which, incidentally, must also be rated to cater for a fairly high ripple voltage. Is it not unusual for electrolytics to be rated higher than 550V DC working?

In Fig. 20, again, MR1 and MR2 should be rated for at least 1,000V, and it should be noted that the feed point for C4 is shown correctly here. The use of a directly-heated rectifier for HT, producing something more than 500V, will require highly-rated capacitors for C2 and C3, for the 5U4 heater will reach operating temperature some time before the indirectly-heated valves in the set. During their warm-up period, about 800V can be developed at the rectifier cathode.

I view with some trepidation the author's suggested use of ordinary audio transformers to obtain 800–1,000V for the EHT circuits. This type of transformer is rarely, if ever, designed and/or constructed to withstand such high voltages. To use them in this way is potentially dangerous and simply courting disaster. In Fig. 21, for instance, at 1,000V rms on the secondary, something like 2,800V peak inverse voltage can appear between primary and secondary windings; it is unlikely that the insulation of an audio transformer would hold up for long under such severe conditions.—W. E. THOMPSON, A.M.I.P.R.E.



IN YOUR WORKSHOP

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

Versatile Amplifier

For anyone who is interested in experimental work or in occasional servicing, a spare AF amplifier that is always "on tap" can prove to be very useful indeed. Such an amplifier need not be a high fidelity piece of equipment nor need it be expensive, as it can usually be made out of odds and ends which may be lying in the spares box.

I have had such an amplifier in my own workshop for quite a few years, and although it is only used now and again, its availability when needed quickly has well repaid the time spent in putting it together. An advantage which I had not foreseen when I made the amplifier originally is given by the fact that any experimental rigs which would normally give results on headphones (bridges, etc., etc.) may be connected to it to give indications on the speaker. This saves a lot of fatigue and prevents those occurrences when an accidentally-moved headphone cord knocks equipment from the bench onto the floor.

In addition, by taking advantage of its circuit, I have made this amplifier perform the further functions of a signal tracer and a roughly accurate valve voltmeter.

The Amplifier

The circuit of the amplifier is shown in Fig. 1. As may be seen, it is a little more versatile than would be needed for normal purposes. It consists essentially of two valves, a 6J7 and a 6V6. No negative feed-back is used, and the amplifier is intended to be run from a normal AC mains power-pack.

This amplifier can hardly be claimed to be a "quality" job, of course, but the fidelity is quite good enough for the functions expected from it. A simple top-cut tone control is given by S2; this switch putting an extra capacitor across the speaker transformer primary when needed. This tone control is intended for use on the one or two occasions when the applied AF happens to be shrill, and helps to save wear and tear on the nerves when this state of affairs continues for a long period of time!

Inputs

Audio input connections to the amplifier are made by means of jacks. To allow for AF sources of varying strength, it is possible to plug the input either into the grid of V1 or V2. Both these grid circuits have volume controls, and these allow the amplifier to cope with input amplitudes varying over a wide range. Thus, if a source of AF is too weak to be amplified by V2 alone, it may be plugged into the grid circuit of V1. Conversely, a strong AF source which would necessitate the V1 volume control being turned almost completely down may be plugged into the grid circuit of V2, whereupon it can be handled comfortably. When both V1 and V2 are used for amplification, the V2 volume control should be kept at "full," control being effected by the V1 volume control only.

It will be noticed that there are several jacks in the grid circuits of both valves. Jacks 3 and 7 give direct connection to the grids (via the volume controls) and chassis, whilst jacks 1 and 5 give the same connections via 0.01μF isolating capacitors. Whilst jacks 3 and 7 will be employed in most cases, the isolated jacks may be utilised for test connections to chassis which are live or which may be intermittently live due to a fault.

Fig. 2 illustrates the input cord which is used with the amplifier. This cord should have an insulated covering over the outside

screening as it can then be laid anywhere on the bench or over a chassis without fear of accidental short-circuits.

Signal Tracer

Components which would not normally find their way into a simple amplifier are the RF-decoupling capacitors C4, C5, C8 and C9, and resistors R1 and R4. These are included to allow the amplifier to function as a signal tracer. When this facility is needed, a probe, using the circuit shown in Fig. 3 is plugged into jack 2 or 6. This probe consists simply of a series germanium rectifier (such as the Osram GEX 55) which detects any RF or IF to which it is connected, and passes the resultant AF to the selected input jack for amplification in the normal manner. (In my own version I have retained a small diode which I originally fitted, instead of the germanium rectifier. This, however, necessitates a further two leads on the probe cord for the diode heater, and it offers no compensatory advantages).

As the detected AF given by the probe is rich in RF, it is necessary to fit decoupling components in both the anode and grid circuits of V1. Without such decoupling, the amplifier would become unstable when tracing low radio frequencies.

It will be noticed that decoupling is applied only to V1. If, due to a large amplitude signal, it is necessary to plug the probe into jack 6, no decoupling is needed as the amplification given by V2 on its own is relatively small. There is, also, a small effective capacitance to earth offered by C9/C12 in the grid circuit, and a large effective capacitance by C14 in the anode circuit.

The gain offered by the amplifier is sufficient, in most localities, to give audible results when the probe is connected to the first grid of a receiver using a good aerial.

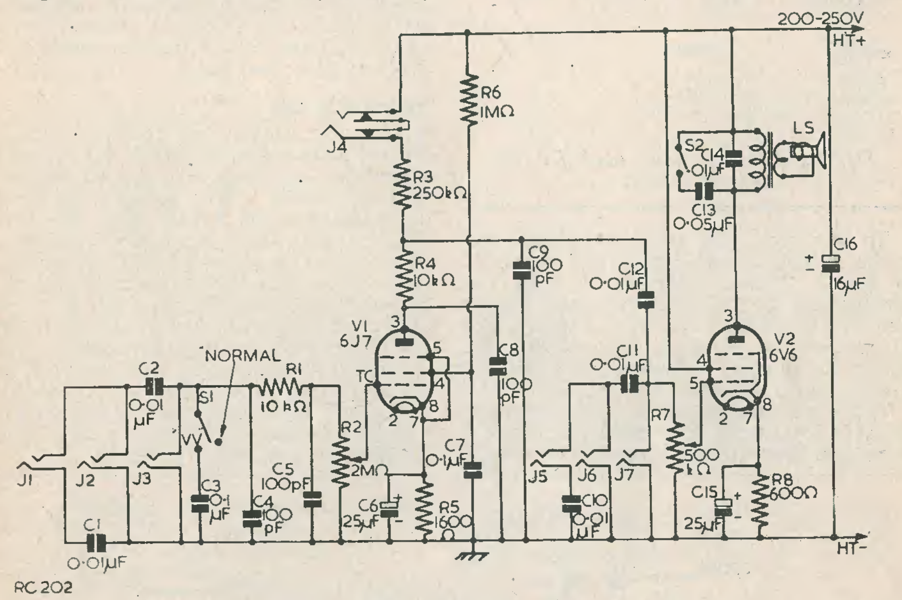


Fig. 1. A Versatile Amplifier

Valve Voltmeter

As little expense would be incurred by fitting a further jack to the amplifier it was decided to have one connected in the anode circuit of V1. (This particular jack is so wired that its contacts short-circuit when the plug is removed). With the assistance of the signal tracer probe, this jack allows V1 to act as the DC amplifier of a roughly accurate valve voltmeter. There would be little point in expecting very accurate results from such an arrangement, but it has proved to be surprisingly useful for quick servicing and similar work.

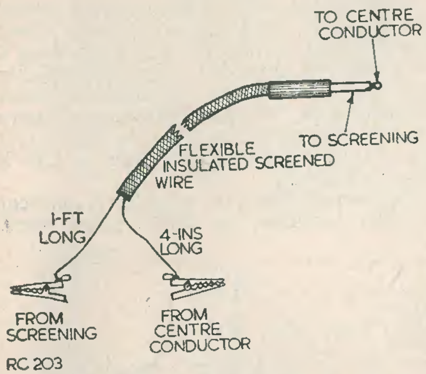


Fig. 2. The test cord used for AF input checks.

To use the valve voltmeter circuit, the probe is plugged into jack 3 and switch S1 is set to "Valve Voltmeter." With this arrangement the DC from the probe rectifier builds up across C3 and biases V1 accordingly. To measure the corresponding changes in the anode current of V1 a testmeter, switched to a current range, is plugged into jack 4.

The input impedance of the arrangement is fairly low, being less, resistively, than 2 megohms. For normal purposes the volume control R2 should be at "full," but the voltage range of the valve voltmeter may be expanded by setting it one tenth of the way up its track. This setting may be obtained experimentally and re-found by providing R2 with a pointer and scale. Alternatively, the volume control could be used as a form of slide-back indicator.

A rough calibration curve of anode current against input voltage could be plotted, but, as was just mentioned, the circuit is not capable of great accuracy. It is, however, extremely useful for checking oscillators (by connecting the probe to the feedback, and not to the tuned coil) and for comparative readings of AVC voltages, and so on.

Sweating It Out

After my remarks last month concerning leakage paths across insulators, etc., I shortly afterwards very nearly started a similar chain of events myself. This occurred when a bead of sweat from the J.R.D. brow fell neatly between pins 3 and 4 of a 6F6 valveholder on an up-turned chassis on which I was working. As the chassis was reproducing music, the bead of perspiration started sizzling merrily on the louder passages, and I had to turn everything off quickly before a breakdown set in. The offending perspiration was soon removed, but it could easily have ruined the valveholder if I hadn't been lucky enough to notice it. I suppose the moral of all this is never to get hot and bothered whilst servicing!

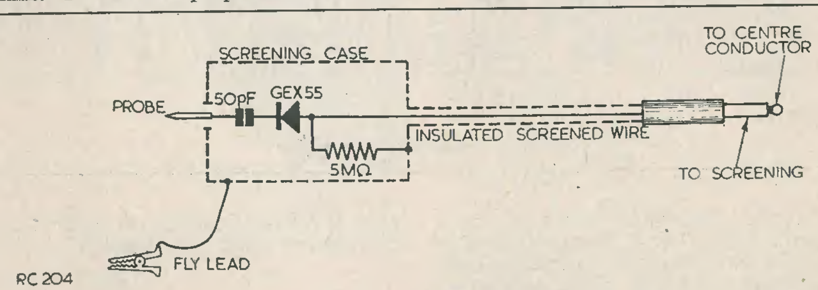


Fig. 3. Signal Tracer Probe

BRIMAR VALVES FOR TV

The Brimar Germanium Diodes **GD3** and **GD4** are particularly suited for use in domestic TV Receivers and recent improvements in materials and manufacturing technique have resulted in increased reliability under adverse conditions of humidity and shock.

The Television RF Pentode **6BW7** which combines high slope, low anode-grid capacity and high input impedance, has been developed to present a marked advance on other valves in this class. It is eminently suitable for operation in the RF amplifier, mixer, IF amplifier and video output amplifier of a modern TV Receiver.

In order to meet the demands of ever increasing EHT, the Brimar **R19** EHT Rectifier has been introduced to cover cathode ray tube developments for many years to come. Its features include PIV of 25 kV max. peak current of 10 mA and average anode current of 2 mA. Mounted on a noval B9A base, it may be used as a replacement of the 1X2A, although of course the max. ratings of the R19 represent a considerable advance on the 1X2A. Special precautions have been taken in the construction of this valve to reduce X-ray radiations which may occur.

Valves and their Power Supplies

PART 8

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

Half-Wave EHT Systems

Probably the most popular way of obtaining EHT for an electrostatic tube of the VCR97 type is by a mains transformer and half-wave rectifier circuit.

These transformers cost around 45*s* and are readily obtainable. Usually, the primary is rated at 0–250 volts, tapped at 200V and 230V. The main secondary winding has a turns ratio to the primary of about 10:1, and gives 2,500 volts across its extremities.

In addition, there is usually a rectifier heater winding rated at 4.0 volts, that is centre-tapped (2–0–2 volts) to enable a 2.0 volt rectifier to be used: there is also a 4.0 volt, 2.0A winding that may be used for the CR tube heater.

All in all, this transformer is a very useful component, and probably thousands of them are in use.

The connections, to obtain negative EHT are shown in Fig. 25. This type of circuit is simple, efficient, and has had ample proof in practice.

To obtain positive EHT the connections are as in Fig. 26. With this circuit, the tube heater and cathode are at chassis potential, the tube deflector plates and anodes being connected to the EHT line.

Peak Inverse Voltage

Consider the circuit of Fig. 26. When the valve anode receives a negative charge, during the mains negative half cycle, no current will flow through the valve. The electrons on the valve filament, however, will charge C2.

During the following mains positive half cycle, however, the valve anode will receive a positive charge from the 2.5kV secondary winding.

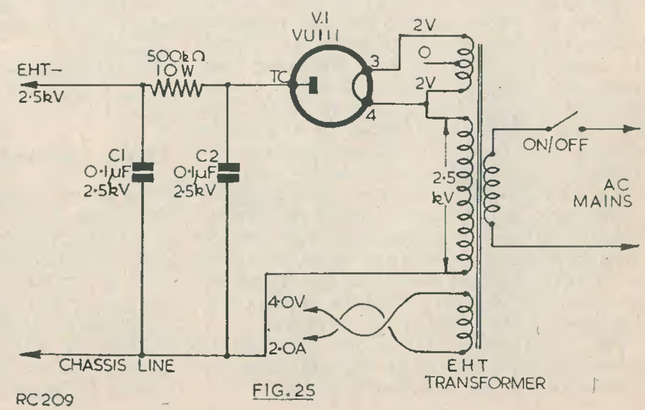


FIG. 25

Now at this point, the anode end of the 2.5kV secondary has a potential of +2.5kV whilst the valve heater winding has a potential of –2.5kV due to the charge on capacitor C2.

There is thus a sudden strain of 5kV thrust upon the transformer, between the heater winding (rectifier) and main secondary; this strain, moreover, will occur fifty times per second, during every positive half cycle.

This abnormally high potential is known as the *inverse voltage*, the "peak" being approximately equal to double the transformer EHT rating.

To have this inverse voltage appear in the transformer is a state of affairs to be avoided, if at all possible. A transformer designed to withstand corona discharge at the normal working voltage of 2.5kV may not stand up to a rapidly intermittent strain of double that figure.

Moreover, with the circuit of Fig. 26 the coupling capacitors between the timebase paraphase valves and the tube deflector plates must have a working voltage of 2.5kV. As usually, four capacitors are involved, this can be a bulky, inconvenient and expensive method.

With the circuit of Fig. 25, however, the transformer inverse voltage strain, and the

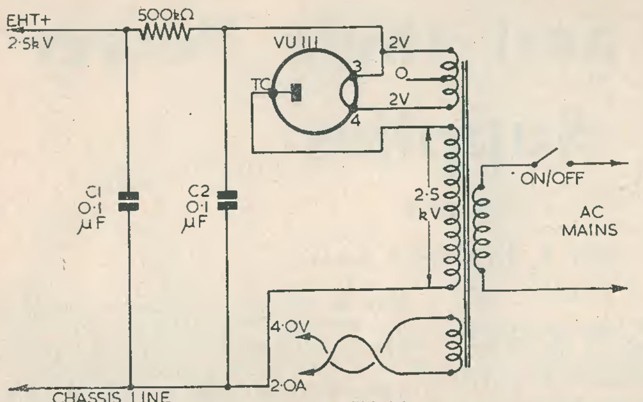


FIG.26

RC210

high voltage tube coupling capacitors are avoided.

The rectifier heater winding and main EHT winding are coupled together, and never more than 2.5kV will appear across these windings.

The timebase coupling capacitors from the paraphase valve anodes to the tube deflector plates need be rated at only 500V working, as the deflector plates will now be connected to the HT+ line.

The coupling capacitors from the phase splitting valve cathode to the CR tube grid, however, must be rated at 2.5kV working voltage, as the tube grid will be at, or near, EHT negative potential, whilst the valve cathode is virtually at chassis potential.

The Valve

Whilst, with Fig. 25, the transformer is spared the inverse EHT voltage, this is not so of the valve.

When the valve filament becomes negative, current will flow across the valve and charge C_2 negatively. During the following half cycle, the filament becomes positive to the potential of 2.5kV, no current flows through the valve, but—a total voltage of 5kV exists between the valve anode and filament by virtue of the –2.5kV charge on C_2 and the anode, and the +2.5kV charge on the filament.

The valve, now, must therefore be capable of withstanding this surge, and, when choice of an EHT rectifying valve is made, it is wise to ascertain that the valve maker's figure for the peak inverse voltage that his product will withstand is not likely to be exceeded.

The peak inverse voltage will also appear across the valve electrodes (as well as in the transformer) in the circuit of Fig. 26.

Voltage Doubling

It is perhaps opportune, here, to refer back to part seven of this series, and to Fig. 21, as it is in voltage doubling that the peak inverse voltage serves the useful function of providing the rectified double voltage.

Consider V1 of Fig. 25 as synonymous with V1 of Fig. 21.

During the negative half cycle (Fig. 21) V1 anode will be positive with respect to its filament, current will flow through the valve and C_2 will become negatively charged via the 250 kΩ resistor.

During the following positive half cycle, however, the potential between the anode and filament of V1 will be 5kV— –2.5kV on the anode due to the charge on C_2 and +2.5kV on the filament due to the transformer secondary.

This positive voltage, however, is simultaneously applied to the anode of V2 and, consequently, current flows through V2.

The filament of V2, however, is connected, also via a 250 kΩ resistor, to the *opposite* set of plates of C_2 (actually to C_1, but this is virtually the same thing).

