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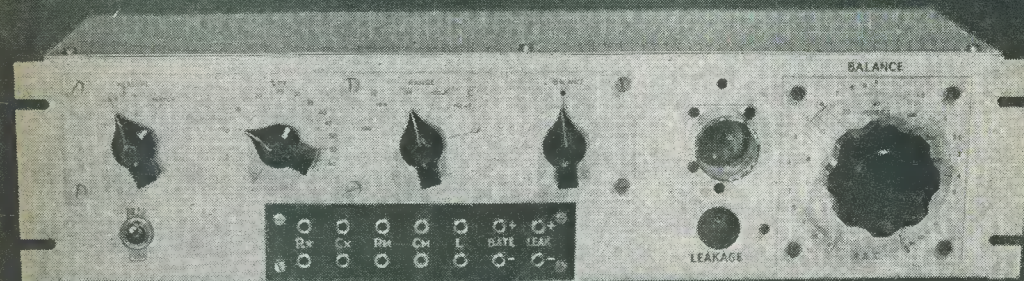
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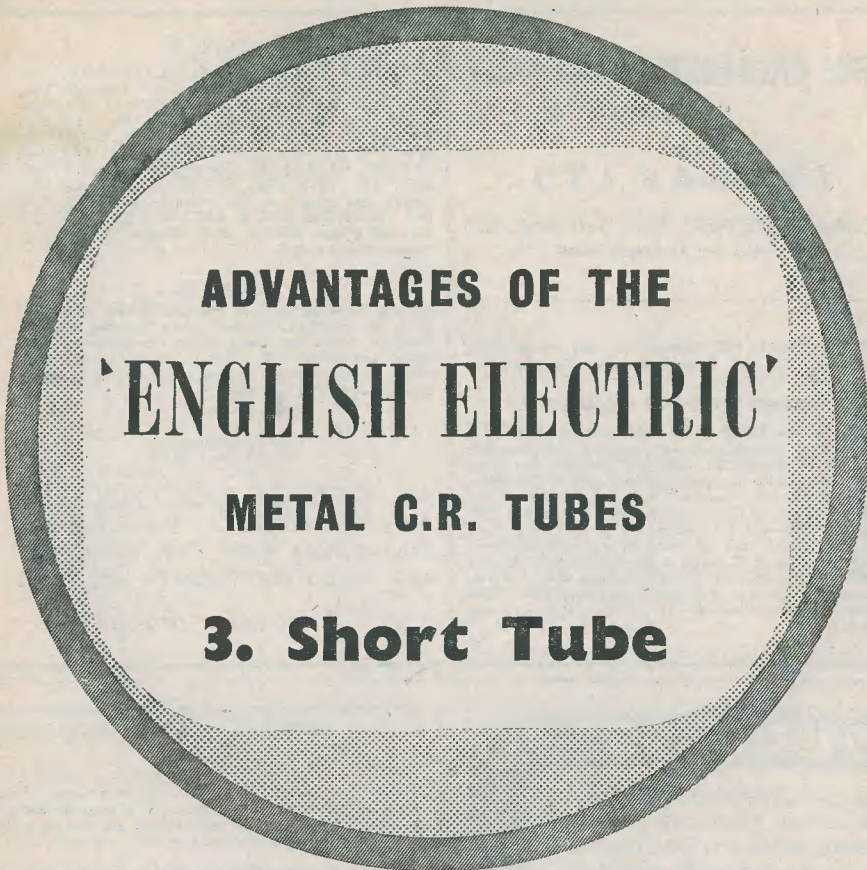
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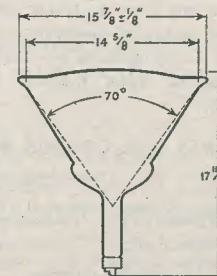


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Edited by C. W. C. OVERLAND, G2ATV

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ON TVI

The extension of the television service area to cover Scotland means that a further section of the Amateur Transmitting Fraternity will become involved in the trials and tribulations of TVI.

We read, too, that a group of MP's propose putting forward a motion for the televising of sponsored programmes during those times when the BBC is itself quiescent.

Ignoring any other reactions, should this proposal come to fruition it will mean still further curtailment of the transmitter's hobby—or will it?

We prefer to think that the Amateur will accept the challenge, which is not confined only to this country, and that he will, in the end, meet it as successfully as similar situations have been met in the past.

Our own experience of television interference is that as soon as the picture becomes distorted, local viewers immediately call and want to know what the heck we are up to—simply because we have a transmitting license!

Even when we prove that the transmitter is cold, and that we ourselves are viewing and suffering from the same interference, we can see that we are excused only for this one occasion.

In future, we are going to produce a copy of *TV Fault Finding*, and persuade the irate viewer that he should purchase one and carefully study the illustrations therein before apportioning the blame.

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. 17: AC/DC/BATTERY POWER SUPPLY

This month we give a power supply circuit suitable for use in an AC/DC/Battery receiver. This circuit allows a four-valve superhet to be operated either from 200 to 250 volt AC or DC mains, or from a 90 volt HT battery and a 6 volt LT battery (two 3 volt units in series). It is considered not worthwhile including the added complications needed to allow the use of a 1.5 volt LT cell, as this would necessitate both filament and bias switching when changing from mains to battery operation. It is, in any case, usually considered economical to employ a separate LT supply, and this could consist of a 6 volt battery just as easily as it could of a 1.5 volt cell.

Circuit Details

The superhet circuit proper employs four valves: 1A7, 1N5, 1H5 and 1A5 output. The filaments of these valves are connected in series. Owing to the fact that the combined cathode currents of the 1A7 and the 1N5 pass through the filaments of the 1A5 and the 1H5, these latter are shunted by R5, which maintains their filament current at the correct value of 50 mA. The cathode current of the 1N5 by itself at the top of the chain would be too small to affect the filament current of the 1A7 overmuch, and no further filament regulating resistors are fitted.

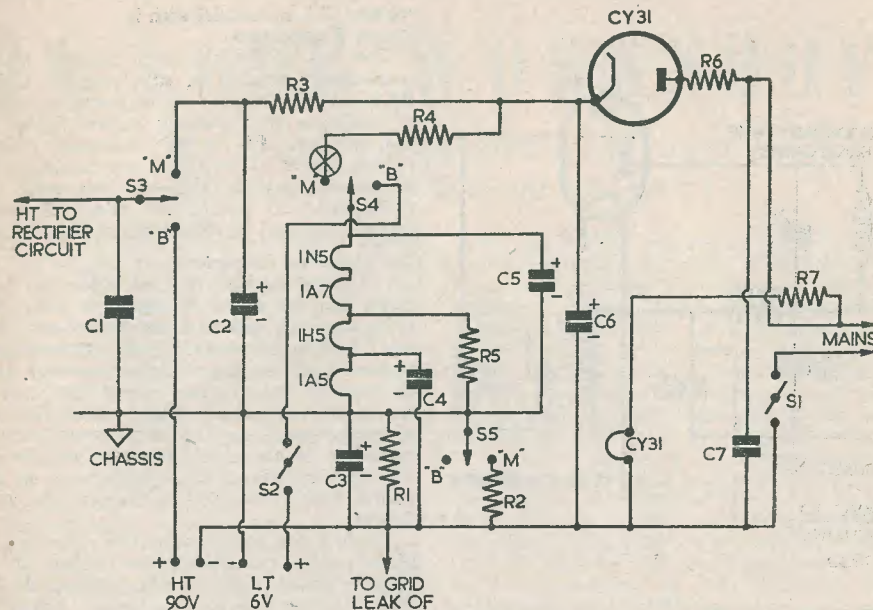
As the 1A5 takes the greatest cathode current, this valve is connected at the negative end of the chain. The 1H5 takes the least cathode current of all the valves, but it is necessary to supply its filament at a more negative potential than those of the 1A7 and 1N5 in order that AVC may be obtained at the correct standing voltage. Using the arrangement shown in the diagram, the standing AVC voltage automatically ensures a bias of 1.5 volts to the 1A7 and 3 volts

to the 1N5.