Consequently, the final EHT rectified voltage will consist of the negative charge of –2.5kV on the chassis side of C_2, previously mentioned, *plus* the +2.5kV charge on V1 filament, now transferred to, and rectified by, V2, and appearing as a +2.5kV charge on the EHT (V2 filament) side of C_1.

With EHT– connected to chassis, the net effect is a +5kV potential between C_1 and chassis.

This principle holds throughout the other voltage doubling circuits shown in part seven.

Corona Discharge

"Corona" means simply "crown," "top" or "peak," and corona discharge is arcing of an alternating voltage (or ripple DC) from a high potential point to a low potential one.

It is termed "corona" because the discharge or arcing occurs when the high potential nears, or is at, its peak or corona value.

With the EHT voltages used in television, there is seldom sufficient current in the EHT circuit to cause burning or other damage to

components should such arcing occur. Therefore, transformers, or other components the insulation of which is insufficient to withstand the corona voltage applied, will usually suffer very little or no damage should the insulation fail, and the discharge take place. The fault, in a transformer, is characterised by a rapid and machine-gun like noise as the voltage flashes rapidly across the relevant windings, or from one winding to the electro-static screen, or core.

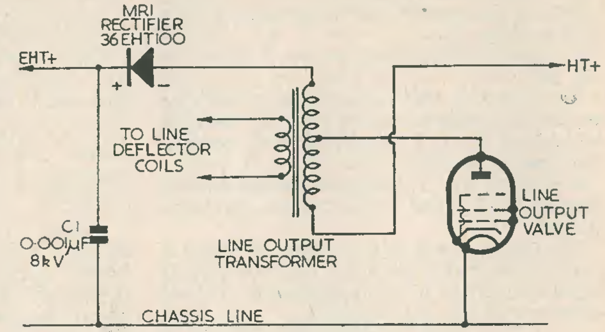


FIG.27
HALF-WAVE LINE FLYBACK EHT

RC 211

Line Flyback EHT

Perhaps the simplest and least expensive method of obtaining EHT for a picture tube (magnetic deflection) is by means of a special line output transformer and EHT metal or valve rectifier, in a half-wave circuit.

The arrangement is shown in Fig. 27. The transformer primary has an extension of its turns to form a high voltage secondary, auto-transformer connected.

The short duration (a few microseconds) flyback pulse voltage between the valve anode and HT+, across the normal primary winding, is thus duplicated across the extension winding, but is in opposite phase.

The two voltages thus add together to produce some 6kV to 8kV, which, rectified by MR1 and smoothed by C_1, forms the final positive EHT voltage. (With 16″ tubes, the EHT voltage employed is in the region of 14 kV—Ed.)

RF Oscillator EHT

From the home constructor's viewpoint, there is one big difficulty in the construction of an RF oscillator unit—that of supplying the rectifying valve with its correct heater voltage. At least, that is the bugbear with a home-wound coil.

Commercial coils may be bought, however (Messrs. Hazlehurst Designs offer a good range) and they are usually supplied with a suitable circuit diagram and instructions anent voltage adjustment, as a guidance to the constructor: from these, quite a useful unit may be built.

Alternatively, of course, a complete RF oscillator unit may be purchased, for a 9″ or 12″ tube, for about £6.

Another method is to buy, or wind, a heater transformer upon a standard output transformer core, and to insulate the heater winding to withstand 10kV. The oscillator coil, without the heater winding, may then be home-wound.

Yet a further idea is to use a metal rectifier

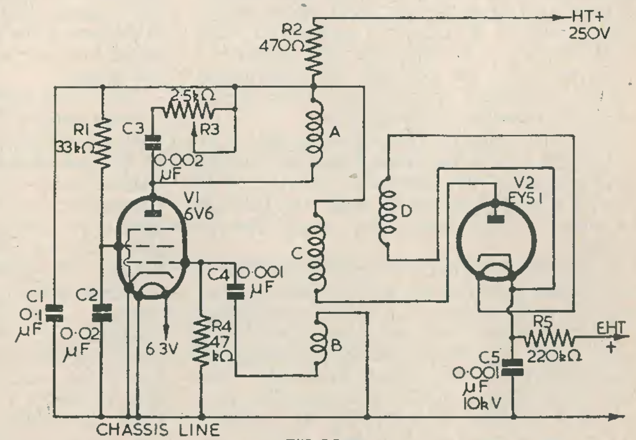


FIG.28
RF OSCILLATOR EHT

RC212

—the 36EHT180 is suitable—but, the cost is fairly high, from £4 10*s* 0*d* upwards, for the rectifier alone.

A typical RF oscillator circuit is shown in Fig. 28.

V1, a 6V6, is the oscillator valve, and the oscillations are generated by virtue of windings A and B of the coil being sufficiently close to give positive feedback.

B is tuned by C_4, whilst resonance may be effected by R_3 and C_3 in series, R_3 being variable.

The ratio of turns in C to those of A and **B** gives a voltage step-up, and a high RF voltage appears across C, which is rectified by V2 and smoothed by R_5 and C_5.

Valve Handbooks

Finally, some notes on valve handbooks.

The World Radio Valve Handbook (A.S.W.P. Ltd., 11/9) gives data about the world's most commonly used receiving valves.

The Wireless World Valve Data Handbook covers 2,000 receiving valves, some small transmitting valves, cathode ray tubes, etc., (Iliffe 3/6).

Messrs. Mullard, Marconi-Osram, S.T.C. Brimar, Ediswan, Mazda, all publish handbooks, varying in price from 1/6 to 5/–, describing their ranges, whilst Tungsram issue a free booklet that is quite useful.

A CONDENSER TESTER

by A. Curtis

The Condenser Tester to be described was built a short time ago. I was doing a certain amount of radio building and servicing when the need for such an instrument became apparent—the parts I was using were mostly pre-war and war surplus, and after nearly putting paid to a couple of receivers I built the following test unit. As my pocket is fairly shallow, the cost of the instrument was an important factor; this tester turned out to be a really inexpensive job.

The transformer in the unit is a little 6.3V 0.3A night light transformer, and the laminations consist of two three-foot lengths of ½″ iron strip, wound round the sides and through the core. A bell transformer would also be suitable.

A 6H6M functions as a rectifier. This valve is not intended to rectify mains current, and to avoid the use of a mains transformer a 1500Ω one-watt resistor is included in its anode lead. A 2.0 μF electrolytic condenser is connnected to the valve's cathodes. The valve is a double diode and functions as a half-wave rectifier by strapping its cathodes and anodes respectively together. A 6J5 could also be used, or a 6X5.

The neon used was a small tubular one such as is used in those pocket testoscopes made by Runbaken of Manchester. It has thin wire electrodes and the glow is between the two; this did not give a good indication on small condensers, so a 500pF mica condenser was fitted across the neon. This spreads the glow down one side of the tube and gives a better indication.

This neon should not be operated without a series resistor of 2 MΩ. If one is not available, a 3 MΩ may be used. The panel is made of ¼″ paxolin and measures 3¾″×4¾″. The chassis came from the bottom of a master contactor unit; it measures 3¾″×3½″×1″ deep. This brass chassis had to have a 1⅛″ diameter hole cut for the international octal valveholder. This valve, transformer, and condenser mounted horizontally, are on the top of the chassis. The leads pass through rubber grommets to their respective connections. Three terminals connect the condenser under test to the unit. For paper and mica condensers, terminals 1 and 3 are used. For electrolytics, terminals 1 and 2 are used to charge, and 2 and 3 give the indication on the neon —which should light on electrolytics.

Good paper or mica condensers will give no indication on the neon save for an occasional flash; if there is a permanent glow the condenser is a bad one and should be discarded. 3 leads should be attached to the unit and should be fitted with crocodile clips. No condenser can be measured for capacitance on this unit; adapting the circuit for this was considered unnecessary.

This unit will also supply high tension power to operate a small one or two valve receiver; it gives 150V at 8mA max. with the 6H6M. The power is drawn off terminals 1 and 2, and an extra condenser and a smoothing choke will need to be connected in the lead from terminal 1 as shown in diagram 2. The value of the condenser should be found by experiment, starting with a 2.0μF electrolytic.

Note that the usual AC/DC circuit precautions should be taken.

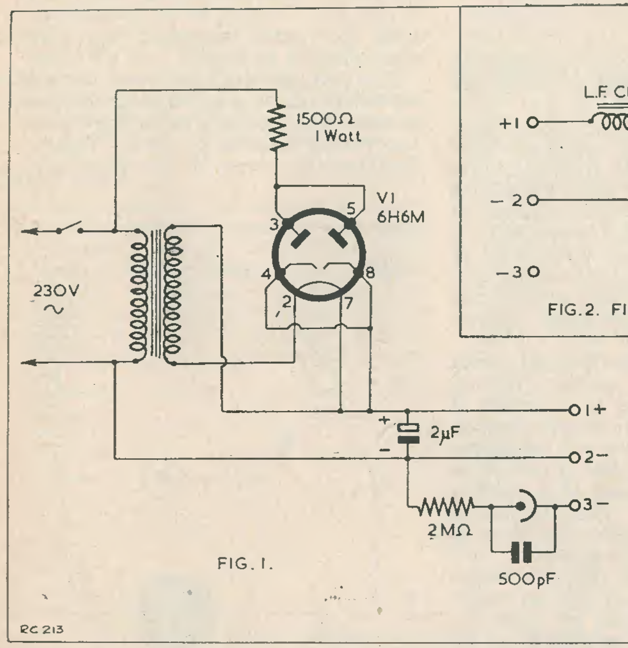


FIG. 1.

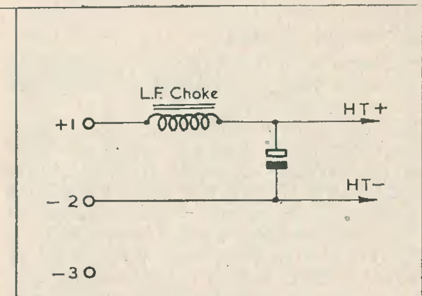
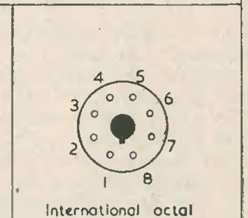


FIG. 2. FILTER CIRCUIT



VALVE BASE

Radio Control Equipment

PART 5

By Raymond F. Stock

Other Selector Systems

The basis of other selector systems, too numerous to describe in detail, is exemplified by the circuit in Fig. 23.

This uses a very simple single-pole, three-way selector, and a motor is supplied (rather as in the previous example) from a centre-tapped battery. In this case only 3 positions are available—motor off, motor rotating in one direction, and motor rotating in reverse.

The motor is supplied with a gear train as already described, and in fact the motor unit would be exactly as in Fig. 22 except for the omission of the brushes and contact segment disc.

By sending the appropriate signal the motor can therefore be started up in either direction or stopped completely, and as it rotates it causes the rudder to move in one direction or the other. The *amount* by which the rudder moves is determined by the *time* for which the selector is permitted to remain on a position before being stepped to 'off.' This introduction of a time factor distinguishes this class of movement from the previous schemes.

It will be realized that the operator has no *exact* knowledge of, or control over the rudder angle since the latter cannot be seen, but quite accurate control can be maintained by observing the model's course and applying the necessary connections, and with experience it becomes possible to assess accurately the time for which starboard- or port-going signals should be held.

It is obviously desirable to provide a definite maximum rudder position either way, and this is done by the inclusion of limit switches in the two battery leads at A and B. These can be fitted to the frame of the motor and gear train and operated by a striker on the operating lever as suggested by Fig. 24.

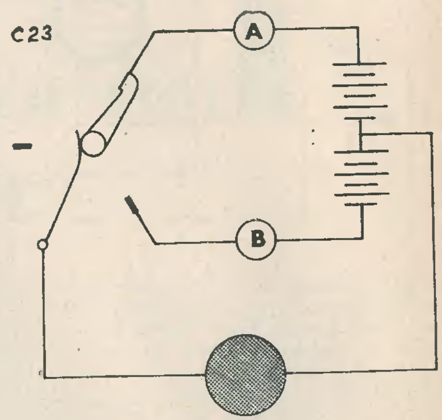


Fig. 23. 3-way Selector involving a "time" factor.

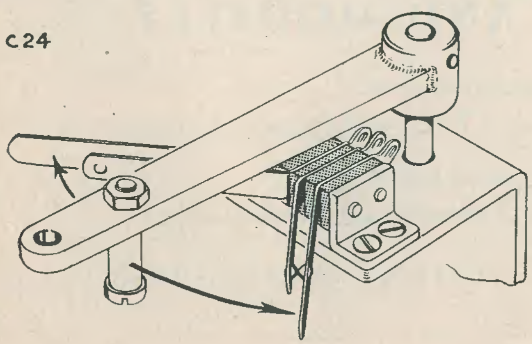


Fig. 24 Limit Switches

Some operators prefer to have, in addition, a third definite position of amidships so that if their judgment fails they have at least 3 certain angles available, viz. hard-a-port, amidships and hard-a-starboard. This is done by combining the features of the two previous systems, and the circuit is shown in Fig. 25.

Four positions are required on the selector, **A, B, C** and **D** representing Port-going, Starboard-going, Amidships and 'Off' (holding whatever angle has been set). **A, B** and **D** are straightforward, and in **C** the selector is wired to a single brush which bears on a contact disc as shown in Fig. 22. The motor in this position thus 'homes' the lever to amidships, whatever its previous position.

Engine Control

No mention has so far been made of this aspect. Any type of escapement and any straightforward selector system (such as Fig. 21) can have a position where a cam or wiper arm on the stepping shaft can break an extra circuit, and thus give some control over the motor. In the case of electric propulsion the main supply circuit can be directly broken; steam and, to a lesser extent, internal combustion engines can be controlled by additional mechanism.

If electric propulsion is used, however, it is probable that its flexibility of control will be utilised, wherever possible, and one might decide to incorporate switching to give, say, Full Ahead, Slow Ahead, Stop and Astern.

The obvious way to do this with a straightforward selector is to combine these positions with the necessary steering positions. Even supposing that only 5 steering positions are used, however, (Port 20°, Port 10°, Amidships, Starboard 10° and Starboard 20°), the total combination is $5 \times 4 = 20$ steps, and the tim delay is probably unacceptable.*

The solution is to give 'priority' to the steering, which must be as near instantaneous in response as possible (designing it without reference to the motor) and then to add *one* additional motor control position. On this step the wiper arm energises a contact wired to a *second, motor control* selector which can then have the necessary circuits connected to it for controlling the motor.

It is important that the steering selector should not operate the motor selector every time it passes the motor control position.

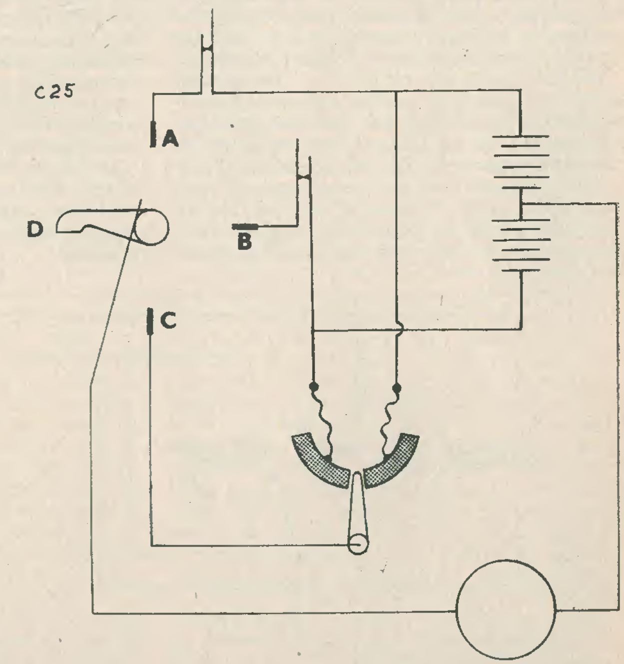


Fig. 25 4-way Selector

* This assumes that all 5 steering positions are required in each of the 4 engine conditions

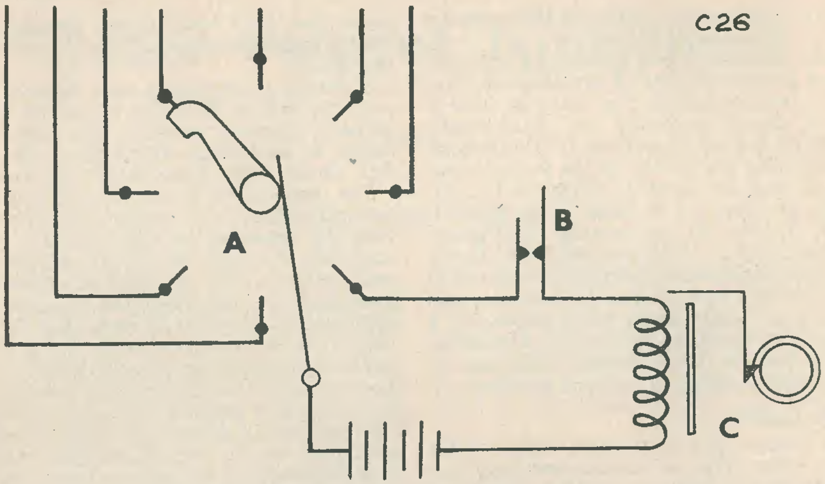


Fig. 26. Use of a delay device.

or we are no better off than with the combination of 20; but this is simply arranged by the use of a delay device which ensures that the motor control selector is not energised until the first selector has rested on its appropriate contact for a small period. In practice, the first selector will normally pass over any position in perhaps a tenth of a second, so the delay need be no greater than ¼ second.

Fig 26 shows a suitable circuit. The steering selector **A** is wired to the various steering positions (not shown) but the last position is connected via the delayed contacts **B** to the operating magnet of the motor selector **C**.

Each time we select the motor position and remain on it for a short period selector **C** steps once; and its 4 positions can give the sequence of Ahead and Astern, etc., previously referred to.

The motor selector can be identical to the steering selector if only 'Stop' and various speeds (introduced by series resistors) are required; but if reversal of direction is intended, then a 2-pole selector with twin wiper arms and twin banks of contacts must be provided for the operation of a permanent magnet propulsion motor, and this is shown in Fig. 27. When a shunt field motor is incorporated the switching must be carried out only in the armature or field circuit; in this case to conserve current in the 'Stop' position the unswitched circuit (field or armature) must be interrupted. It is hardly worth using another complete bank of contacts to achieve this one position, and a small cam of paxolin can be fitted on the stepping shaft to open a pair of contacts when required.

(To be continued)

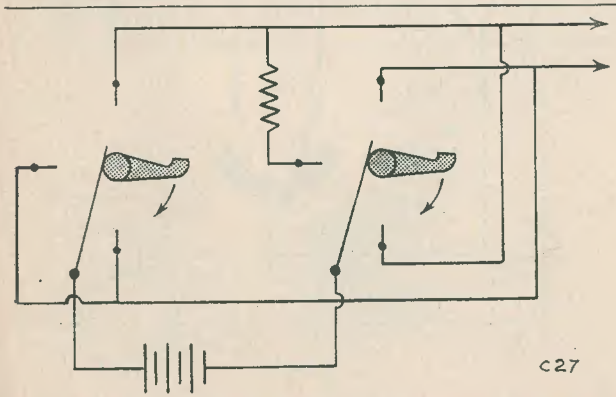
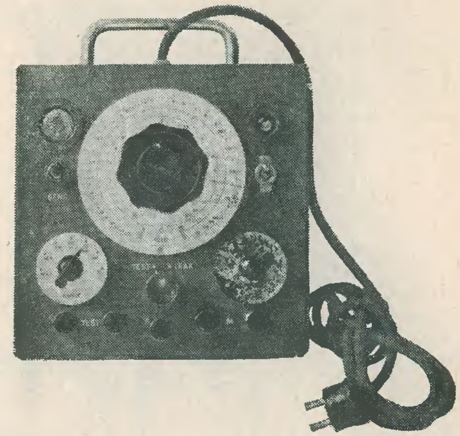


Fig. 27. Connections of 2-Pole Motor Selector shown at "Off." Successive positions are Full Ahead, Slow Ahead, and Astern.

Versatile Resistance Capacitance Bridge



By D. R. Bate

The resistance and capacity bridge described here is a very useful and versatile piece of test equipment to have in one's possession. With careful construction it can give surprisingly accurate readings of capacity from 10 pF to 10 μF, and resistance measurement from 10 Ω to 10 MΩ, and rough checks over ranges 100 times greater than those mentioned above.

The Circuit

Fig. 1 shows the theoretical circuit diagram of the instrument. It will be seen that the bridge circuit proper is essentially a Wheatstone bridge network, two arms consisting of the "unknown" component and the internal "standard," the circuit being completed by the two arms R1-R2 of the main calibrated potentiometer as shown in Fig. 2. If R1=R2, which means that the slider is at the centre point of the potentiometer, when X, the unknown equals S, the "standard," then the AC voltage between the points A and B will be zero. A "magic eye" tuning indicator is used instead of a meter as the null indicating device. This particular part of the circuit is unusual in that an amplifier is incorporated to feed the tuning eye; the reason for this is that the AC voltage supplying the bridge circuit is only 5V, from one of the mains transformer heater windings. Many bridge circuits have up to 30V or 50V appearing across the test leads from a special winding in order to provide sufficient signal to deflect the tuning eye.

Three internal "standard" resistors are used, and three "standard" condensers giving a total of six ranges in all. Range 7 brings the "Match" terminals into use so that two resistors or condensers may be matched against each other, a useful feature when selecting anode loads for push-pull amplifiers, etc. If both the "Test" and "Match" terminals are simultaneously shorted out when on range 7, the 10 Ω 2-watt resistor limits the current that can flow in the external circuit to 0.5 amps. Without it, the 5V winding would be short-circuited.

The 2,500 Ω potentiometer in series with the 1 μF condenser on range 6 is the calibrated power factor control, which gives readings from 0 per cent to 60 per cent. It is effective on range 6 only. When the "leakage-test" switch is in the "leakage" position, the HT is removed from the tuning eye and applied to the small Neon Lamp, and the switching so arranged to place the condenser being tested in series with the neon across the HT supply. With a good component the neon will flash once or twice and then go out. If the condenser is leaking the neon will continue to flash at a rate dependent on the severity of the leakage and the capacity of the component being tested. A very bad leak will show up as a continuous glow of the lamp. The test should not be applied too literally to electrolytic condensers, which must be connected the right way round.

The HT supply circuit is a normal full-wave system, but using an OZ4 as the Rectifier due to the fact that the normal 5V Rectifier Heater winding is used to supply the Bridge circuit. A 6X5/GT Valve could be used with equal success using the normal 6V winding to provide the Heater voltage; the valve is designed to allow the full HT Voltage to appear between Heater and Cathode without ill effects.

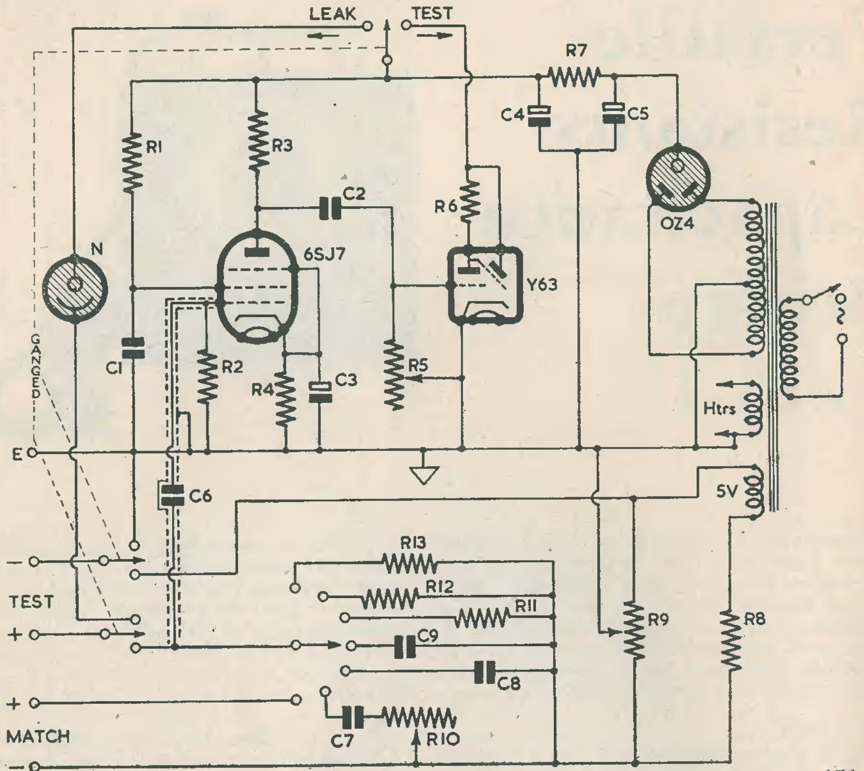


Fig. 1. Theoretical Circuit RC174

LIST OF COMPONENTS

Mains Transformer. 250-0-250V at 60 mA, 6.3V at 2A, 5V at 2A.

Valves. OZ4, 6SJ7, Y63.

Resistors

R1 —1 MΩ ½W
R2 —2MΩ ½W
R3 —680 kΩ ½W
R4 —15 kΩ ½W
R5 —1 MΩ Pot. L/Switch
R6 —2 MΩ ½W
R7 —10 kΩ 1W
R8 —10 Ω 2W
R9 —5 kΩ w/w Linear Pot. Large Diam.
R10—2.5 kΩ Pot. L/Switch
R11—1 MΩ ½W ±1%
R12—10 kΩ ½W ±1%
R13—100 Ω ½W ±1%

Condensers

C1 —0.5 μF 350V
C2 —0.1 μF 350V
C3 —50 μF 25V Elect.
C4 —8 μF 350V Elect.
C5 —8 μF 0V Elect.
C6 —0.0535 μF 350V
C7 —1 μF ±1% (See Text)
C8 —0.01 μF ±1%
C9 —100 pF ±1%

3 Octal Valveholders
3-Pole, 2-Way Rotary Switch
S.B.C. Neon Holder. Bakelite
1-Pole, 7-Way Rotary Switch
On-Off Toggle Switch
3 Black Terminals
2 Red Terminals
2 Spade Terminals
2 Crocodile Clips
S.B.C. Neon Lamp. Small Type
3 Pointer Knobs
1 Small Knob
I Large Knob with Cursor
Aluminium for case and chassis
4 Rubber Feet
1—4″ Carrying Handle
Mains Flex and Plug
Screws, Wire, Ivorine, Perspex, etc.

Construction

The case was constructed from 16-gauge aluminium and measures 8″×8″×5″ deep. A ½″ lip was left all round, top and bottom, to mount the top panel and bottom cover respectively. Fig. 3(a) shows the general procedure adopted in constructing the chassis and panel assembly. The chassis itself measures 7″×7″ to allow it to enter the case from the top. Four supporting pillars were made from ¼″ diameter dural rod tapped 4-BA at each end and bolted to the chassis and panel; their length is 3½″, so permitting the tuning eye to protrude through the 1⅛″ hole in the panel by about ⅛″. Brass or any other material may be used with equal success. The tuning eye valveholder must be carefully positioned on the chassis so that it lines up accurately with the hole in the top panel; ensure that the metal support inside the top of the tuning eye lies horizontally, and that the small deflecting vane under the metal disc is towards the top edge of the panel; in this position the eye is most easily read. Four rubber feet were fitted to the bottom cover. The cursor for the main control knob was made from a piece of ⅛″ perspex and a fine line was scratched on the underside by means of a sharp scriber. Two ebinite rings were made, one to fit over the top of the tuning eye, the other to go over the neon lamp. The chassis and panel assembly is held into its case by means of eight Parker Kalon self-tapping screws fitting into the lip around the top edge.

The layout of the components is not critical, but little, if any, improvement in operation will be gained by radical changes in design. Fig. 3(b) shows the position of the major components on the main chassis, while the control panel layout is shown in Fig. 4. The lead running up to the sensitivity control from the tuning eye was screened from stray fields as a precautionary measure; no trouble was experienced with instability or stray pick-up in the original design. All the internal standards with the exception of the 1 μF condenser are ±1 per cent, and can be obtained at a reasonable figure. They should be wired in as directly as possible in order to keep the capacity of the wiring down to a minimum; the original model had a self-capacity of about 3 pF., and internal resistance error of less than 0.4 Ω.

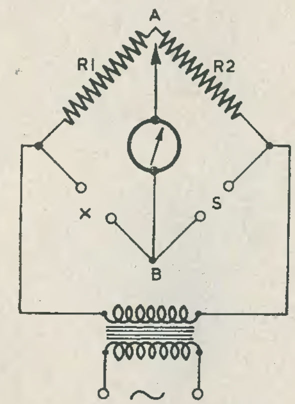


FIG. 2. WHEATSTONE BRIDGE RC175

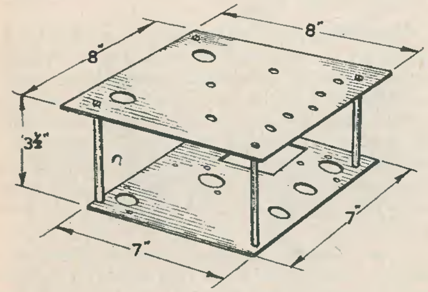


FIG. 3(a) Chassis & panel assembly

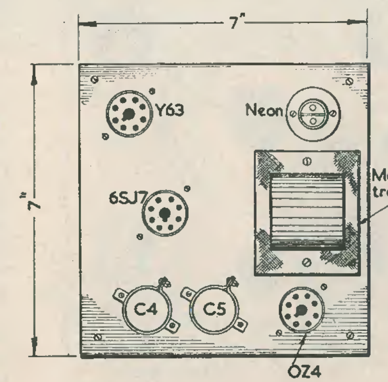
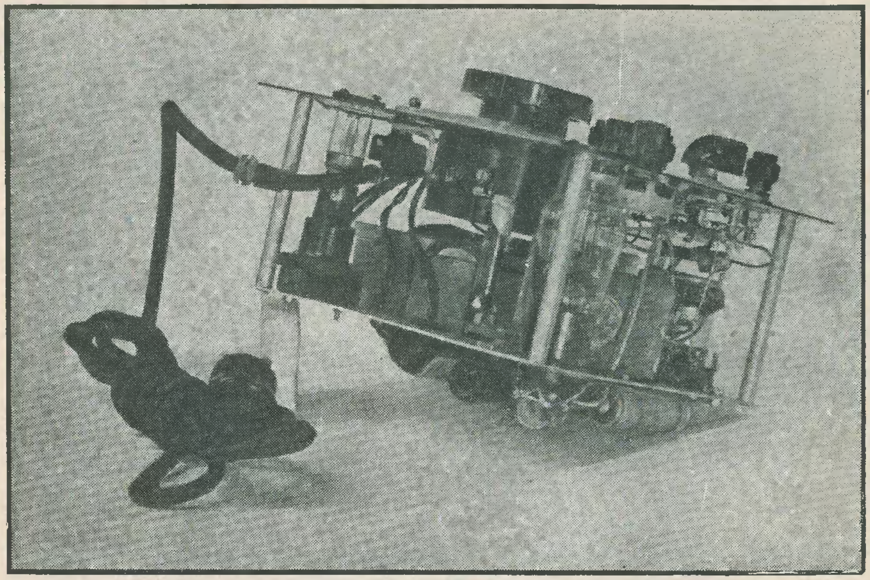


FIG. 3(b) Plan of chassis

RC176



Showing "clock-wise" arrangement of panel and chassis.

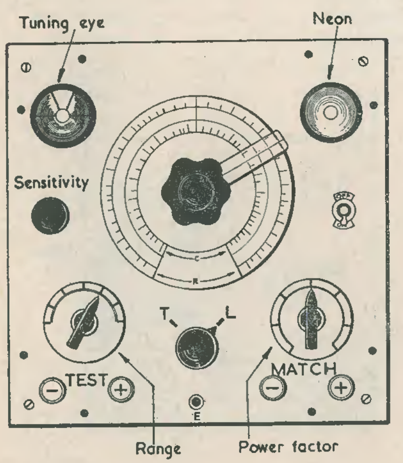
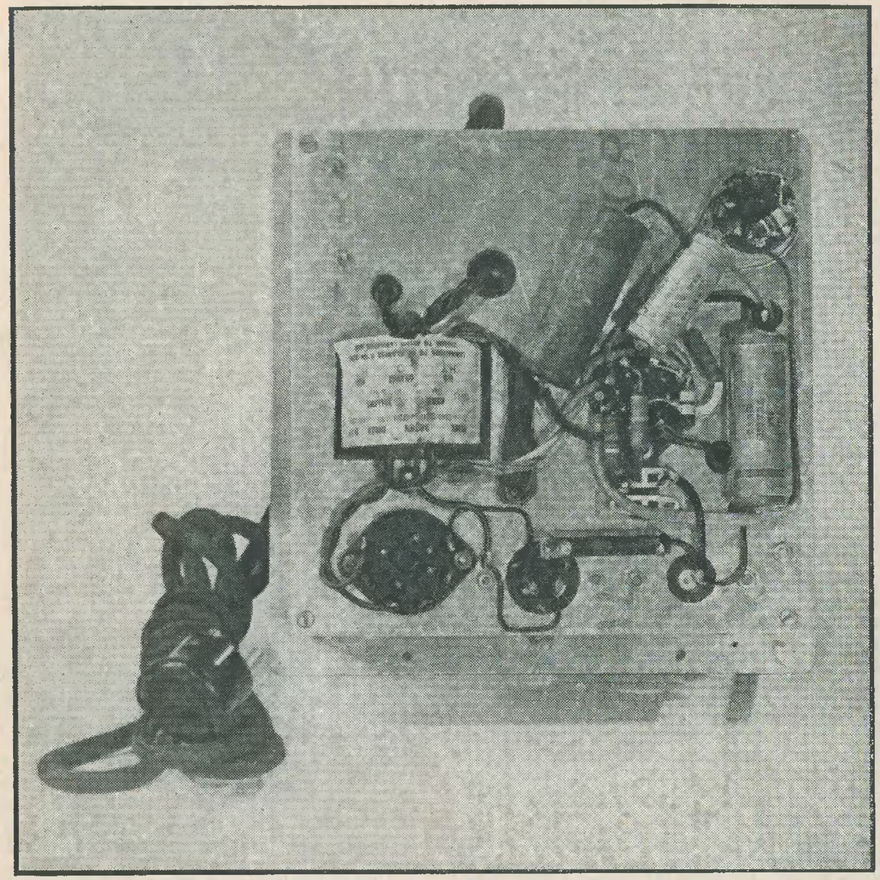


FIG. 4. LAYOUT OF CONTROLS ON TOP PANEL

In selecting the 1 μF condenser, it is a great help if one can beg or borrow an accurate bridge and test a number of condensers; it should be found possible to select one within about 1 per cent and with a low power factor. Alternatively, the bridge can be constructed omitting the condenser, and then measuring a number of 1 μF condensers using the "Match" range and selecting one nearest to the average reading of the total.