The varying AF currents passed by the anode of the 1A5 are liable to build up corresponding voltages across its filament. These voltages could be passed to the filaments of the other valves and so cause audio feedback. It is recommended that the grid leak of the 1H5 be taken to its own filament to reduce this effect. In order to make doubly sure, the filament of the 1A5 is decoupled as well—by C4. C4 is taken to the negative end of the bias resistor R1 instead of to chassis, in order that it may be given a higher polarising voltage. It may be found possible to omit C4 in some receivers.

Mains/Battery switching is effected by S3, S4 and S5. This switch does not handle a great deal of current and it could consist of a miniature wave-change type, if desired. It is inadvisable to operate this switch when a mains supply is switched on. Should such an eventuality occur, however, the electrolytic capacitor connected permanently across the filaments (C5), will prevent a current surge here. There will, nevertheless, still be an HT surge if C2 has an opportunity of charging up when the set is switched to battery operation; and this may cause damage to the valves. If possible, a fool-proof arrangement should be made by means of which it is only possible to switch to battery operation when the mains plug is fitted to a housing in the receiver.

When S3, S4 and S5 are switched to "Battery," the filaments are connected directly to a 6 volt LT battery, and the HT supply to a 90 volt HT battery. Automatic bias (4 volts) for the 1A5 is supplied by reason of the HT current from the negative pole of the HT battery flowing through R1. The receiver is switched on and off by S2, which



C599

FIG. 1

CIRCUIT OF AC/DC/BATTERY POWER SUPPLY

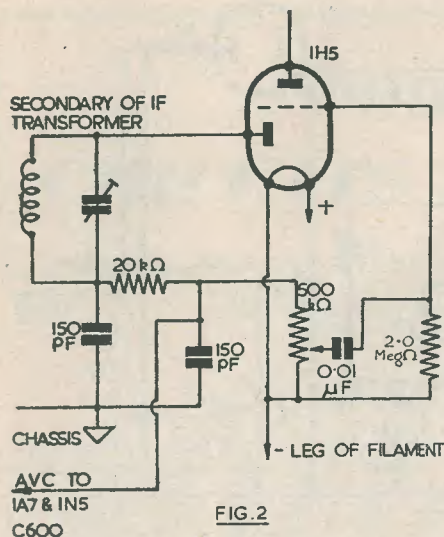
Values of Components

Capacitors		R3	14 kΩ; 5 watts.
C1	1 μF or more	R4	4.5 kΩ; 15 watts.
C2	8 μF; 250 WV.	R5	1 kΩ; ½ watt.
C3, 4, 5	25 μF; 12 WV.	R6	150 Ω; 2 watts.
C6	See text.	R7	1,050 Ω; 50 watts.
C7	0.01 μF; 750 WV.	Switches	
Resistors		S1, 2	On-off switch
R1	400 Ω; ½ watt.	S3, 4, 5	Mains/Battery switch.
R2	80 Ω; ½ watt.		

breaks the LT current. It is difficult to devise a means of breaking the HT supply because the receiver on-off switch will probably be of the two-pole type fitted to the volume control; the second pole being needed for mains switching. Therefore, on battery operation, the electrolytic capacitor C2 is disconnected from the HT circuit as it might otherwise discharge the battery whilst the set was switched off. Nevertheless, a capacitor across the HT supply is still desirable in order to prevent instability when the battery runs low. For this reason it is recommended that C1 be connected per-

manently across the HT battery; this capacitor being a paper component with a value of at least 1μF.

When the receiver is switched to mains operation, the filaments are supplied from the cathode of the CY31 rectifier, the voltage being dropped to the correct value by R4. Smoothing of the filament supply is effected by C6 and C5. HT is also supplied from the CY31, this being dropped by R3 and smoothed by C6, C2 and C1. As, now, the filament as well as the HT current would pass through the bias resistor R1, the value of this is effectively reduced by switching another



resistor, R2, in parallel with it.

Mains Components

The rest of the circuit is devoted to the components needed for supplying the CY31. R6 is a limiter resistor whose purpose consists of reducing the charging pulses passed by the rectifier. R7 is the dropping resistor for the heater of the CY31 and could consist of one element of a 3-way line cord. C7 is included to reduce the effect of mains modulation and to reduce mains interference.

The Reservoir Capacitor

It will be noticed that no value has been given for the reservoir capacitor C6. This is because the value of this component may be critical, and the writer would rather suggest a means of finding it experimentally than to state an actual value which may not be accurate in practice. The reason for this policy is that if too high a value of reservoir capacitor is used, the rectified voltage on AC may be higher than that given on DC mains, with consequent damage to the valve filaments.

To find the correct value for C6, the filament supply line should be broken at the point marked with a cross and a 0–100 milliammeter inserted in series. Capacitor C5 should be short-circuited and a 9,000 ohm resistor connected across C2. The receiver should be set to mains operation, connected to a 230 or 240 volt AC supply and switched on. To ensure full emission it is worth while using a fairly new rectifier valve and to allow it to warm up for five minutes or so. C6 should then be experimentally determined, this being done by increasing its value in 2 μF steps until the current reading in the milliammeter is 50 mA or just below.

Only new electrolytic capacitors (or reliable paper capacitors of any reasonable age) should be used for this purpose, as otherwise they may have lower actual values than those printed on their cases. When the correct value has been found a new capacitor again should be installed. The filament current obtained may very gradually drop as this component ages and loses its capacitance; but this process will take a considerable time and is, in any case, better than burning out the valves by initially using too large a capacitor.

The Second Detector

It was stated above that the position of the 1H5 in the filament chain automatically ensures correct biasing of the 1A7 and 1N5, and that its grid leak should be returned to filament. To clarify this statement a recommended second detector circuit for the 1H5 is given in Fig. 2.

IN YOUR WORKSHOP

This month J.R.D. discusses that well-known ex-RAF Receiver—the R1155

One of the most popular receivers offered on the surplus market since the war ended has been the R1155. Its popularity has probably been mainly due to the fact that it is very easily convertible for home use, and because the low prices at which it has been offered for sale have definitely constituted a worth while bargain.

Nevertheless, some constructors have still had a little difficulty in getting good results from this receiver, and so a few hints might not be out of place in these columns.

Power Supplies

The first thing to remember with this set is that the HT negative line is not common to chassis. In fact, the automatic bias circuit fitted between HT negative and chassis is fairly complicated and can quite easily be put out of balance. A recommended HT smoothing circuit is shown in Fig. 1. The important part of this circuit lies in the fact that the two smoothing capacitors (and especially the reservoir capacitor) must be returned to HT negative and not to chassis. If the chassis of the power pack is connected to that of the receiver this point is liable to be overlooked. A common fault consists of taking a separate HT negative connection from the centre-tap of the mains transformer secondary (as is correct) but omitting to connect the electrolytic capacitor cases, or negative lugs, to this point instead of to chassis.

A further point worth remembering lies

in the fact that the HT applied to the receiver should not exceed 200 volts. This is because, in some of the older or badly-stored models, voltages in excess of 200 are liable to cause capacitor breakdowns. If a capacitor connected between HT positive and chassis (either directly or via a choke or low-value resistor, etc.) should break down, incidentally, it will probably also cause one of the bias resistors to burn out. The first bias resistor to suffer is usually a 2.2 kΩ quarter-watt resistor tucked underneath the chassis to the front of the left-hand side. It is sometimes difficult to trace a broken-down HT decoupling capacitor in this receiver; whereupon a check of the mica capacitors in the back compartment of the BFO unit can occasionally bear fruitful results.

Usually, however, capacitor breakdowns confine themselves to the 3 × 0.1 μF capacitors mounted near each valve, or to the upright single 0.1 μF capacitors fitted inside the coil box.

Leaky capacitors can be very troublesome as, should they cause excess HT current to be drawn, the automatic bias voltages increase and cause poor sensitivity.