Care should be taken with all wiring to the neon, as its response to very slight leakages depends on the insulation resistance across it; a metal lampholder *must not* be used, and the holder itself should be raised from the chassis by means of a block of tufnol or ebonite of sufficient thickness to allow the lamp to protrude slightly through the panel. The "Leakage-Test" switch should be a new one of good quality.

A word about the main calibrated potentiometer — any value from 1kΩ to 5kΩ is suitable and it should be of large diameter, say 3″, and wirewound with, of course, a linear characteristic. It pays to get the best quality one can afford, and one wound with very fine wire gives a smoother variation in resistance, and is to be preferred.



Showing rear of bottom "panel."

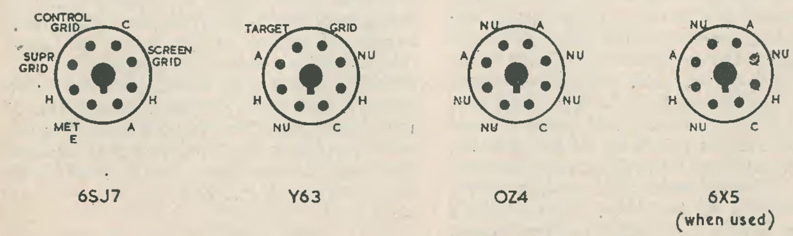


FIG. 6. UNDERSIDE VIEW OF VALVE BASES NU=NOT USED

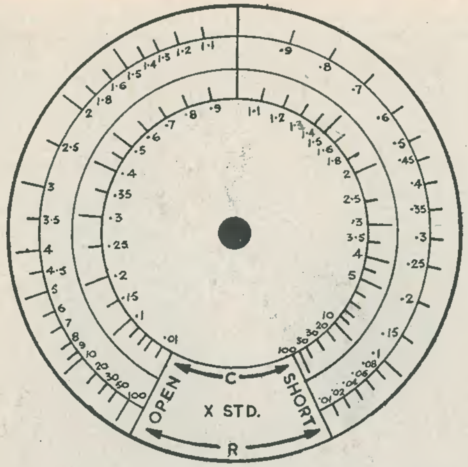


FIG.5. NATURE OF SCALE & CALIBRATION POINTS

RC178

All wiring should be rigid and joints soldered carefully. When wiring the input terminals and the bridge circuit take care to keep the length of the leads down to a minimum, and adequately spacing from each other to avoid strays.

Testing and Calibrating

When the wiring has been completed and checked for HT shorts, etc., the unit may be plugged in and switched on; after a quarter of a minute or so the tuning eye should emit a green glow and open up to a wide "V." If the eye does not light up, the unit should be switched off and the fault investigated. With the changeover switch in the "Leak" position, shorting out the test terminals will strike the neon lamp, which should go completely out on an open circuit.

Switch over to "Test" and to range 1, so bringing the 100Ω "standard" into circuit. A 100Ω resistor across the test terminals will open up the eye (which appears closed when off balance) when the potentiometer is roughly in its central position. The sensitivity control should be turned about half way up. Similarly, resistors of different values will cause the eye to open up at other positions of the control. When the instrument is working satisfactorily, calibration of the main and power factor controls remains to be done. The author's scales were made from matt white ivorine sheet, which is an ideal material to use as it marks easily with a pencil and is later engraved or inked over. The main "C" and "R" scale is $4\frac{1}{2}''$ in diameter, the other two being 2". The "R" scale is the outer of the two, the "C" scale being the reciprocal of the other. Fig. 5 shows the general arrangement of the calibration points. With the bridge switched on, turn to range 7 (Match) and place a 100Ω ±1 per cent resistor across the match terminals. It is strongly advised to try and obtain the use of a standard resistance box for calibration purposes, connecting it to the test terminals. When the resistance in circuit is 100Ω, the ratio between the two is 1:1, and the position of the pointer for balance should be marked on the scale as 1. With 90Ω in circuit across the test leads, the balance point should be marked 0.9 and so on, from 1Ω (Ratio 0.01) at one end of the scale to 10,000Ω (Ratio 100) at the other. To calibrate the capacity scale, the 100Ω resistor should be put on "Test" and the resistance box on "Match," the above procedure being repeated which will give the reciprocal readings of the "R" scale, 100 coinciding with 0.01, 50 coinciding with 0.02, etc.

The more carefully the calibrating is done, the more accurate will be the readings given by the bridge on other ranges. To find the value of an unknown component, the reading on the scale at balance is multiplied by the value of the "standard" in use; for instance, a reading of 0.68 on range 3 indicates a resistor of 680kΩ; a condenser giving a reading of 15 on range 5 indicates 0.15μF and so on. If a resistance box cannot be obtained, a number of ±1 per cent resistors between 1Ω and 10,000Ω can be used to mark major points on the scale, the others being inserted by interpolation. Alternatively, lengths of resistance wire could be used, but this is rather a laborious process.

It will be found that, with the test leads shorted the eye will open up right at one end of the scale; this should be marked SHORT; the eye will open up at the other end of the scale when the leads are on open circuit, and should be correspondingly marked.

(*continued on page 599*)

The Universal Large Screen AC/DC Televisor

Part 2. Described by A. S. Torrance, A.M.I.P.R.E., A.M.T.S.

(*by kind permission of* IKOPATENTS LTD.)

With the completion of the chassis and mechanical structure, a thorough understanding of the design is necessary before wiring-up is attempted. For this purpose, the circuit has been divided into three parts—the two receivers with timebase requirements and, in separate sketches, the heater supply chain and HT arrangements.

The Superhet Sound and Vision Receiver

This has been designed to cover all existing channels, and selection is achieved by varying the cores of L1, L2A and L2B. A chart will be seen later, and if this is faithfully followed constructors should have no difficulty in obtaining a 3 Mc/s resolution.

An outline of the circuit will introduce the various aspects. Input to L1 is designed for co-ax feeder, and it must be noted at once that C1 is absolutely imperative. Without this component the entire aerial would be alive to one side of the mains, and a most dangerous situation would arise. UNDER NO CIRCUMSTANCES MAY C1 (1000 pF) BE OMITTED. If any aerial adjustments are required, the mains plug should be removed completely from the wall socket, thus establishing the greatest safety factor. At the same time, it must be pointed out that no external earthing connection may be made to the "Universal."

The signal is amplified by the RF stage, in the cathode circuit of which is inserted the sensitivity control. From this valve the signal is fed to the Mixer, which is tuned by L2B. The IF is 19.75 Mc/s for vision and 23.25 Mc/s for sound.

The IF proceeds through each stage of amplification to L4, where the sound is tapped off from L5.

The Contrast Control is seen in the cathode circuit of V4. By this means, sensitivity may be set to suit individual and local requirements for both sound and vision. Individual adjustment for sound is then set by the normal volume control (VR4), and the picture set by the Contrast Control.

Two further vision IF stages carry the signal to the Detector, Vision Interference Limiter and thence to the Video stage and the CRT, the Mullard MW43-64.

Some mention should be made of L7. This coil, by mutual induction, absorbs any sound signal left at this stage of the vision receiver. Please note that this coil is not connected in any way.

The Sound Receiver

From L5, the sound signal, at the IF, is taken to the transformer L12A-L12B, which is supplied pre-tuned to the sound IF of 23.25 Mc/s. This component must be handled with great care to avoid changing the core settings. Do not interfere with these cores, as the lining-up procedure depends entirely on this component being set at 23.25 Mc/s. By this means it is quite simple to resolve Test Card "C" without the use of test oscillators.

The remaining stages of the sound receiver follow conventional lines.

The Mullard MW43-64 enables a completely focused picture to be obtained. This tube contains an entirely new electrode arrangement specifically designed to obtain an optimum focus. Constructors should carefully note the connections to this tube, and particularly the external connection from the additional anode.

The Timebases

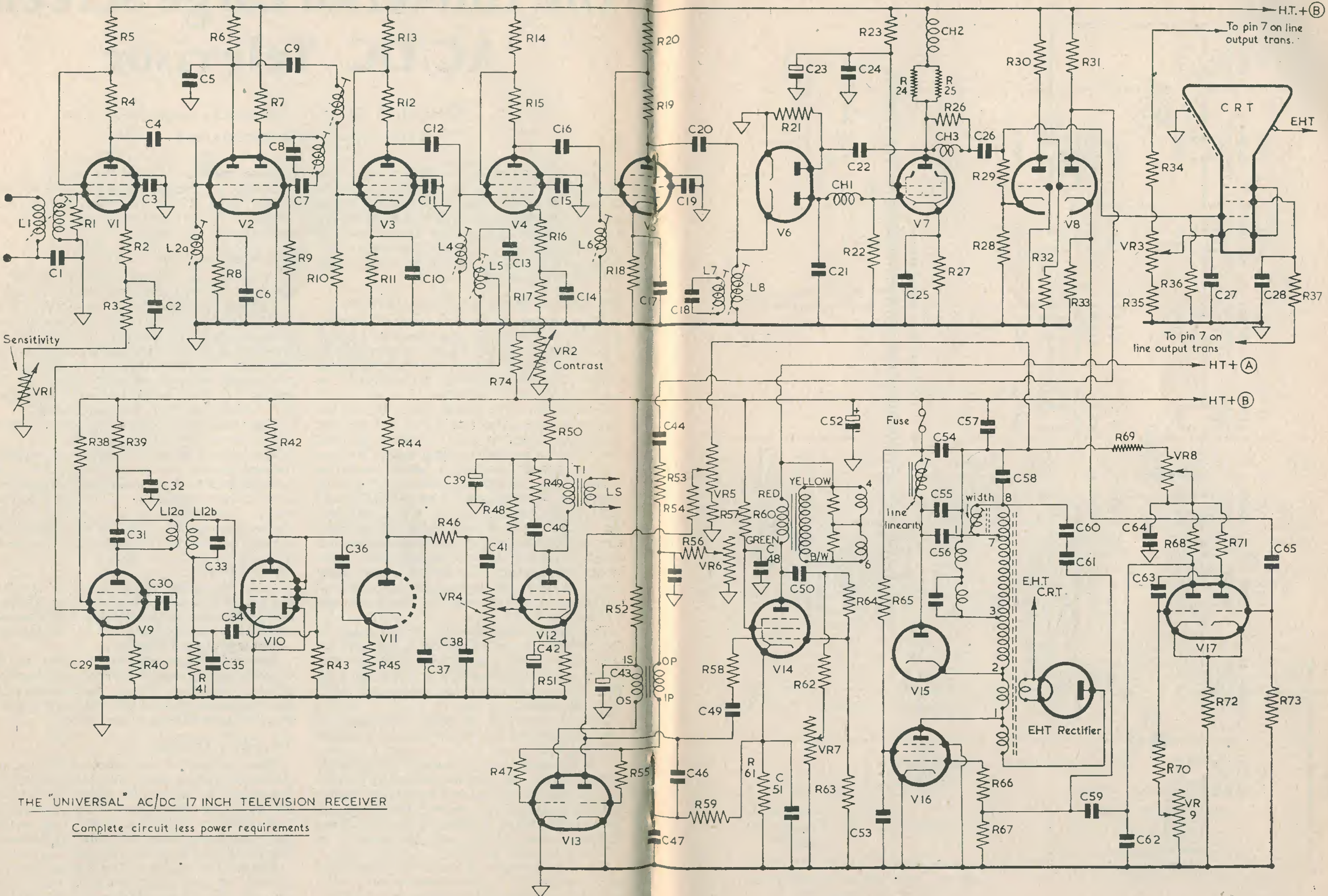
A double triode multivibrator (V17) drives the line output valve (V16), and the efficiency of this depends upon the boosted HT voltage obtained from the diode V15. Note that this circuit is protected by a fuse.

Two inductances, one for linearity and the other for width, control the shape and horizontal size. However, it must be borne in mind that various condensers also affect this relationship. These will be discussed later.

The Frame Timebase

The frame is a blocking oscillator and discharge valve, again operating from the boosted HT. Adequate drive is obtained for the frame output valve V14. Linearity is controlled by VR7, but again one or two components may affect the final performance. These will also be discussed later.

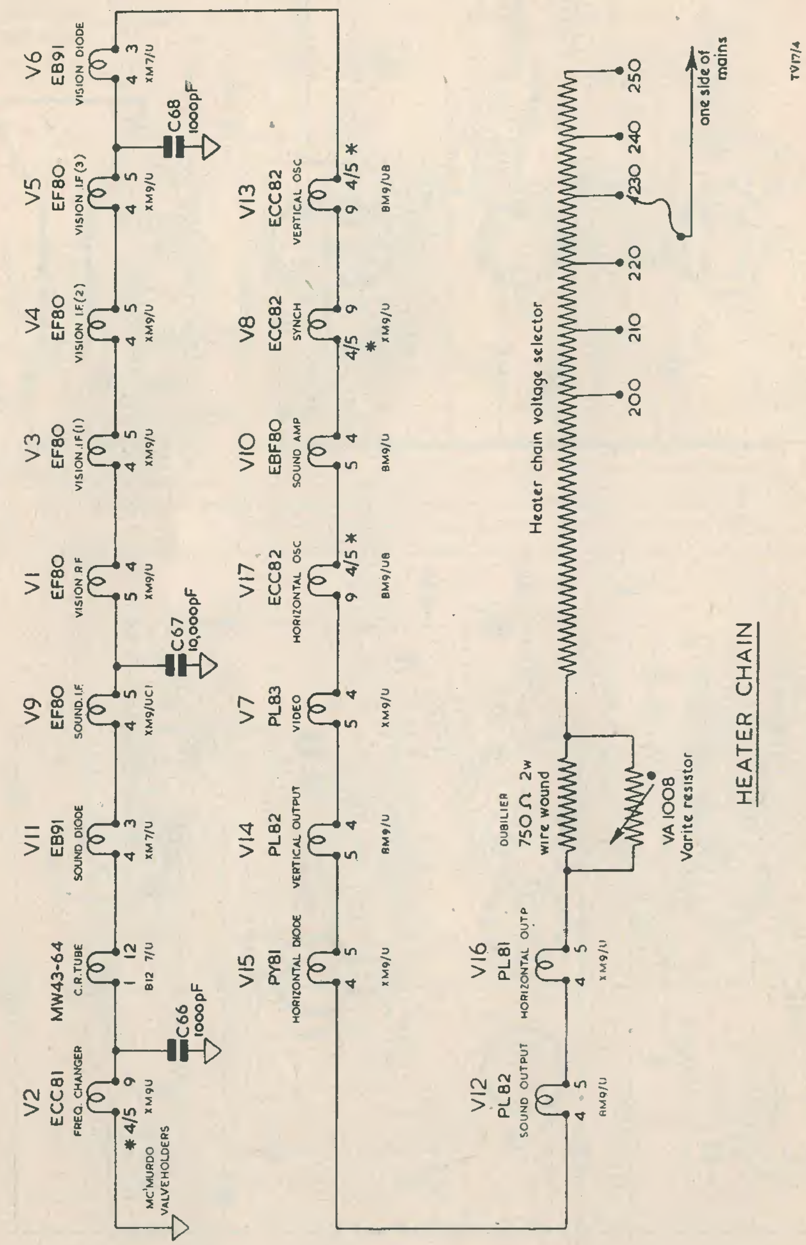
The EHT supply is of the flyback type and the efficiency of the line output transformer depends almost entirely upon the Mullard Ferroxcube around which this component



THE "UNIVERSAL" AC/DC 17 INCH TELEVISION RECEIVER

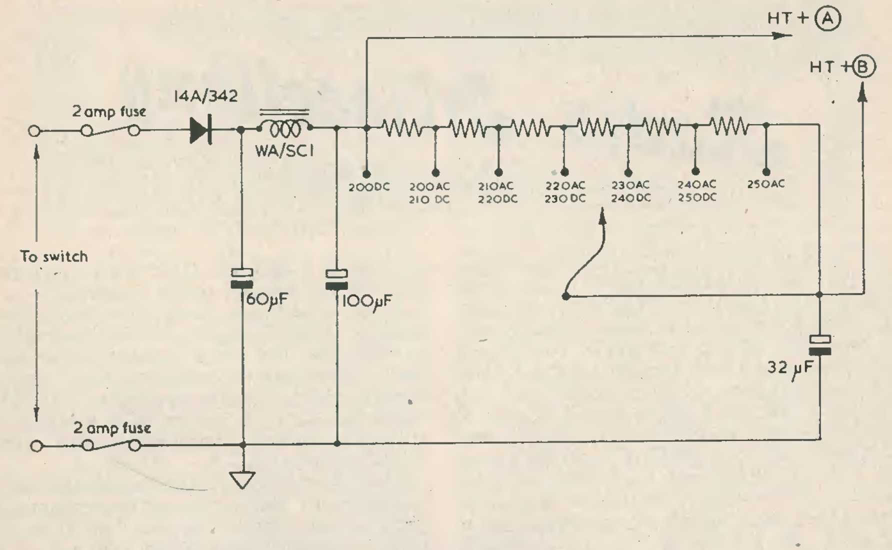
Complete circuit less power requirements

NOTE: *The coil in parallel with C8 is L2B; The coil in series with C9 is L3*



HEATER CHAIN

* Pins 4 & 5 externally strapped together



THE "UNIVERSAL" POWER SUPPLY

TV17/5

is wound. The EY51 rectifier chosen is capable of withstanding a high peak inverse voltage and consequently a long life for this valve may be expected. The CRT arrangements fed from pin 7 of the line output transformer has been designed to assist collapse of the residual spot which so often leaves a mark or blemish on the tube screen. An alternative circuit will be seen later in this book which completely eliminates this effect. Final smoothing for the EHT is secured from the graphite coating on the MW43-64. Connection to this can be easily arranged through a spring wire attached to the bolts securing Part D to Part C.

The EHT supply to the tube should be protected from accidental contact with the operator. A suitable connector is obtainable and will be given in the Parts List next month.

The Heater Chain Supply

This is fully explained in the point-to-point wiring sketch to follow, and also in the schematic diagram. It is absolutely imperative that the order shown be followed. Any deviation from this will almost certainly result in interaction, instability and parasitic oscillation.

The HT Supply

Great care should be given to wiring both supplies, to ensure that the correct resistors be employed, and to make certain that the tapping point suitable for the local mains voltage be selected. Methods of connecting will be given later. *(To be continued)*

Radio Miscellany

We still occasionally get gratuitous advice on what the "average reader" wants. Just lately it seems that the average reader does not want any more about aerials, oscilloscopes, amateur transmitting and model control! I had hoped that I had disposed of the fallacy of a statistical average reader months ago, but apparently not. As I am supposed to write a monthly column to please everybody—I was persuaded into it in 1937—I *ought* to know, but I don't. I've been to dozens of Club meetings and amateur gatherings here and abroad, but each time I try to conjure up a vision of an average reader, the hazier I become. Once I got to the point of looking up the lists of subscribers and I only became more puzzled than ever.

I remember there were lots of plain Misters. Some with letters after their names which seemed to have nothing to do with radio, so that didn't help a lot. Then there were a number of Doctors and a few Revd. gentlemen. I had an uneasy feeling that ought to suggest something but for the life of me I couldn't think what. Then there were a lot of good old British names from unheard-of places in the far flung corners of the Empire, and others with curious c/o addresses who may be merchant seamen or other wanderers. Instead of helping to clear up the mystery, they only started me wondering how and when they did their constructing. Perhaps they don't, and simply content themselves with reading about it.

Suddenly a Miss Somebody-or-the-other came to light. Ah! perhaps she sends it on to her boy friend in Korea. My streak of romanticism conjures up a picture of her speeding it on its way with a pretty little note and a touch of perfume to remind him of old times.

Pushing on, we come to quite a number more Misses. Nice to feel the boys in Korea are so well stocked up, but my fond imaginings are shattered when I look back and find most of the Misses' names go back over several years. Surely they don't keep blokes out in Korea that long?

They must buy it to read themselves—there seems to be no other explanation. The *Radio Amateur* files seem to have proportionately even more than R.C. It certainly put a new angle on this average reader problem.

I still sometimes pause to wonder what these YL readers are like. Female enthusiasts so often turn out to be such formidible creatures. The cartoon version springs to mind. Straight hair, pebble spectacles, wrinkled stockings and thick ankles, with a bundle of advanced political literature clutched grimly under one arm.

I shuddered and hurried on through the names. Addresses in Europe, some unpronouncable names from India and the Far East and more of these baffling Misses who get me so worried. Then the addresses behind the Iron Curtain. That gets me worried, too, and I wonder if only the politically reliable are allowed to see it and if it has to be censored first.

All in all, you will see it is impossible to think of a *type* of reader, let alone an average reader, so we can only please everybody by covering as wide a range of radio subjects as possible. In the meantime save your copies; you will come back to, and enjoy, the very articles you hurry past to-day.

P.S. If one of those YL readers gets a shy little note from me enclosed with her copy with a request for a snapshot (which I promise to return, post paid) I hope she will understand she, and her kind, have been bothering me for a long time and if I worry over it much more I shall be losing sleep. As for the mysterious readers on the far side of the Iron Curtain, it seems at last that Mr. Malenkov might raise the corner of the curtain an inch or two. In any case they won't cause me any loss of sleep—that is, if they are only comrades, and not comradesses!

Cap this one

One of the minor irritations of the correspondence columns of our daily newspapers are the claimants of useless "records." Luckily, the first hearer of the cuckoo, if he gets in quick, silences all challengers—unless some determined character, not to be outdone, claims to hear two cuckoos! As the cuckoo-hearing season is so restricted, these champions and challengers have plenty of time to think up all sorts of other records during the close

season. The hen-owner whose bird lays umpteen eggs per month, is successively outbid by those whose birds lay umpteen-plus-one, plus two and so on. At the point when an uncappable claim appears the Editor adroitly applies a closure on the correspondence to avoid claims going beyond the realm of possibility. Then it builds up all over again, perhaps with match-splitters. First the man who splits each match into two strik-able stalks. A challenger claims three, another four, and up and up we go.

Recently in an evening paper crystal set owners had their turn. Following the usual formula they all claimed to get louder and still louder signals. Not merely local stations either, but Moscow.

Quite how it finished up I still don't know, as on the critical night I was too late to get my copy. It began to get exciting when Moscow signals on a bedside crystal set regularly woke up the owner. The following evening we had the chap whose next-door neighbours complained that his crystal set reception of Moscow used to prevent them from getting off to sleep. What was more, his wasn't one of these new-fangled crystal sets, either. It was over 30 years old, and made in the days when crystal sets were crystal sets and made by craftsmen—not just chucked together on an assembly line. Lovely tone, too!

I still haven't found out if that one was capped because it was the next evening that the paper was sold out. Of course it may have been because I was later than usual but I have a sneaking suspicion there had been a run on them by people, like me, who were holding their breath to see what came after that. Maybe this claim silenced the opposition and left them furiously thinking up new records and next week we shall see something like the following. "Sir, I bought my wireless set in 1932 since when it has been in regular daily use. The valves are better now than ever they were and the tone of the set is greatly superior to the sets now offered for sale. All of my friends have to make constant valve replacements in their post-war sets. There seems little doubt that the standards of workmanship have seriously declined in recent years, Yours, etc."

Money Matters

Following my report of the RSGB SGM a number of readers have written: some to speculate on what happens next! To quote the usual Hollywood inanity, I haven't a clue, but I sincerely hope to see an early compromise settlement acceptable to both points of view.

Many readers feel there has been a tendency to overlook the fact that even if the Society had one hundred per cent support from licensed amateurs, a considerable BRS support would still be necessary to ensure its financial stability. I feel there is a danger that with an Entrance fee and a high subscription, the Society might price itself out of existence as far as BRS members are concerned. Several of them already complain that BRS interests are inadequately catered for in the pages of the Bulletin.

One reader points out my report was "bad publicity" for the Society. Wasn't it Sam Goldwyn who said there is no such thing as bad publicity? Another wrote saying he had read my report and then seen the Bulletin, and enquired if they both referred to the same Meeting!

A reader from Gorleston-on-Sea writes "I joined so that I could become a member of our local Radio Club whose slogan is, no RSGB, no local Club." He adds he has made a survey of the last 24 Bulletins and, other than the advertisements, finds there is less than ten per cent of the contents of any interest to him.

Another correspondent puts forward a couple of pertinent points. He says "Despite all the arguments, I have not seen or heard a single word about increasing the membership or even starting a drive to stimulate recruitment. By my reckoning barely three-quarters of licensed amateurs are members. Are the Council indifferent about this? Then what about listeners? If at long last an attractive programme could be started to make membership worth their while, both the influence of the Society would be enhanced and its financial difficulties eased."

I do not propose to comment on these points, but oddly enough at a local Club meeting a few evenings ago, someone suggested the Society ought to have a Public Relations Officer. True, he did not mean it in quite that sense. He was thinking in terms of BCI and TVI, Town Planning and Aerial erection, and of putting the amateur case generally to the public.

Maybe some genius could manage both jobs!

Centre Tap *talks about* THE AVERAGE READER-RECORDS — R.S.G.B. COMMENTS

SIMPLE GEIGER-MÜLLER TUBE DEMONSTRATION UNIT

By R. C. Walker, B.Sc.(Lond.) A.M.I.Mech.E., A.M.I.E.E.

With the increasing industrial usage of radioactive isotopes as by-products of the Atomic Pile, and the search for natural sources of uranium as fuel for atomic energy stations, apparatus for detecting beta and gamma radiation is very much in the thoughts of enthusiastic amateurs.

Contrary to the general belief that the apparatus required to give a simple demonstration of the existence of beta and gamma radiation involves some mysterious components inaccessible to the ordinary person, the construction of a mains operated circuit which will give audible indication of radiation is quite simple, and such an equipment can be easily constructed by the average handy man.

Fig. 1 shows a mains-fed circuit suitable for such a purpose built around Osram valves and G.E.C. Geiger Muller tubes type EHM2S. Modification for battery operation is easily made if required by substituting battery valves, with the necessary circuit alteration. Fig. 2 shows an external and Fig. 3 an internal view of one form of portable mains apparatus incorporating the circuit of Fig. 1. This particular unit is provided with a socket at the bottom of the front panel so that a

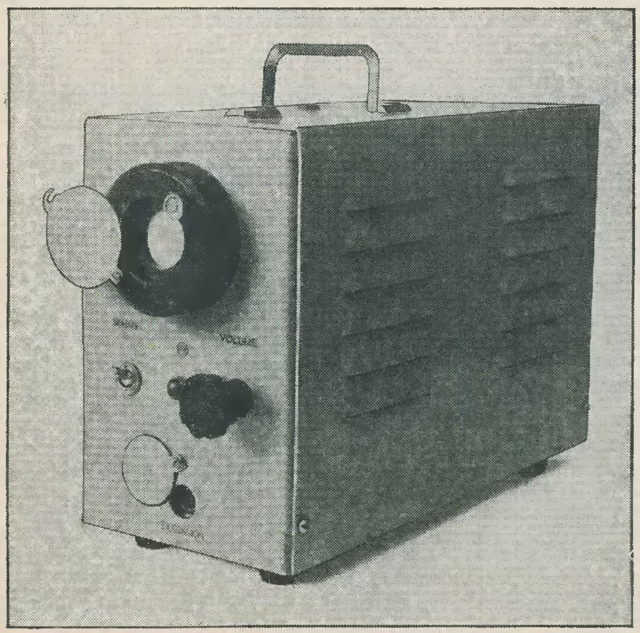


Fig. 2.
External view of portable mains operated beta ray detector.

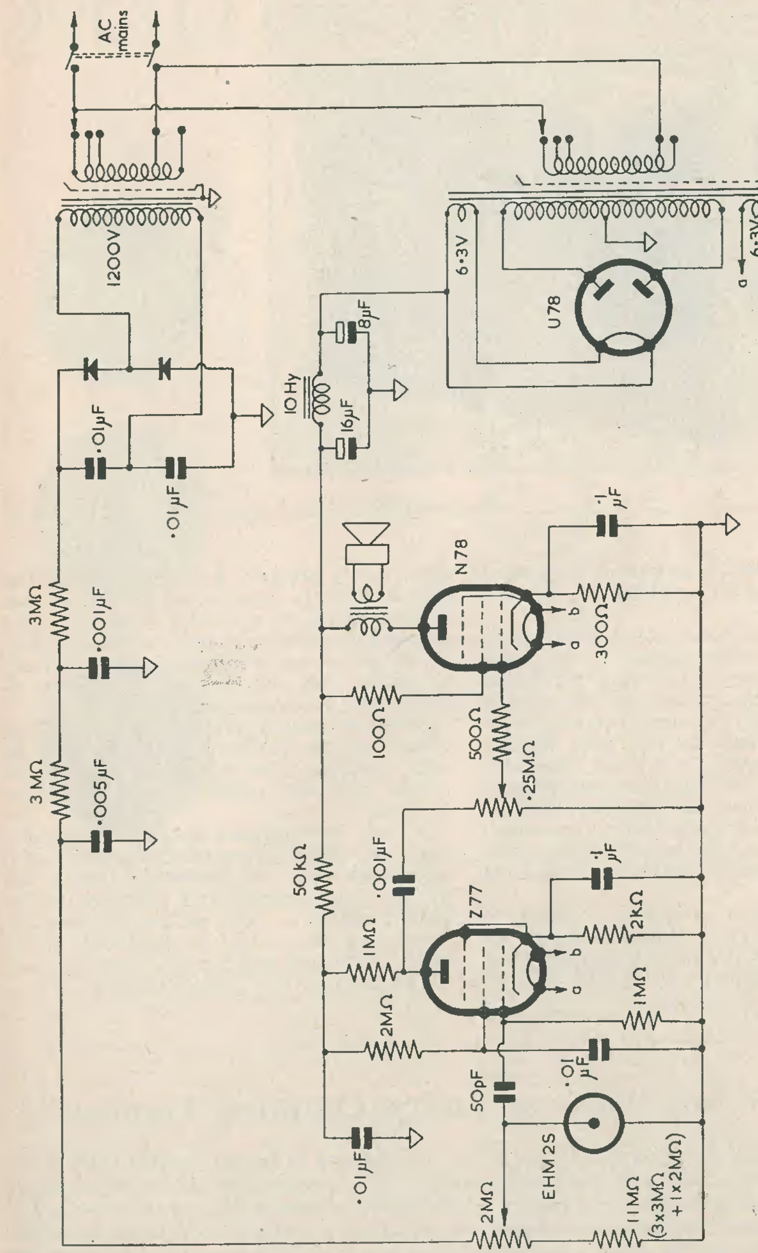


FIG. 1. GEIGER MÜLLER AUDIBLE WARNING INDICATOR

RC215

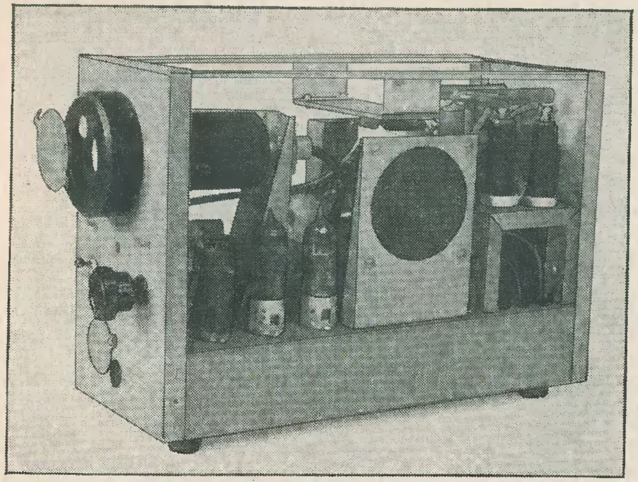


Fig. 3. Internal view of portable detector.

separate G.M. tube on an extended screened cable remote from the amplifier can be used if required.

When an internal tube is used, it is housed behind a metal cover shown in the open position at the top of the front panel and recessed in a bakelite moulding. The cover is intended to provide mechanical protection to the tube and prevent the thin mica window from being damaged. When the apparatus is not in use, the tube window can thus be covered and the cover can be fastened in the closed position with the milled nut provided.

In the centre of the panel is the mains switch and live circuit pilot indicator and the volume control.

One of the most convenient sources of radiation with which to demonstrate the set is part of an old luminous instrument dial. The face of a luminous watch may also be used, but is generally less effective since the thickness of the glass cover or plastic case absorbs some of the beta radiation, thus reducing the effective intensity of the source.

Not all of the so-called luminous surfaces are either truly self luminous or suitable as sources for demonstration.

Some are merely phosphorescent coatings which become luminous when exposed to light, and retain that luminosity for a limited period after the exciting source has been removed.

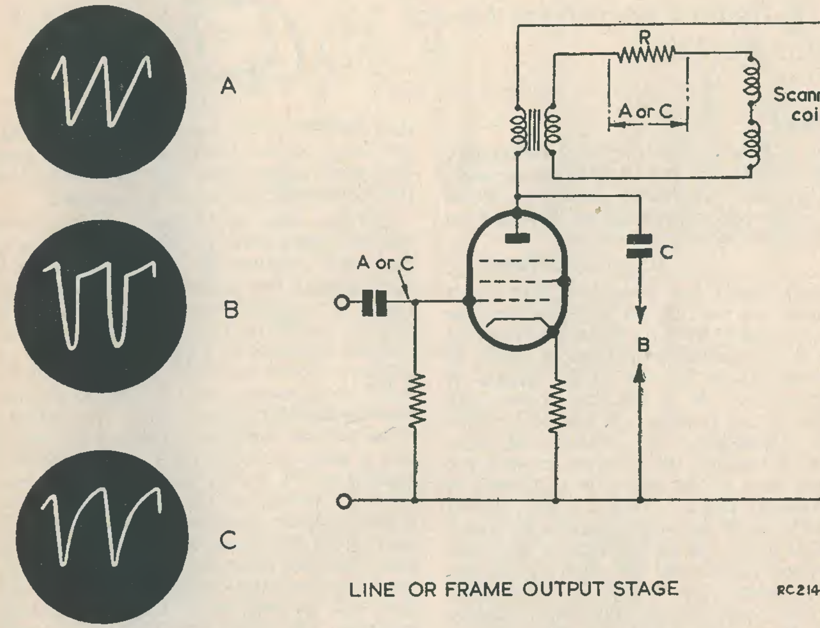
A truly self-luminous source consists of a phosphor mixed with a minute quantity of a radioactive salt, the luminosity being due to the bombardment of the phosphor by the emitted radiation. The radioactive substance has a long life, so that the luminosity is virtually permanent and is present however long the surface has been kept in the dark.