Another reason for keeping the receiver HT at 200 volts or below is due to the fact that too much heat may otherwise be dissipated inside the set, with consequent frequency drift on the highest frequency range. The question of heat dissipation really precludes the additional fitting of a large output valve

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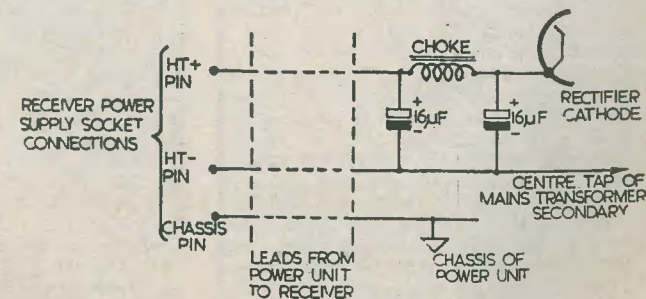
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Fig. 1 A suggested smoothing circuit for the R1155, ensuring an isolated HT negative line.



C601

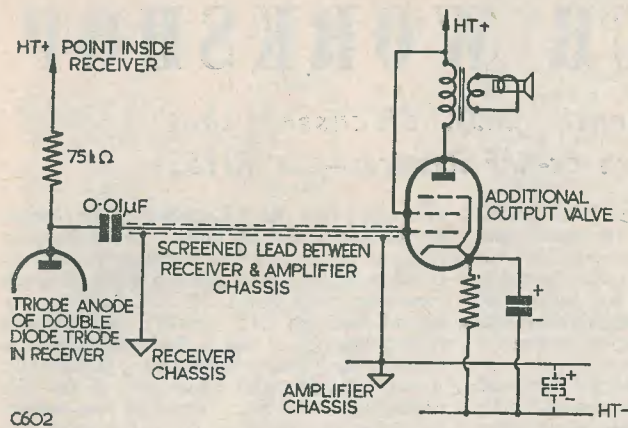


Fig. 2 Fitting an additional output valve. It is a good plan to mount this valve (with the speaker transformer) on the same chassis as the power pack. The electrolytic capacitor shown in dotted outline will be needed in occasional instances only.

inside the receiver case. (The best plan consists of fitting such a valve to an external power pack chassis).

Output Circuit

When an additional output valve is fitted to the R1155, care must be taken to avoid upsetting the bias network. One of the simplest ways of ensuring that this does not happen consists of using cathode bias for the additional valve, and to supply its cathode from the HT negative line and not from chassis. A 25 μ F low voltage electrolytic capacitor between HT negative and chassis is sometimes helpful in removing hum when the extra valve is used; but it is needed only in occasional cases.

The output valve already fitted in the receiver is a triode, (part of the double diode triode second detector), and its anode feeds into an AF transformer which alters the impedance to that required for high resistance phones. Better quality will be obtained if this transformer is disconnected and a resistance-capacitance circuit used for feeding into the new output valve. This conversion is quite simple, consisting merely of breaking the screened lead to pin 3 of the valve in the receiver, and substituting a 75 k Ω resistor between that pin and the nearest HT positive point. No decoupling is necessary. A 0.01 μ F capacitor from the same pin can then be connected to a screened lead which carries the AF to the additional output valve. Fig. 2 shows the circuit both for this method of coupling and for the new output valve. For the sake of neatness, the screened lead could travel to the external output valve

via the now disused headphone output pin on the supply socket.

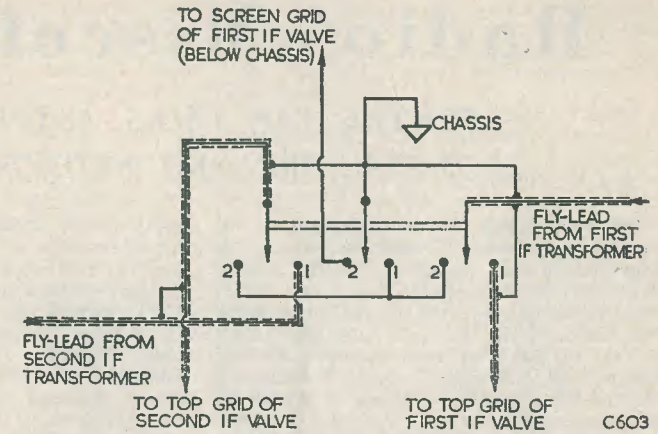
Variable Selectivity

Owing to the high selectivity of the IF circuits, quality of reproduction from the R1155 is not always as pleasant as that provided by most domestic receivers. If the constructor cares to experiment a little, he could fit a switch to the receiver designed to cut out the first IF valve and the second IF transformer when better quality reproduction is desired. This will, of course, cause a considerable loss in sensitivity, although it will ensure higher fidelity reception of local stations.

A suggested switch circuit is shown in Fig. 3; and it will be seen that this has two positions. On position 1 the fly-leads from both IF transformers are connected to their respective grids, and normal working results. The link which, on position 2, bridges the first IF valve and the second IF transformer, is now connected to chassis on position 1; this connection preventing it from assisting a possible capacitive coupling between grids resulting from inter-contact switch capacitances. On position 2, the "fidelity" position, the fly-lead from the first IF transformer is taken to the grid of the second IF valve. At the same time, the screen-grid of the first valve is connected to chassis, thereby rendering the valve inoperative. It would probably be advisable to increase the wattage of the screen-grid resistor to allow for the extra current which would then flow.

If it is decided to fit a switch of the type just described it will, of course, have to be

Fig. 3 Using a switch to provide two degrees of variable selectivity. (See text).



mounted as close to the valve grids as is possible. The chassis connection would need to be taken from the nearest point above the chassis that is available. The length of the lead to the screen-grid of the first valve is relatively unimportant, but all the grid leads must be screened and kept very short. It is possible that instability will be caused by capacitive coupling on position 1 and, to prevent this, the two sets of contacts devoted to switching the fly-lead of the transformer and the grid of the second IF valve should be on opposite sides of the switch wafer. If trouble still occurs, the two sets of contacts should be screened from each other. An easy method of doing this could consist of using a double-wafer switch with a screen between the wafers. As mentioned above, the link between the two sets of contacts can cause no trouble because it is earthed on position 1.

The writer has mentioned earlier that this is an experimental circuit. He makes this statement because, although he has satisfied himself that cutting out the valve and transformer *does* improve quality, he has not himself installed such a switch in an R1155. Nevertheless there is no reason why, if care is taken, the circuit should not work properly. Some difficulty will be caused by the lack of space available for mounting the switch, and for controlling it from the already crowded front panel. (One possible solution to the question of panel space could, of course, be given by removing one of the D/F controls). However, these problems are not insurmountable

and are well within the scope of the average constructor's ingenuity.

I must hasten, before the wrath of readers falls too heavily upon my head, to point out a misprint which occurred on page 212 of the January issue in "In Your Workshop." As published, the third paragraph on this page starts: "It is true that the vast majority of constructors do allow themselves to ignore the necessity of employing adequate screening in their designs..." Unfortunately, the little word "not" was omitted after the word "do"! Most readers will probably have realised that there was a mistake somewhere, since the printed sentence does not fit in with those following. Nevertheless, I think I should point out the omission; if only to keep on the safe side!

J.R.D.

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Radio Miscellany

CENTRE TAP TALKS ABOUT SET CONSTRUCTION AND PHOTOGRAPHY

The cylindrical chassis arrangement of one of the newer TV receivers, which has four sub-chassis arranged radially around the neck of the cathode ray tube, makes one wonder how long the present conventional flat chassis style will last, and also reflect on the evolution of ordinary radio receiver design. In the earliest days of broadcasting all the components, including a whole lot of unnecessary switches, terminals, rheostats, etc., were mounted on both sides of a slab of ebonite which was then laid flat across the top of a box. The valves were stood on top, mounted in loose pins. Incidentally, it was not until some time later that holders were introduced, and then they were of solid ebonite as deep as the valve base itself.