Proving a Soft Valve or Faulty Coupling Condenser

Often one is faced with a set that has the output valve drawing an excess of current. This can be caused by three things, one being a faulty cathode component. A voltage check in the cathode circuit will prove this by being low, but if the reading is high then it is either the valve or the coupling condenser. To prove this, leave the meter in the cathode circuit and earth the grid; if the voltage returns to normal, then disconnect the coupling condenser. If this is faulty then the cathode voltage will return to normal with the grid resistor in circuit. If the valve is soft, disconnecting the condenser will make no difference. A high resistance or disconnected grid resistor will give the same result.—J.S.K.

OSCILLOSCOPE TRACES

by A.B.



No. 1. A simplified scanning output stage. and the most important waveforms connected with it.

A perfectly linear sawtooth waveform is shown in A, and if the stage is doing its job the same waveform should appear in the scanning coil circuit. A small resistor R must be inserted in series with the coils as shown in the circuit diagram in order to convert the *current* waveform into a *voltage* suitable for application to the oscilloscope. This resistor should be of the order of 20Ω.

The non-linear sawtooth, shown in C, is the type of waveform that causes cramping of the picture—depending upon whether it is the line or frame—either at the righthand or bottom edge.

The voltage waveform at the annode of the valve and across the scanning coils may be like that shown in B. This shape varies considerably from one type of set to another, but is generally of this form.

Due to the very high voltages developed at the anode and across the coils during the flyback period, a condenser C must be used to couple the oscilloscope to the circuit. The condenser should be small in capacity and have a high working voltage.

Waveform A is also the one to be found at the plates of an electrostatically deflected tube. In this case the oscilloscope can be connected to the plates without the complication of the 20Ω resistor required for the electro-magnetic type. Waveform B would not appear in an electrostatic deflection tube.

Query Corner

A Radio Constructor service for Readers

Silent Tuning

Having a good quality five-valve radiogram, I am interested in adding a silent tuning arrangement to it. Can you please suggest a circuit which I might add without having to make too many modifications to the receiver?

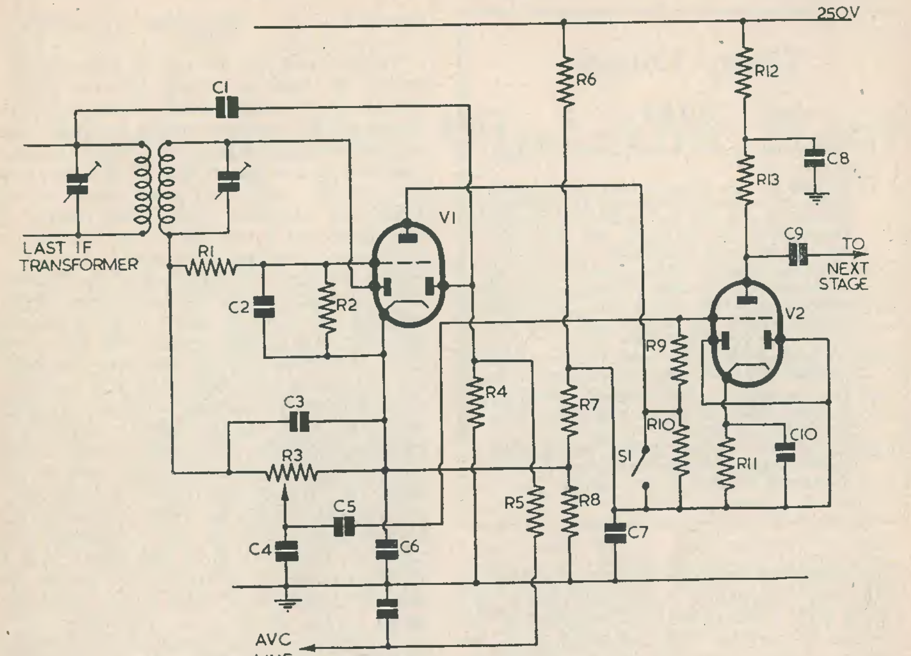
G. Penton, Shrewsbury.

Not very much has been heard of silent tuning since the war; this is probably because most set manufacturers have been attempting to keep their receiver selling prices down to a minimum, largely because of the burden of the purchase tax. It is therefore conceivable that some of our readers will not be familiar with this refinement. The function of silent tuning is to render the receiver inoperative until such time as the signal level exceeds a predetermined value. Thus, when tuning across the band all very weak stations including interstation noise will be eliminated, and only the stronger signal will be received in the normal manner. The device is particularly suitable for inclusion in the better quality receivers, particularly when they are normally used only for local station reception. A switch is, however, usually provided so that the additional circuit can be made inoperative and the receiver allowed to function normally. Such a switch is essential if, for example, any short wave listening is to be done.

Many different circuits have been used to achieve silent tuning, but in general the basic principle remains the same. A negative bias is applied to one of the audio amplifier stages when no signal is being received. This renders the controlled stage inoperative, but as soon as the signal level is increased the negative bias is removed and the stage functions in the usual manner. It is most important to ensure that once the signal level has exceeded the threshold value the negative control bias is removed immediately and entirely, as otherwise a certain amount of distortion will be introduced. In this connection, it is advantageous to so arrange the circuit constants that the delayed AVC comes into operation at the same signal level as the silent tuning. This point in particular was kept in mind when the recommended circuit was chosen.

Turning now to Figure 1, it will be seen that one extra valve is required. It is assumed that the receiver to be modified already incorporates the conventional double diode triode for detection and first AF amplification; this we will term V1 on the diagram, but its original function is somewhat changed. The diodes perform their original job of signal and AVC rectification, but the triode section is used as the bias control valve. The additional valve V2 now operates as the first AF amplifier and is bias controlled by V1. The anode load resistor of V1 is R10, and this is also part of the grid resistor of V2. Now if V1 is biased beyond anode current cut-off, there will be no current flowing in R10, and V2 will therefore function normally. If V1 is allowed to pass current, the voltage developed across R10 will be such as to bias off V2, thereby reducing the audio amplification to zero.

The first valve is operating as a DC voltage amplifier and is controlled by the rectified and smoothed output from the signal detector diode. As the signal level increases, so the negative bias on the grid of V1 increases until the point is reached when the valve is cut off, and then as already described the receiver functions normally. At very low signal levels V1 is conducting and V2 is cut off. To keep the grid base of V1 short and the cathode potential of V2 as low as possible, the anode voltage for the first valve is obtained from a divider across the HT supply. The anode tap is taken at a point about 65 volts positive, whilst a further tap on the divider is used to supply 2 volts for the AVC delay. Using the circuit values recommended, the receiver will operate with about the same degree of sensitivity as it had before being modified, and in fact with the silent tuning switched out of action by means of S1 the set should provide its original performance.



RC 208

FIG. 1

COMPONENT VALUES

All resistors ½W. unless otherwise stated

R1	— 1 MΩ
R2	— 0.25 MΩ
R3	— 0.5 MΩ log. pot.
R4	— 1 MΩ
R5	— 1 MΩ
R6	— 60 kΩ (1 Watt)
R7	— 22 kΩ (0.5 Watt)
R8	— 470 Ω
R9	— 1 MΩ
R10	— 0.5 MΩ
R11	— 2.2 kΩ
R12	— 22 kΩ
R13	— 100 kΩ
C1	— 50 pF
C2	— 0.1 μF
C3	— 100 pF
C4	— 100 pF
C5	— 0.02 μF
C6	— 25 μF 25V
C7	— 8 μF 250V
C8	— 2 μF 350V
C9	— 0.02 μF
C10	— 25 μF 25V
V1	— EBC41 Mullard
V2	— EBC41 Mullard

Capacitors in Series

Is it in order to connect two or more capacitors in series so that they might operate on a higher voltage? I have a number of 1 kV working capacitors which I would like to use to smooth a 2.5 kV EHT supply.

E. Kinsley, Plymouth.

We will divide this problem into two parts, the first to deal with paper capacitors as mentioned by our correspondent, and the second part to deal with the rather different case of electrolytics in series. The series connection of paper capacitors is not permitted unless some precaution is taken to equalise the voltage across each component. Without such a precaution the applied voltage is distributed over the capacitors in the ratio of their leakage resistance; those having the higher resistance will operate at the higher voltages and will be most prone to breakdown.

Query Corner

RULES

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

(2) Queries on any subject relating to technical radio 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.

The simplest method of equalising the voltage across each capacitor is to shunt each one with a high value resistor. The value of the resistors should be low compared with the normal leakage resistance of the capacitors, and yet not so low as to consitute an appreciable load on the voltage source. Usually a resistance of between 2 and 5 MΩ is suitable; the resistor must, of course, be capable of withstanding the applied voltage, and it is worthwhile remembering that providing the maximum dissipation is not exceeded the standard 1 watt components are suitable for use up to 1 kV.

Turning now to the use of electrolytics in series, we have a rather different state of affairs. It is characteristic of an electrolytic that a certain leakage current is passed under normal working conditions. This current is probably in the region of 0.25 mA, but it will rise rapidly once the maximum working voltage is exceeded. Thus the voltage distribution over a number of electrolytics will normally be substantially equal. Now if the supply voltage is increased one of the capacitors may tend to reach its maximum working voltage, but this will result in an appreciable increase in its leakage current. As this current must also pass through the other capacitors the voltage across them will rise and so in turn will their working voltage. Therefore the increase in voltage will be taken by the capacitors which have the lowest leakage current and are therefore better able to withstand it. Thus, the series connection of electrolytics of similar type and capacitance is permissible without any equalising shunt resistors, but it is most important that the capacitors should be similar, otherwise their leakage currents may differ widely with consequent uneven distribution of voltage.

If it is required to series connect dissimilar electrolytics then recourse must be made to shunt resistors, but in this case the resistors must be of relatively low value. This actual value will depend largely upon the working voltage and the degree of difference between the capacitors, but if they are arranged to bleed 5mA no trouble should be encountered due to short electrolytic life.

A Low-Hum, Low-Microphony AF Pentode on the Noval Base

A valve that should prove of considerable value for use in high-grade amplifier applications in communications and industrial electronic equipment, has recently been made commercially available by the Communications and Industrial Valve Department of Mullard Ltd. It is the EF86 low-hum, low-microphony AF voltage amplifying pentode on the B9A (Noval) Services Preferred base.

This valve has been designed for use in high-grade resistance-coupled, audio-frequency voltage amplifier circuits. In these circuits it is essential that the hum and microphony introduced by the amplifying valve be kept to an absolute minimum. The hum level in the EF86 has been kept to 5 micro-volts, referred to control grid. This extremely low figure has been achieved by careful internal screening and by the use of a bifilar heater. Moreover, the control grid pin is placed equidistant from the two heater pins, so that, providing the heater winding has a centre-tapped earth, any hum induced from the heater pins is virtually balanced out. The rigidity of the electrode structure contributes, to a large degree, to the extremely low microphony inherent in this valve. Other features of the EF86 are its small size, high gain and single ended construction.

The main characteristics of the EF86 are

Heater Voltage	6.3V
Heater Current	0.2A
Anode Voltage	250V
Anode Current	3mA
Hum level	5µV
Mutual Conductance	1.85mA/V

Further details of the EF86 may be obtained on request to the Communications and Industrial Valve Department.

Let's Get Started

3: How to Get What You Want

by A. Blackburn

By now you should have a fairly sound knowledge of the properties of the valves we shall be using in our elementary designs. So now we will have a change and turn our attentions to another aspect of radio, in which we don't use any valves at all.

You all know, of course, that hundreds of radio stations are each transmitting their own programmes simultaneously. It follows, therefore, that Mr. Molotov's speech from Moscow, the American crooner, and Mrs. Dale's Diary are all in the air at the same time, only waiting to be picked up by your radio receiver. If this is the case, why is it that Take It From Here isn't mixed up with a French sports commentary, a symphony concert and the weather forecast?

Before we talk about how one station may be selected from the many, however, it would be as well to find out exactly what selection entails.

The Radio Signal

A radio signal consists essentially of two separate parts—the "carrier" and the "modulation." The carrier comprises high frequency waves which are radiated from the transmitter by high frequency currents flowing in the transmitting aerial. These waves have many of the properties of light, in that they apparently travel through the same medium, sometimes called the ether, and they can be beamed and reflected as required. If no attempt is made to beam them in any particular direction, they radiate from the transmitting aerial in a similar way to the ripples which move outward from a pebble dropped into water. Upon striking a receiving aerial they induce into it small currents, which are really tiny replicas of the currents in the transmitting aerial. The simplest way of transmitting intelligence with these waves is to interrupt them in the form of dots and dashes to make a morse signal. Their frequency is, of course, far too high to be detected directly by the ear, so some means of detecting and translating them into a visual or aural signal has to be used. A morse signal has special application to communications, but the transmission of speech and music is rather more complicated.

The process of superimposing speech or music on a carrier wave is called modulation. A varying voltage corresponding to the speech is superimposed upon the carrier in such a way as to cause the carrier amplitude to vary correspondingly. This may be difficult to imagine, but Figs. 1a, b, and c should help to clarify it a little. Fig. 1a shows an unmodulated carrier wave, Fig. 1b a single note or sound wave. The carrier modulated by the sound waveform is shown in Fig. 1c. Modulation will be dealt with in greater detail later on.

We have, then, a great number of radio transmitters radiating modulated carrier waves, one of which we wish to select. This apparently difficult operation can be performed with a very simple circuit, consisting of an inductance (i.e. a coil of wire), and a condenser, and is scientifically known as a "resonant" circuit, shown in Fig. 2. The phenomena of resonance occurs in mechanical things as well as electrical, and as the action in both cases is similar we

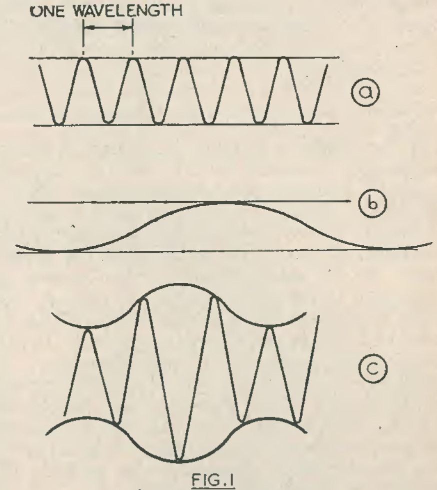


FIG. 1
(a) CARRIER WAVE
(b) MODULATING WAVE
(c) MODULATED CARRIER WAVE
RC205

can draw a parallel between a familiar mechanical conception of resonance and the tuned circuit.

When a bell is struck it produces a note which is determined by its shape, size, metal and other considerations. It is also a fact that if two bells producing precisely the same note are placed side by side, and only one of them is struck, the other will tend to ring in sympathy with it. Probably a better known example of this is that a fine wine glass will shatter if a violin is played at exactly the same note as that which the glass would emit if it were tapped, i.e. its resonant frequency. In other words, forces are set up in the glass by the sound, which are equivalent to a blow sufficient to smash the glass.

work, they are used in millionths of a unit, the microhenry (μH) being applied to coil measurements and the microfarad (μF) to condensers.

In order that it may cover a definite range of frequencies, the condenser is normally variable, 0.0005μF being used for medium and long wave purposes. This is the maximum value of capacity of the condenser with the plates all in. The minimum value, with the plates all out, is normally about 0.000040μF Even now, having brought the Henry and Farad to more manageable units, they are still awkward figures to deal with, and an increasingly popular unit of capacity is now in use called the picofarad (pF), which is one millionth of the microfarad. So the maximum and

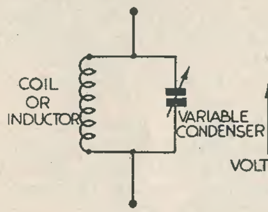


FIG. 2
REJECTOR TUNED CIRCUIT

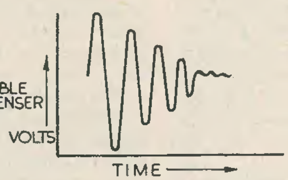


FIG. 3
"RINGING" OF TUNED CIRCUIT

FIG. 4
ACCEPTOR TUNED CIRCUIT

RC206

If we were to connect a battery voltage across our resonant circuit, in Fig. 2, and suddenly interrupt the voltage with a switch, the circuit would " ring " electrically as shown in Fig. 3. You will notice that the waves thus produced die away just as the sound of a bell does. If an aerial replacing the battery is connected to the circuit at the top end and an earth to the bottom end, signals picked up in the aerial will be applied to the circuit. If the circuit, now resonant at one frequency, is adjusted to the frequency of a transmitted signal, it will select that one and reject the others. The result is that all the unwanted signals are passed through the circuit to earth, but the required signal can be picked off across the circuit.

Coil and Condenser Values

I have talked a good deal about the frequency to which the circuit tunes, but as yet nothing has been said about how to decide what values to give the coil and condenser. A coil, or inductor to give it its proper name, is measured in Henrys and a condenser in Farads. As these units are rather large, particularly for radio

minimum values of the condenser become respectively 500pF and 40pF.

To calculate the inductance of a coil required to tune to a particular frequency with a given capacity, the following formula is used:

$$f = \frac{1}{2\pi\sqrt{L \times C}}$$

where f is frequency in Mc/s (megacycles/second), L is inductance in μH, C is capacity in μF and π is 3.142.