The bright emitters of those far-off days gave off a brilliant light, so in any case we should have probably felt it a shame to waste it by shutting them up in a box, even if such a revolutionary idea had occurred to us! So much so, that when in later years it became fashionable to use a vertical ebonite panel we fitted the valve holders on to the back of it so that we still had the satisfaction of seeing their re-assuring glow through a piece of gauze mesh.

Then came the breadboard era, and during that period we sometimes, by way of variation, arranged the valve line-up to run from right to left instead of the more usual left to right. Quite why, no one has ever discovered. Obviously, with those crude straight sets there was no real improvement in the lay-out, and we still cheerfully tolerated grid and anode leads of longer-than-strictly-necessary proportions.

The Next Step

As the circuits began to get more complicated, panel and breadboard construction became universal and its influence remains with us to-day, but before the breadboard itself was finally abandoned it became the mode to metalise it. This was sometimes done by spraying one surface with metallic paint, or more usually by lining the upper surface with copper or brass foil.

In turn, this led to the inverted tray which could hardly be bettered for the design of

most simple apparatus, until recently. The miniaturisation of valves and components, and the additional space demands of modern equipment (especially that incorporating a CRT, such as test gear and TV receivers), is causing designers with more advanced ideas to ponder whether, after all, the single chassis is the best constructional form. It seems wasteful and irrational to cluster everything on to the two surfaces of a single sheet, especially when several times the amount of space inside the cabinet remains unused.

The popular demand for a booming bass requiring a large baffle area, and the cheapness of materials entailed, gave no great incentive to designers to cut down the cabinet dimensions in pre-War years. It is now easier to get an adequate bass response with a much reduced baffle area, while the increased cost of materials in themselves are a sufficient urge to reconsider the distribution of components.

Tight Fit

Compactness, too, provides further grounds for a re-orientation of our ideas. During the War, aircraft equipment particularly had to be squeezed into the least possible space, although the tendency to any marked extent has been delayed in influencing design.

It is fairly certain that the multi-deck chassis will become increasingly popular in TV receiver construction. Such apparatus lends itself admirably to encouraging the urge to modernise our ideas. The circuits fall naturally into separate units—Sound, Vision, Time base and Power. By treating them as such they can be so much more conveniently disposed around the cathode ray tube.

Our ideas on sound receiver component disposition may well become modified, and will certainly not seem so revolutionary, once we get used to cylindrically designed TV receivers. In about 1935 one leading manufacturer introduced a receiver built in a drum-shaped bakelite cabinet little bigger than the speaker itself. The components of this set were spread around the inside of the cabinet. This particular model,

while popular in itself, failed to set a new fashion. Possibly the prejudice of servicing engineers helped to discourage manufacturers generally from adopting it, although other departures from the single deck have repeatedly appeared among the portables.

Every reader who has had occasion to service one will be well aware of the headaches they cause when it comes to making replacements. One very nearly has to pull the thing to bits and then, as likely as not, you find the substitute part just won't fit, despite the apparently insignificant difference in physical proportions. Anyway, without a servicing chart, it is usually a bigger puzzle to discover the correct order of dismantling than it is to understand the explanatory notes from the torn-up bits of an Income Tax form.

Three Guesses

A reader asks if any special equipment is necessary to enable photographs to be taken of cathode ray tube traces and TV pictures. It is rather odd he should ask me (except of course it is cheaper than Query Corner where a fee of 2/6 is charged) as I have never, as far as I can remember, hinted that I am an expert photographer. Oddly enough, I did make some of the earliest published pictures of TV—back in early 1937, I believe. I remember, then, I took an exposure reading and obstinately decided it was all cock-eyed, and then proceeded on trial and error lines—only to find out the meter was near enough right after all.

Last year, whatever conceit remained regarding my expertness was rather shaken when I went to the local group on R.S.G.B. Field Day. It seemed that almost everyone else who turned up came armed with a Leica, Contax or Rolleiflex, etc. I felt like hiding my mere twenty-odd-pound camera under my jacket and sneaking silently away. Instead, I fell to pondering (a) why there is such a to-do whenever the question of increasing R.S.G.B. subscription rates is mentioned and (b) why there are not more amateur photographs in radio magazines.

Since then I have decided (a) they had probably only borrowed the cameras for the day from their wealthy and clever photographic friends (b) nobody likes paying more for anything than they have to, and that it is just as well to have a grumble to make sure that none of the services are reduced despite the increase of a few extra shillings, and (c) that radio amateurs don't flaunt their best photos, as it might mistakenly be thought they are inclined to boastfulness. After all, they have a reputation for being modest chaps and not given to shooting a

line about the DX they've worked or heard, so one would hardly expect them to make a display of the best photographs they turn out. Maybe I'm wrong on all three points.

The Seeing Eye

To get back to our reader's question. Photographing both oscilloscope traces and TV pictures is possible with an ordinary good camera. I am presuming, of course, that the trace is of a recurrent nature which remains steady for up to a fifth of a second or so while the exposure is made. Transient traces are rather out of the question for even the average experienced photographer, although there is a book published by a film manufacturer which deals with the subject in detail. This book, incidentally, deals with taking pictures with simple apparatus as well as with more specialised equipment.

The photographing of a TV picture is a comparatively straightforward job, although to get a picture of even density the shutter speed should be some multiple of one twenty-fifth of a second. With the lens in question (f/4.5) a fifth of a second should, with a fast film, be about right, or the lens can be stopped down if desired and the exposure prolonged accordingly. Obviously pictures can only be made when there is no movement during the exposure, which rather limits the subjects which can be photographed, except with a faster lens.

The reason for basing the exposure on a given number of 1/25th seconds is, of course, because that is the time taken for the spot to fully scan the screen. A fiftieth for tracing the first set of lines and a fiftieth for the interlace. Any other speed is likely to produce a picture showing two differing brightnesses—the greater the overall exposure, the lesser the contrast between them. As the conjuror said, it is the quickness of the scan that deceives the eye!

The only other point to watch—make sure no extraneous light is falling on the outside of the screen, as this might cause reflections and loss of detail.

The Undeceived Eye

I wonder how many readers noticed that during the TV broadcast of a recent International match the commentator apologised for being uncertain of details of the play on the far side of the field, owing to poor light.

The camera penetrated the gloom far better than the eye, and viewers enjoyed a clear view of the points of play that were lost to the commentator. It was certainly odd to hear him saying that he *thought* such and such a thing had happened, when all the time you *knew* it had.

A MAINS OPERATED BRIDGE

by W. E. THOMPSON

ACKNOWLEDGMENT

The writer does not claim originality for the circuits and principles described in this article other than the switching facilities he has devised which render calibration simpler and handling of the bridge easier. Similar basic circuits were published some few years ago in *WIRELESS WORLD*, and by M. G. Scroggie, B.Sc., M.I.E.E., in his book *RADIO LABORATORY HANDBOOK*, where he describes the circuits for measuring resistance, capacitance and inductance. The method of calibrating and the formulae involved are also due to him.

The bridge described by the present writer, unlike that due to Scroggie, has the inductance bridge incorporated in the same mounting (or case) as the resistance and capacitance bridge, instead of being a separate item which can be connected to the main bridge as occasion demands.

The method of construction is, however, an original design.

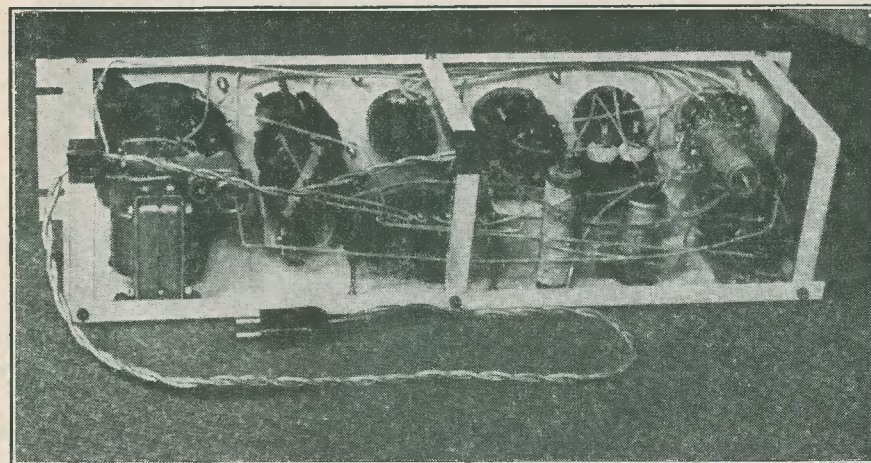
Most radio men reach the stage eventually when the need is felt for a reliable bridge, but find that the cost of a suitable instrument is beyond their means. They fall back, therefore, upon that maid-of-all-work, the multi-range meter, and if it happens to have a capacitance range as well as a resistance range one makes do for the time being, hoping that one day a more accurate and versatile instrument will be found.

A bridge which can measure capacitance, resistance and inductance under the same roof, so to speak, is naturally regarded as being in

the "expensive" class, as no doubt it would be if one is prepared to pay the price. The instrument to be described is not expensive to make, is reasonably accurate, and covers the three classes of measurement mentioned, with the addition of a few frills. It can be made up mainly from components obtainable in the surplus market, and the only aspect which can in some cases present a difficulty is the calibration, since it is preferable to have access to an accurate decade resistance box. In the absence of this it is still not impossible to calibrate, but the task is in consequence made a little more difficult. Therefore, beg, borrow or steal a decade box.

The instrument has the following features:—

1. Measurement of resistance from 1.0 ohm to 100 Megohms.
2. Measurement of capacitance from 10 pF to 100 μ F.
3. Measurement of inductance from 1.0 H to 1,000 H.
4. Provision for applying up to 100 mA DC component on inductors to be measured.
5. Measurement of power factor, expressed as a percentage, on capacitors of 0.01 μ F and upwards.
6. Neon lamp leakage test indicator.
7. Facilities for matching resistors and capacitors against a required value.
8. Magic eye balance, or "null point," indicator.
9. Mains unit for power supply.



The resistance and capacitance ranges are each covered in three steps, and the bridge is responsive to values from 1/100th to 100 times that of the standard value in use. At the extremes of the ranges, however, the sensitivity is less, so that the most reliable parts of the calibration are found to be between 1/10th and 10 times that of the standard. The lower sensitivity is particularly noticeable when measuring resistance over 10 Megohms and capacitance below 10 pF, due to the fact that high impedance is offered to the 50-cycle excitation. This can be improved by stepping up the AC voltage applied to the bridge on these ranges, and a method of doing this will be given later in the article. The ranges covered are as follows:—

Standard	Useful Range	Extremes of Range
Resistance:		
100 ohms.	10 ohms to 1.0K ohms.	1.0 ohms to 10K ohms.
10K ohms.	1.0K ohms to 100K ohms.	100 ohms to 1.0 Megohm.
1.0 Megohm.	100K ohms to 10 Megohms.	10K ohms to 100 Megohms.

Capacitance:

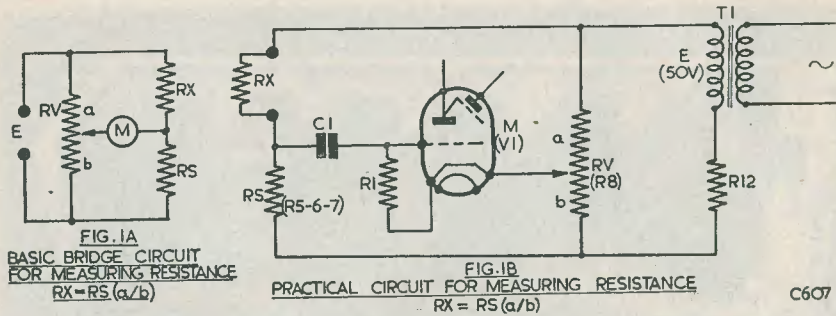
100 pF.	10 pF to 0.001 μ F.	Up to 0.01 μ F, not reliable below 10 pF.
0.01 μ F.	0.001 μ F to 0.1 μ F.	100 pF to 1.0 μ F.
1.0 μ F.	0.1 μ F to 10 μ F.	0.01 μ F to 100 μ F.

Inductance is covered in one range from 1.0 H to 1,000 H, the scale closing progressively as the value gets greater, and the standard used is a close-tolerance 0.25 μ F paper capacitor.

Power factors up to 60 per cent. are indicated by a calibrated variable resistor in series with the standard 1.0 μ F capacitor.

In order to fully understand the operation of the bridge, some consideration of its basic circuits will not be amiss. The simplest form of resistance bridge is shown in Fig. 1A. This comprises a known standard value R_s , the unknown value to be measured R_x , a variable ratio arm R_v , a source of excitation E , and a balance indicator M . It can be shown, and for that matter it is generally known, that if

Measures: RESISTANCE
CAPACITANCE
INDUCTANCE



Rv is rotated to a position where M indicates no current flowing, the bridge is balanced, and under these conditions $R_x = R_s(a/b)$. Therefore, any value of R_x can be found, within the limitations of the instrument, and the ratio arm Rv can be calibrated in terms of (a/b) . The range of the bridge is altered by changing the value of the standard R_s , and the calibration of Rv still holds good since it refers to ratios, not actual values. In Fig. 1B the practical application of this basic circuit is shown.

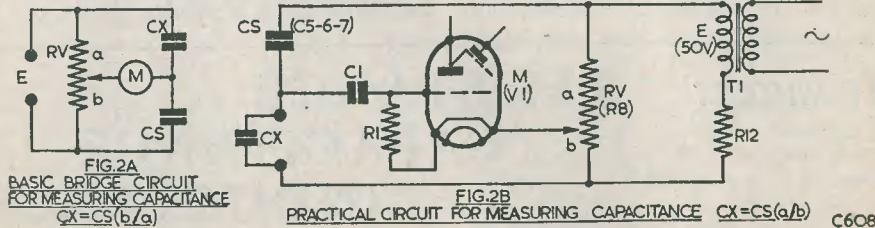
By replacing the resistors R_s and R_x with capacitors C_s and C_x as in Fig. 2A, any value of capacitance can be measured in the same way, but in this case when the bridge is balanced $C_x = C_s(b/a)$. It will be noticed that in effect the ratio arm Rv now reads the reverse way round, since the ratio (a/b) in the resistance equation now appears as (b/a) in the capacitance equation. To avoid having to make two separate initial calibrations for Rv, provision is made on the actual bridge to reverse the positions of C_s and C_x , and this can be seen in the full circuit diagram for the instrument.

Incidentally, by obviating the need for an additional scale the chances of mis-reading it are removed also, so there is less risk of interpolating a value incorrectly. The circuit of Fig. 2B is the practical version of the basic circuit of Fig. 2A.

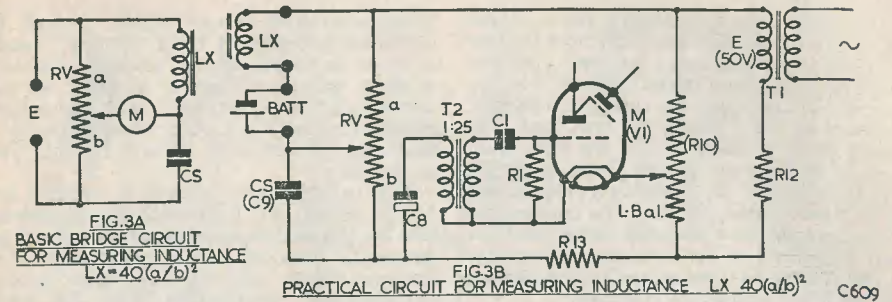
If, now, C_x is disconnected and replaced by an inductor, as in Fig. 3A, the impedance of L_x can be balanced against C_s . Since in most iron-cored coils the resistance is fairly small compared with the reactance, it can for most practical purposes be neglected, so by regarding the impedance as a reactance it is possible to obtain a measure of the inductance. For this bridge, on balance $L_x = 40(a/b)^2$. It is thus possible to make an inductance calibration on the scale of Rv, using this formula. Fig. 3B depicts the practical circuit condition of the bridge for measuring inductance.