To find the inductance, therefore, we have

$$L = \frac{1}{4\pi^2 f^2 C}$$

and the capacity,

$$C = \frac{1}{4\pi^2 f^2 C}$$

A typical coil to tune over the medium waveband with a 0.0005μF (500pF) condenser could be made on a 1¼ in. diameter former with 60 turns of 30 swg enamel copper wire close wound.

A confusing point to many beginners is what is meant by the wavelength. It will be easier to understand if you will look back again to Fig. 1a. The wavelength is the distance

measured from any part of the wave to the same point on the next wave, say, from crest to crest. Wavelength and frequency are related by the following formula:

$$\text{wavelength in metres} = \frac{300}{\text{frequency in Mc/s}}$$

Therefore, a frequency of 0.5 Mc/s is equal to

$$\frac{300}{0.5} = 600 \text{ metres.}$$

Acceptor and Rejector Circuits

The resonant circuit shown in Fig. 2 is known as a rejector circuit and is so called because it has a very high impedance when tuned to resonance. In our circuit connected to an aerial and earth, a number of signals will be applied to it from the aerial. If the impedance of this circuit is high at its resonant frequency the wanted signal will appear across the tuned circuit and all unwanted signals will travel through it to earth. It would seem from this that it were, in actual fact, an acceptor circuit, for it appears to accept the required signal and reject the unwanted ones. This unfortunate confusion in terms is derived from the application of these circuits to radio instead of to pure electricity, where they were originally used.

It is just as well to mention the acceptor circuit, shown in Fig. 4, although this does not find wide application in ordinary radio practice. It can be seen that in this case, the inductance and capacity are in series. This circuit has, in every respect, exactly the opposite characteristics of the rejector circuit, the most important being that its impedance is very low at the required frequency and high at all others. For this reason it seldom finds application in the tuning circuits of a receiver, but in certain cases may be of inestimable value elsewhere. I have only mentioned these two circuits briefly because detailed treatment involves much formidable mathematics.

Coupling

So far we have connected the aerial direct to the tuning circuit. The aerial, however, does not have a very high impedance and its effect on the tuned circuit is to " damp " it. An analogous condition would be to place one's hand on a bell when it is struck. The vibrations in the bell, as you know, would die away almost immediately. In these circumstances a tuned circuit is less selective and its ability to select one station without interference from others is impaired.

To obviate this damping another coil is wound in close proximity to the tuning coil, one end being connected to the aerial and the other end to earth; see Fig. 5. Clearly, the further this coil is removed from the tuning coil the less signal voltage is induced into the tuning coil, but the more selective the tuning circuit becomes.

Conversely, the closer the two coils are together, the greater is the voltage induced into the tuning coil but the less the selectivity obtained. A compromise has to be reached, therefore, between these factors. A very simple way of coupling a tuning circuit to an aerial is merely to connect a small capacity condenser between the aerial and the circuit.

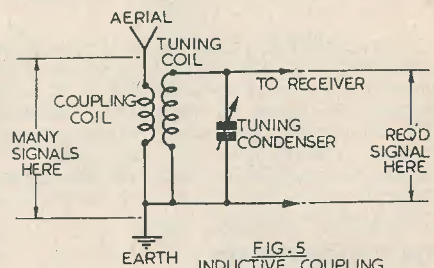


FIG. 5
INDUCTIVE COUPLING FROM AERIAL TO TUNED CIRCUIT

RC 207

The condenser, being of very low value, represents a high impedance in series with the aerial and therefore reduces some of the damping effect. In very simple receivers such a condenser is often connected between the aerial and the coupling coil, and is made a variable component in order that the coupling between the aerial and the tuning circuit can be varied at will.

Next month we will combine our knowledge of valves and tuned circuits, and deal with oscillators and detectors.

THE " WYRE-JOYNT "

A useful item for the emergency repair kit on field days, or on any occasion where it is not possible to use a soldering iron, is the " Wyre-Joynt." This consists of a ceramic tube or connector containing a lining of solder and a non-corrosive flux. The wires to be joined are carefully cleaned, inserted one in each end of the tube, and heat from a couple of matches applied to the tube. The result is a perfect joint which is, moreover, insulated. An illustrated leaflet describing this item is available from Wirejoints Ltd., 355-8 Grand Buildings, Trafalgar Square, London, W.C.2.

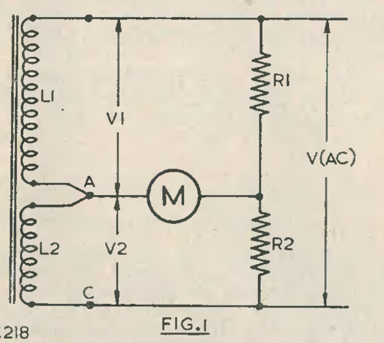
Transformer Ratio Finder

by M. C. Paul

Among enthusiasts and radio experimenters generally, there has been a long-felt need for some simple, ready-to-hand method of determining the ratios of transformer windings. This is especially true where secondhand and surplus transformers are acquired. The author has brought a simple principle to bear upon this problem and has, for a few shillings, fabricated a very useful device.

The Working Principle

Fig. 1 depicts a simple, double-wound transformer with its windings L1 and L2 in series across an alternating voltage source V. Thus the individual winding voltages V1 and V2 together add to V, L1 and L2 being in effect a potential divider, and when their relative resistances are in proportion to the relative impedances of L1-L2, then points A



RC218 FIG.1

and B are at equal potential, and the voltmeter M will read zero, or very nearly. i.e., Zero reading on M when:

$$\frac{L1}{L2} = \frac{R1}{R2}$$

It will be seen that the impedance of a winding need bear no relationship in ohms to its opposing resistor, and that, providing the above equation holds true, the combined values of R1+R2 need not equal X1+X2. This fact is useful inasmuch as fairly high ohmic values may be used, and the degree of 'loading' of the transformer windings adjusted where necessary.

Under zero reading (M) conditions, the percentage load on each winding is the same, and accurate evaluation of their mutual turns ratio is automatically indentical to the ratio R1/R2.

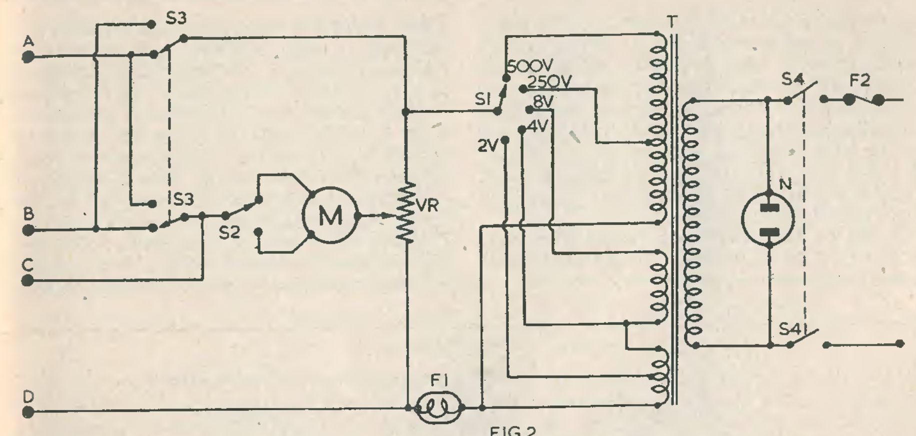
Fig. 1 is not intended to depict a practical circuit, and in Fig. 2 R1, R2 is replaced by a variable resistor to which an old degree-calibrated type of tuner knob is fitted. Since this potentiometer is wirewound its action is linear, and a fixed pointer may be placed at its 90° position. This pointer enables the angles either side of it to be read directly off the scale in degrees, and their ratio to equal that of the windings under test. i.e.:

$$\frac{L1}{L2} = \frac{VRa}{VRb} = \frac{\angle a}{\angle b} \quad \text{: see Fig. 3.}$$

The Practical Circuit

In the foregoing survey of the operating principle the potential difference between points A and B was taken as zero. This is, however, not strictly so, as the windings are inductive and the potential at A will be appreciably out of phase with that at B, thus a minimum reading will be obtained and not necessarily a zero one. For this reason a meter incorporating a high voltage range is shown in Fig. 2, the actual reading being of no importance. This out-of-phase voltage will generally be small, since the input V will usually be kept well below the operating voltage of the windings under test.

M as shown is a dual range Moving-Iron meter of the pocket tester type, and should have as high an internal resistance value as possible to minimise the out-of-phase current across it. S3 is a 2-pole, 2-way switch for the purpose of reversing one winding, should it be 'cross-connected' to AB. VR is a 50kΩ wirewound potentiometer of the 3-5 Watt variety and should be of good quality and contact. S1



RC219 FIG.2

is a 5-way, 1-pole selector switch, which selects various values of input voltage for application to the transformer under test, i.e. A-D. T can be any type of mains transformer, but the 250-0-250 volt 60mA, 4 volt, 2-0-2 volt types is best suited. The primary of T is, of course, standard 240/230/220-0, and is isolated from the mains by the 2-pole, 1-way switch S4, and protected by the fuse F2. It will be noted that a small fuse, F1, has been included between VR and the common output line of T. This serves to protect it from failures of any windings under test, but if desired may be omitted. A 50 mA rating is ample for F1, and 0.1A rating for F2. N denotes a 0.5W 240V neon lamp across the T primary; this is a useful accessory and will give visual warning in red of the energised condition of the tester.

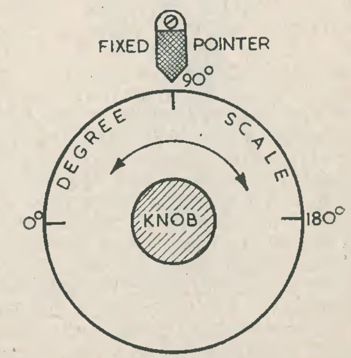
Some Possible Modifications

Some constructors of the unit may dislike the slight nuisance value of the out-of-phase potential across the meter; this may be obviated at the expense of another meter. It will, however, be argued that where two meters are incorporated they might very well be placed across AB and CD respectively and VR dispensed with. This is true, but the author prefers the easily read degree scale of VR to two separate meter scales, which often would be indicating on separate ranges. Mistakes are therefore more likely. For the sake of completeness, and for those who worship at the shrine of high accuracy—VR may be retained by placing one meter from A to C and the other from B to C (Fig. 1) and VR adjusted for *identical* readings of the meters. Dual ranges should be a feature of each instrument, and their range switches ganged.

When testing certain types of transformers, a voltage input between 250 and 8 may be necessary and may be easily added as shown in Fig. (4). With such an arrangement the neon should be brought to an earth terminal so that warning of *live metalwork* is given. Under this arrangement it *will not* glow under correct operating conditions. Where space is available an extra 40 to 60 volt transformer may be included or one embodying the extra winding(s) procured.

Using the 'Tester'

Before the transformer to be tested is connected to the tester it should be checked for continuity of its windings with an ohmmeter.



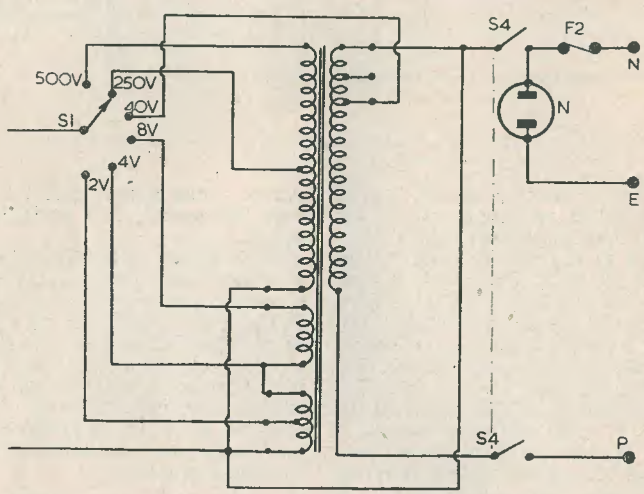
RC220 FIG.3

The ohmmeter readings will also indicate whether or not the windings are of low or high voltage rating. Fig. 2 will be taken as the circuit used. After connecting the transformer to the AB, CD terminals, ensure that VR is centrally positioned, i.e. with the fixed pointer on the 90° graduation, and that S1 is switched to the 2 volt (lowest) range of input voltage. The tester can then be energised by closing S4, when N should glow.

It will be advantageous to know something of the type of transformer under test before proceeding further.

until the meter indicates zero or minimum reading; the angles either side of the fixed pointer may now be noted and compared, $\angle a/\angle b$, and the winding ratio thus determined.

Resistances may be compared in the same way, but care must be taken to ensure that they are not over-run. Condensers, or rather Capacitative Reactances, may similarly be compared, but are better suited to the twin meter modification due to their greater out-of-phase-effect upon a single meter. However, where Capacitances are required with accuracy it is better to utilise a simple bridge, where the



RC 221

FIG.4

As far as the Ratio Finder is concerned, there are three kinds of transformers: (a) Mains types requiring a high energising voltage of 250 to 500 volts. (b) Intervalve types where ratios are fairly close and only low voltages, comparable to their signal handling capacities, are required, i.e. from 2 to 8 volts. (c) High ratio transformers associated with loud speakers where medium voltages are required. It is, of course, advisable to energise a transformer core reasonably, and not to 'starve' it of flux by grossly under-volting the windings. Also, care must be exercised in using S1 *to prevent over-volting* and subsequence damage to the transformer.

Bearing these points in mind, S1 is set to an input somewhat lower than that rated for the windings under test, after first switching S2 to High (scale). If the meter reading is small it can be shown to greater accuracy on the lower scale. VR is then swung to and fro frequency is accurately known.

Some Constructional Points

One of the chief sources of irritation in test equipment are the output terminations. The author has found that the old type of screw-down bakelite capped type are about the best, especially when provided with a small diametrically drilled hole. In the original tester four such terminals were utilised in conjunction with leads attached to rubber shielded crocodile clips. The fuses are best bolted to the panel so as to be readily accessible.

Since most pocket types of voltmeters are provided with twin input prongs, these may be brought straight to the range toggle switch S2 via small press-on cylinders of sheet brass or copper. In so doing, no harm is done to the prongs or heat transferred to the movement during soldering, as the short switch-to-meter wires are soldered to these cylinders before pressing them onto the prongs. The neon indicator should project through the panel so that its glow may be readily seen.

Where an earth terminal is used (Fig. 4) the *metalwork must not* be connected to it, as the neon could be short circuited where the frame is used as a 'common line' via soldering tags from the various components.

The original unit was contained in an aluminium box with a hinged lid (approx. 6½″×6″×3″). The transformer and neon holder were secured inside the box, the mains lead entering it via a grommet in the side. All other components were attached to the panel cover and linked to the box interior components with a multicore flexible cable such as that employed by several manufacturers for linking cabinet mounted speakers to chassis. This unit is a simple one, and no difficulty should arise in its construction or operation. It will be found an asset by all 'junk box' enthusiasts.

VERSATILE RESISTANCE, CAPACITANCE BRIDGE

continued from page 578

The Power Factor control is calibrated from 0 to 60 per cent and measures the power factor of condensers from about 0.1μF to over 10μF. To calibrate this control, short out the 1μF standard condenser and turn the control to zero resistance. The control is then rotated and balanced by means of resistors connected across the test leads. Table 2 shows the power factor percentage against the amount of the potentiometer resistance in circuit, and the points should be marked on the small scale. A perfect condenser has a power factor of zero; many good quality paper condensers will have a very low power factor; electrolytic condensers usually show a much higher figure. In use, after the condenser being tested has been measured for its value by peaking the deflection of the tuning eye, the power factor control is then rotated and it will probably be found that the eye will open out still further until it peaks again. At this point the power factor of the condenser is read off the scale.

Table giving the ranges and their coverages:

TABLE I

Range 1: 10Ω to 1,000Ω. 100Ω "standard."
Range 2: 1,000Ω to 100,000Ω. 10,000Ω "standard."
Range 3: 100,000Ω to 10MΩ. 1MΩ "standard."
Range 4: 10pF to 0.001μF. 100pF "standard."
Range 5: 0.001μF to 0.1μF. 0.p1μF "standard."
Range 6: 0.1μF to 10μF. 1μF "standard."
Range 7: Match.

RESISTANCE (OHMS).	POWER FACTOR %.
0	0
160	5
320	10
485	15
650	20
820	25
1000	30
1190	35
1400	40
1610	45
1830	50
2080	55
2370	60

In operating the sensitivity control, it will normally be turned about $\frac{3}{8}$ to $\frac{1}{2}$-way round, but for very small capacities of, say, below 30pF, whose reactance at 50c/s is extremely high, it will usually be necessary to employ the full sensitivity of the instrument. Also, when dealing with such small capacities it is advisable to disconnect the test leads and strap the component directly across the terminals. To maintain the accuracy on Range 4 (10pF to 0.001μF) it is a good idea to earth the case of the bridge, a terminal being provided for the purpose. Capacities of 8pF, are easily measurable, the null point being quite sharply defined.

When completed, the instrument should be given a coat of grey or black paint; the author's case was finished in black crackle and a 4″ carrying handle fitted. Once constructed it is sure to find a dozen uses around the workshop or shack, and will well justify the care with which it has been built.