Under working conditions an iron-cored coil usually carries a steady DC as well as an AC component (e.g., a speaker field or smoothing choke), and altering the value of the DC has a noticeable effect on the inductance. Increasing the DC reduces the inductance and vice versa,

C607



C608



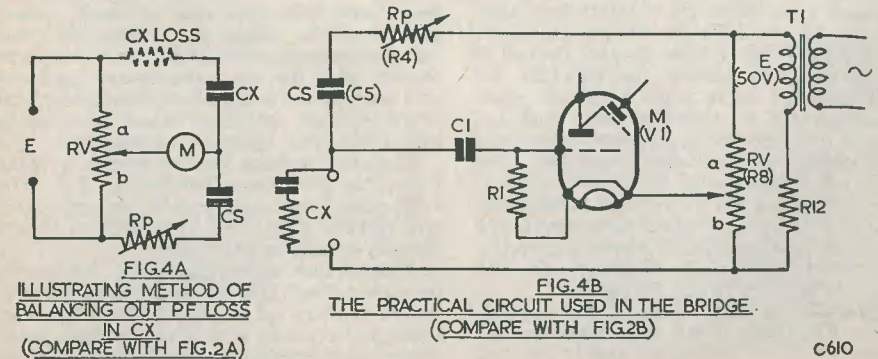
C609

so in order that one can obtain an indication of the inductance of a coil under working conditions, provision is made in the bridge to apply DC through the coil under test. A battery, variable resistor and milli-ammeter will be needed, and it should be noted that the applied DC ought not to exceed 100 mA.

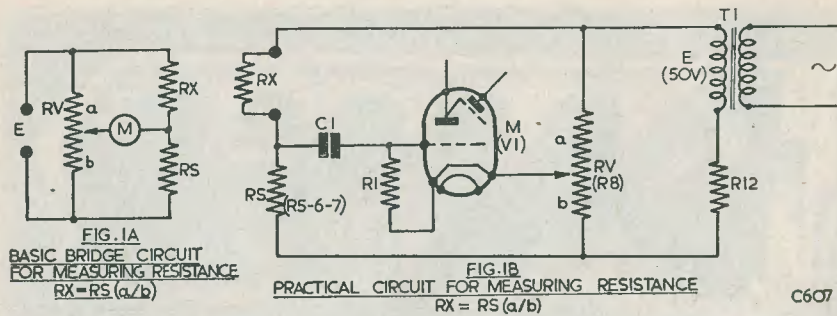
When a capacitor becomes faulty it develops a degree of internal leakage resistance. An ideal capacitor has no losses; the current then leads the applied voltage by 90° . Power factor can be expressed in terms of the cosine of the phase angle ϕ between the current and voltage, so for our perfect capacitor since $\cos 90^\circ = 0$, the power factor = 0. If now the capacitor has inherent resistance the phase angle becomes less than 90° , so $\cos \phi$ becomes some figure between 0 and 1. By multiplying this figure by 100 and expressing it as a percentage, one can say that a capacitor has a power factor (or "badness" factor) of, say, 10 per cent. This is the method adopted in this bridge.

If such a capacitor were placed on the bridge for measurement it would not be possible to obtain a clear balance, but by deliberately adding resistance in series with the standard C_s we can simulate the fault in the component being measured, and balance it out. Fig. 4A gives the principle of the scheme, and it should be compared with Fig. 2A to which it bears marked resemblance. The loss in C_x is represented by the dotted resistor in series with it, whilst the variable resistor R_p in series with C_s can be adjusted to balance it out. Fig. 4B shows how the power factor control is introduced in the full bridge circuit. When balancing the bridge Rv and R_p are both set so that a clear balance is obtained (there is some inter-dependence between them) and the capacitance is read off Rv in the manner already described. The power factor will be shown by the position of R_p on a scale previously calibrated.

It is sometimes necessary to match components against a required standard, such as



C610



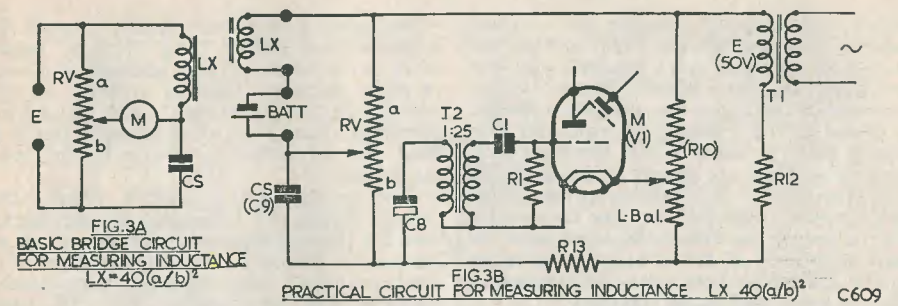
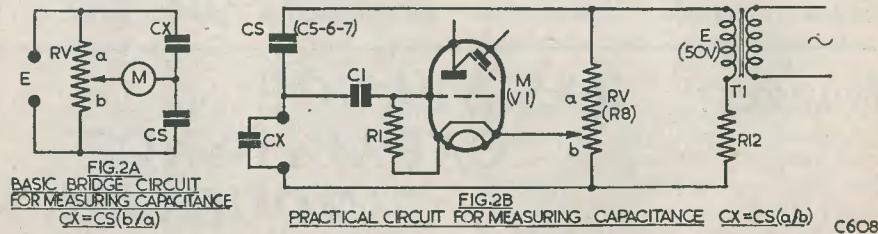
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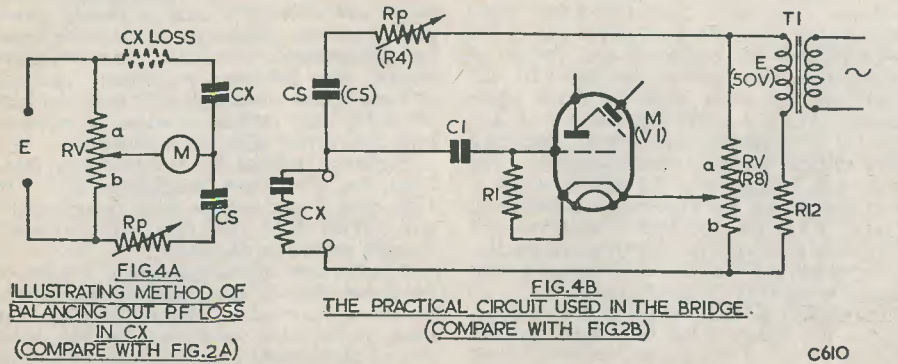


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It is sometimes necessary to match components against a required standard, such as



anode and cathode resistors for a phase splitter, or the resistors and capacitors used for inter-stage couplings in a "quality" push-pull amplifier. By means of the "Match" facility provided on the bridge the component selected is placed in the "standard" arm, and after setting R_v to 1, where $a = b$, the other components on hand are placed in the R_x or C_x arm as necessary. By adjusting R_v the amount of difference in the values of the components can be judged, so that those which need the least adjustment of R_v to balance the bridge can be selected as those most closely matching the one being used as the standard.

The full circuit for the bridge is shown in Fig. 5. In the upper part will be seen the neon leakage indicator, the magic eye which shows balance of the bridge, and the power supply for this part of the circuit. The lower part consists of the arms of the bridge and its excitor. The main functions are selected by the switches S_1 - S_6 , which are all ganged, being a 2-bank Yaxley type switch with 3-poles 3-ways on each bank. These switches are shown in the diagram set at the position for measuring resistance or capacitance. S_7 , the range switch, selects the standard resistor or capacitor required, and this switch is preferably of the ceramic type in order to keep strays to a minimum. A paxolin type, of doubtful vintage which the author tried was found to introduce nearly 60 pF error on the 100 pF range.

The standard resistors R_5 - R_7 should be 1 per cent. tolerance precision carbon type, rated at 1.0 watts. These are not very expensive items, but close-tolerance capacitors can present a problem to shallow pockets. Having this in mind, the tolerances have been relaxed somewhat—the 100 pF standard should be 1 per cent. and need not cost a great deal, whilst the 0.01 μ F standard of 2 per cent. tolerance can also be fairly reasonable, but when it comes to a 1.0 μ F standard a close-tolerance component can cost a fair sum. This can be overcome by making use of the properties of the bridge in the course of construction. By setting up the 0.01 μ F range one can select a good 1.0 μ F paper capacitor which is a little less than 1.0 μ F and adjust it to the desired accuracy by means of a small variable trimmer wired in parallel. The bridge will balance with R_v at 100, which is an extreme range, but with care an accuracy of, at most, ± 5 per cent. ought to be achieved, and is certainly good enough for measuring electrolytics which are usually manufactured with tolerances between 20 and 50 per cent.

The heart of this bridge is the variable resistor R_8 , which is the main ratio-arm R_v of Figs. 1 to 5. It is essential that it be a well

constructed and robust article, smooth in operation and control, for a "jumpy" resistance element here can ruin attempts to obtain a sharp balance. There is available on the surplus market a 1,000 ohm 10 watt component which is about 3 ins. diameter, and this is a first class job eminently suitable for this type of bridge.

The variable R_{10} is used to balance the bridge initially for inductance measurements, and the physical requirements here are not so stringent. Provided that a smooth control is present, almost any 500 ohm wire wound variable will be suitable. The 200 ohm resistors R_9 and R_{11} serve to limit the current in R_{10} , so there is no reason why this latter should not be 1,000 ohms and R_9 , R_{11} omitted.

The 0.25 μ F capacitor C_9 is the standard for inductance measurements and should be fairly close tolerance. It can be selected and adjusted in the same way that the 1.0 μ F standard was obtained, but it should nevertheless be of good quality and have a negligible power factor.

Transformer T_2 is 1 : 25 step-up ratio and can be a small output transformer. The 0.02 μ F capacitor across its secondary serves to limit the effects of any harmonics which may be introduced by T_2 . The 25 μ F capacitor C_8 prevents DC from the external battery flowing through the primary of T_2 , and it is important that this electrolytic is wired the right way round. Other components are not critical, and their tolerances are indicated in the list of items given later.

The circuit of the magic eye is conventional, and it will be seen that when the bridge is balanced no voltage change exists between its triode grid and cathode. The shadow angle will therefore be at its maximum. Varying degrees of unbalance reduce the shadow angle, and the balance point will be found to be quite clear and sharp.

The modest power requirements of the magic eye necessitate only a simple power pack, and the current to operate the neon leakage indicator is derived from the same source. For the neon, the author used one of a pair taken from an S.B.A. indicator, and the 4.7K ohm resistor is wired in series to limit the current taken by the lamp.

Excitation voltage for the bridge is taken from the 50V 50mA winding of T_1 . The 1.0K ohm 3 watt resistor R_{12} prevents excessive current drain from this winding should the test sockets be shorted.

A front view of the instrument is given in the Cover Photo (Fig. 6), and a rear view with the cover removed is seen in Fig. 7. With these photographs and the sketches giving constructional dimensions it should be possible

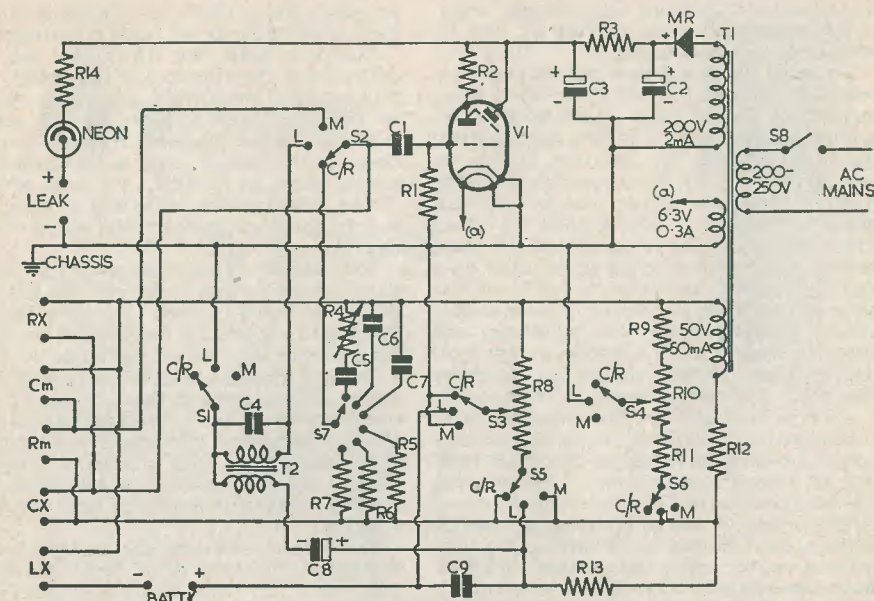


FIG. 5
CIRCUIT OF THE BRIDGE

C611

LIST OF COMPONENTS

R1	4.0 Megohms $\frac{1}{2}$ watt 20%	C9	0.25 μ F 350V working paper tubular (for tolerance see text)
R2	2.0 Megohms $\frac{1}{2}$ watt 20%	S1-S6	2-bank, 3-pole, 3-way Yaxley type, paxolin
R3	10K ohms $\frac{1}{2}$ watt 10%	S7	On-off toggle
R4	2.5 K ohms Wire wound variable, linear law	S8	1-bank, 1-pole, 6-way Yaxley type, ceramic (Note. If S_9 is included, this switch should be 1-bank, 2-pole, 6-way).
R5	1.0 Megohm 1 watt 1% precision carbon	V1	EM1, EM34, or similar
R6	10K ohms 1 watt 1% precision carbon	MR	J50 rectifier, or similar
R7	100 ohms 1 watt 1% precision carbon	T1	Mains transformer, Primary 200/250V Secondaries, 200V 2mA; 6.3V 0.3A; 50V 50mA. (For constructional details see text)
R8	1.0K ohms 10 watt Wire wound variable, linear law. (Berco).	T2	1 : 25 output transformer
R9	200 ohms 1 watt 20%	T3	1 : 3 or 1 : 4 interval transformer, if required
R10	500 ohms 3 watt Wire wound variable, linear law.	Other items	Suitable valveholder for V1, low voltage neon and holder, 14 wander plug sockets, say 6 wander plugs, 4 crocodile clips, 2" diam. knob, 4 small pointer knobs, 16 SWG aluminium sheet, 1/16" perspex, 1/8" paxolin, wire, sleeving, screws, nuts etc.
R11	200 ohms 1 watt 20%		
R12	1.0K ohms 3 watt 10%		
R13	500 ohms 2 watt 10%		
R14	4.7K ohms $\frac{1}{2}$ watt 20%		
C1	0.01 μ F mica		
C2	8+16 μ F 350V working Electrolytic		
C3			
C4		0.02 μ F 350V working paper tubular	
C5	1.0 μ F paper 200V working (for tolerance see text)		
C6	0.01 μ F mica 2%		
C7	100 pF mica 1%		
C8	25 μ F 25V working Electrolytic		

to reproduce this bridge fairly simply, but it is thought some written instructions may be acceptable by constructors.

The front panel and base are bent up from one piece of aluminium sheet, the cover being made from another piece. Half-hard quality is quite strong enough in the thickness quoted, the bends making the structure assume its own rigidity. A tip here regarding the trimming of edges—the author uses an iron jack plane for this job. A sharp, finely set cutter, with some lubrication of the sole of the plane enables a fine clean shaving to be taken on a shooting board, and the “edge” on the plane-iron seems to stand up to this treatment. Cabinet makers, joiners and carpenters will doubtless regard such methods as criminal, but experience shows that this sort of crime does pay. Still further to add to their horror, it will now be stated that the author bores all holes up to one inch diameter with a carpenter's brace and twist bit! Larger sizes are made with an adjustable tank cutter. And to help still more coals on the furious fires now burning in the hearts of the aforementioned woodworkers, burrs thrown up by drills and cutters are removed by simply slicing them off with a sharp wood chisel. The result is clean sharp entries to all holes, an effect obtainable only

by punch press, which, of course, is not the method available to the home constructor.