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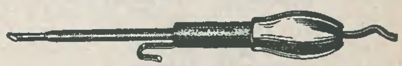

Reg. Design No. 860302
(British, U.S. and Foreign Patents

Designed for wireless assembly and Maintenance
Supplied for all volt ranges from 6/7v to 230/250v.
3/16" Dia. Bit Standard Model 25/6
Sole Manufacturers **ADCOLA PRODUCTS LTD.**
Sales Office and Works: **Cranmer Court, Clapham High St. London SW4** (MAC 4272)

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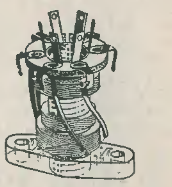
IR5	7/9	6F6g	8/6	6SA7	7/6	6V6g	8/6
IS5	7/9	6F12	7/6	6SG7	6/6	6V6gt	8/6
IT4	7/9	6G6	5/9	6SK7	6/9	8D3	7/6
IS4	7/9	6J5g	4/6	6SN7	8/6	12AT7	7/9
3S4	7/9	6K7g	4/6	6SQ7	7/6	12AX7	5/9
3V4	7/9	6K7	6/6	6X4	8/6	57	6/9
5U4g	8/6	6K8gt	8/6	6X5	7/6	954	2/-
5Z4g	8/9	6K8g	8/9	7C7	7/9	2C34	2/-
6AM6	7/6	6Q7g	8/9	7H7	6/9	EB91	6/6

MATCHED PAIRS 6V6g and gt 17/–; 6F6G 17/–; KT66 21/–; 807 15/6; 6G6 12/–; 6J5g 9/6 per pair
P. and P. 6d per valve

R. COOPER
32 SOUTH END CROYDON SURREY

R E P

HIGH GAIN DUAL RANGE COIL WITH REACTION



COMPLETE WITH 2 BATTERY AND 2 MAINS CIRCUITS

PRICE 4/- POST 3d.
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Radio Experimental Products Ltd.
33 MUCH PARK STREET COVENTRY

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FOR SALE Receivers R107, R208. UHF Receiver needs alignment. Hunts Bridge, C. R. B., Avo 7, Radio Magazines etc. SAE, all letters answered. Box No. C125.

FOR SALE E.E. Televisor, 9" Magnetic P.M. Focus, 6 kV EHT. Working order, fitted in spotless commercial console cabinet. Bargain £20. TV Amateurs only. Box No. C128 or AMB 3706.

FOR SALE BC433, 200-1700 kcs. £2. BC800, 15 valve IFF, 30/–. Indicator 62A, less VCR97, 35/–. Approx. 150 surplus valves, metal and GT, cheap. 55 copies *Electronic Engineering* 26/–. 60 copies *Wireless World* 25/–. Carriage extra. Kimber, 61 Gale Lane, Acomb. Yorks.

FOR SALE Lane Tape Table and M.O.S. Amplifier with oscillator, nearly completed, needs one head, unused, first offer £12. Apply Head Master, St. Ignatius College, London, N.15.

EXCHANGE Brand new R1224A for "Globe King" with three or more coils, or would sell R1224A, £5. Box No. C127.

FOR QUICK SALE any reasonable offer will secure the following, singly or otherwise. BC312N, R1155 Model F, R1355 converted sound, needs power pack and speaker. Readily converted vision with RF24, 25 and 26 units. 63DS, 11¾ inch Electrostatic Tune in original crate. All in good condition. Box No. C115.

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FOR SALE SWL selling up has for disposal PCR Rx together with usual "junk" valves and circuit diagram, whole load of magazines and text books. SAE for list. £15 or near offer. Swanson, 83A Downscourt Road, Purley, Surrey.

FOR SALE Two 813 valves, Sylvania, brand new. One CV128 valve. Offers to Davey, 6 Station Road, Dunstable, Beds.

(*continued on page 607*)

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5 HARROW ROAD LONDON W2
Open Mon. to Sat. 9—5.30 (Thurs. 1 p.m.)
Telephone **PAD 1008/9 and 0401**

SPECIAL VALVE OFFER

Ten EF50 Brand New (Ex-Units) 55/– set.

SET OF 5 MAINS VALVES
6K8CT, 6K7GT, 6Q7G, 5Z4, 6V6G or KT61, at **42/6** Set.

SET 5 AC/DC VALVES
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SET 5 AC/DC VALVES
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SET 5 AC/DC VALVES
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SET OF 4 BATTERY MINIATURE 1.4v. VALVES
1R5, 1S5, 1T4, 1S4 or (3S4 or 3V4) at **32/6** Set.

SET OF BATTERY VALVES 2 volt MAZDA TYPES
TP25, HL23/DD, VP23, PEN25 or QP25 at **27/6** Set.

COMPLETE SET OF 10 SPECIFIED VALVES FOR "PRACTICAL TELEVISION" PERSONAL REC.
5- 6AM6, 2- 6AK5, 1- EA50, 1- 6J6, 1- 6C4 and 3BP1 C/R Tube in case at **£5.12.6** Set.

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6v. 1 amp G.E.C. ...	4/–
12v. 2½ amp. Westinghouse ...	12/6
12v. 4 amp. S.T.C. ...	17/6
12v. 8 amp. S.T.C. ...	32/6

S.T.C. RECT'S. E.H.T.

K3/25 650v. 1 m/a. ...	4/7
K3/40 1000v. 1 m/a. ...	6/–
K3/100 8,500v. 1 m/a. ...	14/8
K3/200 10,500v. 1 m/a. ...	26/–

H.T. RECT'S

S.T.C. 150v. 120 m/a. ...	4/6
S.T.C. 250v. 250 m/a. ...	18/–
G.E.C. 1 m/a Meter Rect. ...	11/6

RECEIVER R1355. As specified for *Inexpensive Television.* Complete with 8 valves VR65 and 1 each 5U4G, VU120, VR92. Only **55/–** *carriage* 7/6. Brand new in original case.
RF24 **25/–**, RF25 **25/–**, RF26 **59/6**, RF27 **59/6**.

CATHODE RAY TUBES
VCR97. Guaranteed full picture **40/–**, *carriage* 2/–.
VCR517. Guaranteed full picture **40/–**, with Mu-Metal Screen.
3BP1 Suitable for 'scopes **25/–**, *carriage* 3/–.
Mu-Metal Screens **10/–**. 6" Enlargers **17/6.**

PYE 45 Mc/s STRIP. Type 3583 Units. Size 15"x8"x2". Complete with 45 mc/s Pye Strip, 12 valves, 10 EF50, EB34 and EA50, volume controls and hosts of Resistors and Condensers. Sound and vision can be incorporated on this chassis with minimum space. New condition. Modification data supplied. Price **£5,** *carriage paid.*

INDICATOR UNIT TYPE 182A. This unit contains VCR517 Cathode Ray 6" Tube, complete with Mu-metal screen, 3 EF50, 4 SP61 and 1 5U4G valves, 9 wire-wound volume controls and quantity of Resistors and Condensers. Suitable either for basis of Television (full picture guaranteed) or Oscilloscope. Offered BRAND NEW (less relay) in original packing case at **79/6.** *Plus* 7/6 *carriage.*

VCR517C BLUE AND WHITE 6½in. TUBE
This Tube replaces the VCR97 and VCR517 without alteration and gives a full Blue and White picture. BRAND NEW in original crates, **45/–,** *plus* 2/– *carriage.*

"WEYMOUTH" 3-WAVE BAND COIL PACKS
Short, Med. and Long with Gram. Switch. Brand New Miniature type complete with circuit, **19/6.** P.P. **1/6** Absolute bargain.

SEND 3d. FOR 28-PAGE CATALOGUE

SMALL ADVERTISEMENTS

(continued from page 605)

FOR SALE Eddystone S640 with Instruction Book, mint condition, £20, write—Edwards, 40 Butler Estate, London, E.2.

WANTED Information on converting the ex RAF TR 1340 receiver. R. Kevern, 72 Nelson Road North, Great Yarmouth.

TRADE

FREE CATALOGUE now available, Viewmaster, Tape, Gram. etc., at lowest prices. Swift Radio, 21 Hibbert Road, Harrow, Middlesex.

OAK TYPE SWITCH SERVICE. Multi-Way Switches made to specification, approx. cost 2/6 Clicker Plate + 2/- per wafer. Box No. C117.

I.P.R.E. PUBLICATIONS. 5,500 Alignment Peaks for superhets 5/9. Sample copy *The Practical Radio Engineer* 2/-. Membership-examination particulars 1/-. Syllabus of TV and radio courses free and post free. Secretary, I.P.R.E., 20 Fairfield Road, London, N.8.

FREE ! Brochure giving details of Home Study Training in Radio, Television, and all branches of Electronics. Courses for the Hobby Enthusiast or for those aiming at the A.M. Brit.I.R.E. City and Guilds Telecommunications R.T.E.B., and other professional examinations. Train with the College operated by Britain's largest Electronic organisation. Moderate fees. Write to E.M.I. INSTITUTES, Postal Division, Dept. RC28, 43 Grove Park Road, London, W.4. (Associated with H.M.V.).

METALWORK. All types cabinets, chassis, racks, etc. to your own specification. Philpott's Metalworks Ltd. (Dept. R.C.), Chapman Street, Loughborough.

KENDALL AND MOUSLEY, Manufacturers of Laboratory Equipment, chassis and instrument cases, also suppliers of B.V.A. valves, Radio and T.V. components. 99 Dudley Port, Tipton, Staffs.

Announcement

New Service for the Amateur and Experimenter

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

AMATEUR STATION RECORD CARDS, 6″×4″, best quality card, for recording that QSO and full details of the contact. An invaluable aid to quick reference of stations worked etc., 3/- per 100 from Data Publications, 57 Maida Vale, London, W.9.

(continued on page 608)

CLYDESDALE
Ex-Services Electronic Equipment

SPECIAL CABINET OFFER

WALNUT-FINISH WOOD RADIO CABINET
Dim.: Int. 8½in.x15⅝in.x7⅞in. approx. Ext. 9½in.x17in.x 8in. approx. With 3 W.B. glass dial, expanded metal L.S. grill. 3 1½in. dia. fluted knobs.
ASK FOR No. B/H945. **25/-** POST PAID

WALNUT-FINISH CABINET
With other items as H945 plus 2-gang 350PF. Condenser, 5 valveholders (your choice), 3-bank wavechange switch 2-pole 5-way each bank, 16-8 mfd. 450V. El. cond. and clip, 2-speed S.M. drive, drum, 4 pulley wheels, 9 assorted tag strips, ½ meg. volume control with switch.
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Ready Made for T.V.

THE POWER UNIT TYPE 285
A.C. mains, i put 230V. 50 cps. Outputs E.H.T. 2kV. 5 mA. H.T.350V. 150 mA. L.T. 6.3V. 10A. and 6.3V. 5A. Fully smoothed and rectified with valves VU120, 5U4G, VR91 (EF50) plus cond., resistors, etc.
ASK FOR No. B/H947 **£4. 19. 6** CARRIAGE PAID

NEW LIST No. 8D gives details and illustrations of ex-service and other items. Price 1/6. (Credited on first 10/- purchase).

Order direct from: *Telephone SOUTH 2706/9*
CLYDESDALE SUPPLY CO. LTD.
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Branches in Scotland England and North Ireland

We are sorry . . .

that we cannot repeat our December publicity offer, but as we are continually being asked for the L.M.S.2 coil-pack together with the specially matched pair of I.F. transformers we are now offering a parcel comprising these items. The price is surprisingly low at **£2.7.6** *post paid.*

L.M.S.2. Miniature Coil Pack
38/6 *Post & Pkg.* 1/6
*3 wave band.
*High quality—outstanding performance.
*Only 5 wires to solder—one nut to tighten.

Miniature 465Kc. I.F. Transformers
12/- *Post & Pkg.* 1/-
**Specially matched to L.M.S.2. Coil unit.*

Supplied Separately or in bargain parcel.

5" Loud Speakers brand new nearly all sold last few **11/6** *post paid*

DEAL COMPONENT CO.
105 Evering Road N16

SMALL ADVERTISEMENTS

(continued from page 607)

"GLOBE-KING" (Regd.) Miniature Single Valve Receiver gets real Dx. Amateur Radio enthusiasts, should send for free copy of interesting literature and catalogue (enclose stamp for postage). Write to makers: Johnsons (Radio), 46 Frair Street, Worcester.

BOOKBINDING. Volumes of *Radio Constructor* and *Radio Amateur* fully bound, imitation leather, gold lettering, 7*s* 6*d* post free. Prices for other publications on application. Jerome Alcock; CHEADLE, Stoke-on-Trent.

JOIN THE ISWL. Free services to members including QSL Bureau, Translation, Technical and Identification depts. Dx certificates, contests and activities for the SWL. Monthly magazine 'MONITOR' duplicated, containing articles of general interest to the SWL and League member, 10/6 per annum, post free. ISWL HQ, 86 Barrenger Road, London, N.10.

BLUEPRINTS. High Gain 10 Metre Converter, with a de-luxe circuit comprising EF91 RF stage, ECC91 double triode mixer and oscillator, EF92 IF amplifier, with stabilised voltage supply via a 7475. 1*s* 8*d* post free with full instructions. A.S.W.P., 57 Maida Vale, London, W.9.

Miller's "PANL"—the air drying black crackle enamel. From dealers 3*s* 6*d* jar or direct 4*s* 6*d* including postage. —8 Kenton Park Crescent, Kenton, Middx.

OSMOR—for efficient coils, coilpacks etc. Send 5*d* stamp for FREE circuits and lists. Dept. RCC, Osmor Radio Products Ltd., Borough Hill, Croydon, Surrey. Tel. Croydon 5148/9.

VALVES, VALVES, VALVES, EF91, EC91, 6J6, EL91, 12AX7, 6SJ7M, 7/6. EF92, 6C4, EAC91, 6J5, 6J7, 6N7, 6/-. 6AL5, D77 6/6. 12AT7, 6BW6, 6SN7, 6SL7, 807, 6V6M, 9/-, 3C23, 3B25, 15/-. Skillman, Franchise Street, Weymouth.

ARE YOU STUCK? PRE WAR VALVES from 6/- each WAVEMETERS, VOLT and MILLIAMP-METERS from 15/-. S.A.E. for list. LAWRENCE, 134 Cranley Gardens, London, N.10.

RADIO CONTROL THAT MODEL. Circuits, Methods, unlimited advice, Details, 3/6. Carter, A.M.I.E.T. 101A High Street, Harlesden, N.W.10.

VALVES! VR21 1/6; VR18 3/-; ARP12 3/9; HL23 2/6. 6J5 5/-; EF50 7/6; (Red 8/6). Alladin coils 9*d*. 4 mfd. 350v. Electrolytic condrs., 1/6. 20mfd. 50v. 1/6. 6 valve American Command receivers less dynamotor. Cases soiled only 37/6 inc. valves. Add 6*d* postage under 10/-. 2½*d* stamp for Bargains list. Pimble, 12 Liverpool Road, Newcastle, Staffs.

"YOU CAN RELY ON US"

COILS
Wearite "P" Coils. All types in stock including AF.1, RF.1. Price 3/-.
Midget I.F. Transformers Type 800. **21/-** *per pair.* Standard Type 500/501 (465Kc/s) **20/-** *pair*

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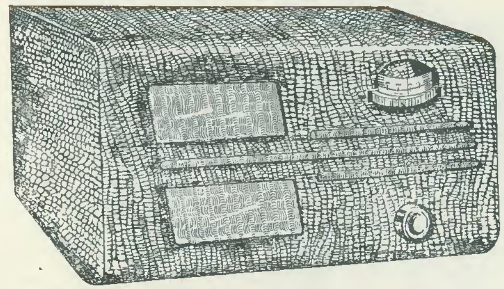
1200ft Reels **35/-**
Spare Reels **4/3**



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Osmor Midget iron-cored "Q" Coils **4/-** *each.* Leaflet on request.
Coilpacks Type H.O. **52/-**. LM **43/4**, MTS **54/2**, TRF **43/4** all including Tax.

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All new Postage Stamp Ceramic. 4-70pf **8d**, 40-100pf **10d**, 20-150pf **1/-** 100-550pf **1/3**.

LINECORD
3-way ·3a at 60 ohms per foot **6d** ft., ·2a at 100-ohms per foot **8d** ft

The "MAXIMITE" AC/DC SUPERMIDGET SUPERHET — *Full Plans 1/-*

WAVECHANGE SWITCHES
Midget rectangular Type, 2P2W **2/6**, 2P3W **2/6**. Midget Circular Type 1P12W, 2P6W, 3P4W, 4P3W, each **3/6**.
Standard Yaxley Type (2 Bank) 2P11W, 4P5W, 6P3W, 8P4W, **7/6** *each.*
All above are NEW and have 2" Spindles

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RM1 **5/3**, RM2 **6/3**, RM3 **7/-**, RM4 **21/-**, K3/45 **8/2**, K3/50 **8/8**, K3/100 **14/8**. Westinghouse 36EHT100 **29/4**, 14A86 **20/4**, 14D36 **11/-**, WX6 **3/9**, WX6 **3/9**.

T.C.C. CONDENSERS
Midget Picopack, 1mfd 350v, 2mfd 150v, 10mfd 25v 20mfd 12v, *each* **2/6**.
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1⅜" WALNUT or IVORY...Volume, Focus, Contrast, Brilliance, Brightness, On/Off, Record/Play, Tone, Bass, Treble, Wavechange, Tuning, Radio/Gram., Brill/OnOff, S.M.L.Gram. All **1/6** *each.*

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MACaulay4155

fidelity at all speeds
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Uniformity within a reel ± 0·5 d.b.

Frequency Range
50 c/s to 10 kc/s at a playing speed of 7½ in/sec.

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