Clearance holes for BA screws are best drilled with the appropriate size metal twist drill and hand brace, whilst the oblong opening on the front panel to clear the test sockets mounted on the paxolin strip can be made either with a fretsaw, using a fine-tooth metal sawing blade, an Abrafile, or a series of holes can be drilled on the waste side of the marks and the opening trimmed to size with a smooth file.

The holes to suit the fixings for the paxolin strip and the perspex scales are best left until the actual fitting is done. By using these as templates to locate the positions of the fixing holes a more accurate setting can be obtained.

To bend the sheet, stout pieces of hard wood can be cut and fitted in the vice, one on each side of the workpiece. Use a substantial piece of wood to apply an even pressure all along the sheet, and set the angle as sharp as possible. To get a nice sharp finish to the bend, beat down the bend with a piece of hard wood and a mallet.

The holes in the base for fixing the components mounted on it are best marked out from the actual items, using a scribe. This saves time in setting out.

To be concluded in next issue

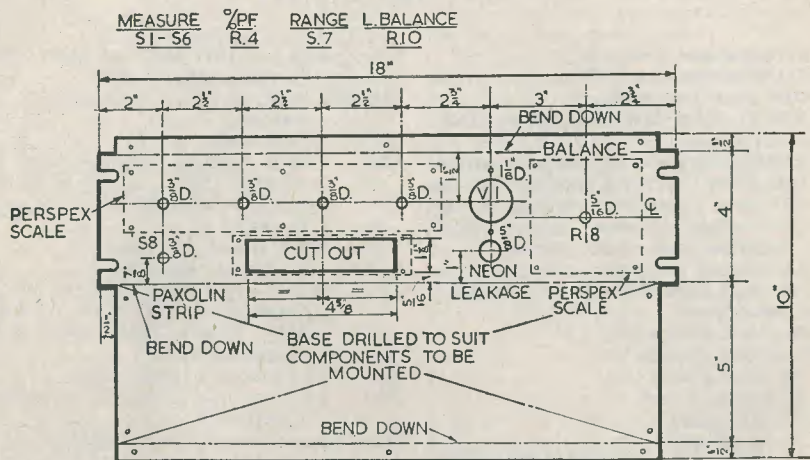
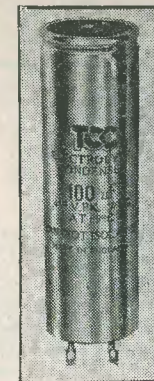


FIG. 8.

FRONT PANEL & BASE DRILLING PLAN

TRADE NEWS



High Temperature Electrolytics

T.C.C. introduce a range of electrolytics with the outstanding features of being able to work at 85°C without voltage derating. Salient characteristics include exceptionally low leakage current at room temperature with only minor increase when the temperature is raised. Extremely long shelf life, and because of their low leakage current and normal high working temperature they handle much higher ripple currents for the same size of case. The *PHOTOGRAPH* attached shows one of the larger capacities but they are also available in a full scale of values and voltages in similar appearance to the famous T.C.C. 'MICROPACK' and 'PICOPACK' designs.

Neon Voltage Indicators

Philips Electrical Limited have re-introduced two Neon Voltage Indicators, for use in testing low and medium mains installations.

The popular pencil type, Cat. No. Q.5000, is priced at 5/- each, list, and can be used on A.C. or D.C. mains voltages between 110 and 500. It is housed in a black insulating pencil-shaped case, with a pocket clip.

The Voltage and Polarity Indicator, Cat. No. Q.5005, is a much larger type suitable for 80/750 V. A.C. and 100/750 V. D.C., and for indicating polarity on D.C. It has two black "Philit" moulded insulated test prods, fitted with collars to prevent accidental hand contact with the metal probes, joined by a 39" length of tough rubber covered cable. One prod houses a Type 4017 Indicator Lamp, which can be replaced. List Price is 30/- Supplies of both types are available immediately.

Emitron Valves—Distribution Arrangements

Emitron valves and cathode ray tubes manufactured by Electronic Tubes Limited of High Wycombe, can now be supplied to the Wholesale and Retail Trade for maintenance and replacement purposes and arrangements have been made for supplies to be available from:—

E.M.I. SALES AND SERVICE LIMITED,
HAYES, Middlesex,

to which address orders should be forwarded.

The word "Emitron" has been registered with the British Radio Valve Manufacturers' Association and Emitron valves and cathode ray tubes are recognised as officially branded BVA products.

A list of the current range of Emitron valves and cathode ray tubes is available.

Mullard Exhibits at the Physical Society's Exhibition

At the Physical Society's 36th Exhibition of Scientific Instruments and Apparatus, the Research Laboratories of Mullard Ltd. exhibited and demonstrated many interesting new developments.

Among these, of interest to readers were an extremely stable Local Oscillator Assembly for Communications Receivers and a High Stability Crystal Controlled Master Oscillator with an Automatic Frequency Correcting Unit.

The local oscillator unit shown combines an extremely stable multi-range oscillator with a reduction drive and optical scale of equivalent accuracy.

The oscillator consists of a Mullard EF72 pentode operated in an electron-coupled Hartley circuit. This subminiature valve has a very stable electrode structure. A feature of the oscillator design is that the frequency drifts due to HT and LT changes tend to be self-compensating, and stabilised supplies are unnecessary. Frequency changes due to variations of load reactance and to warming-up have been reduced to extremely low limits.

In the design of this unit special attention has been paid to the reduction of frequency drift with respect to changes of ambient temperature and to uncertainty of turret location. The tuned circuits consist of compensated inductors and the Mullard precision variable capacitor, which was demonstrated for the first time at the previous exhibition of the Physical Society. The turret unit consists of two mechanical castings mounted on ball races, and rotated by means of a spring-loaded split-helix mechanism.

The High Stability Crystal Controlled Master Oscillator exhibited is designed for operation in the frequency range 0.5 to 1.5 Mc/s. It has a free running frequency stability of the order of ± 5 parts in 10^8 per day. Associated with the oscillator is an automatic frequency correcting system for making periodic corrections to the oscillator frequency with respect to a standard 200 kc/s signal (B.B.C. Light Programme). A special feature of this master oscillator is a temperature controlled crystal oven having a temperature stability of ± 30 mill°C under all ambient conditions from 0° to +40°C. The apparatus was shown working with an automatic recording of the frequency stability with respect to the standard.

QUERY CORNER

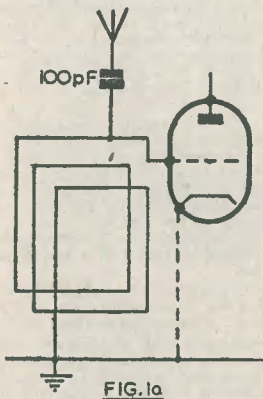
A "Radio Constructor" Service for Readers

External Aerial for Portable

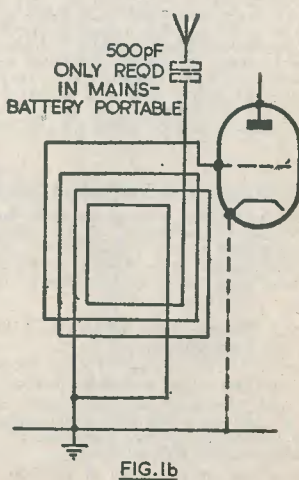
I would like to extend the range of my portable receiver by the use of an outdoor aerial. The receiver is at present fitted with a normal frame aerial, will you please recommend the best method of connecting the external aerial.

G. Flain, Yeovil.

There may well be other readers who wish to extend the range, and incidentally also improve the signal to noise ratio of their portable receivers by the addition of outdoor aerials. A further advantage of such an arrangement is that the receiver is no longer directional, thus obviating the necessity for turning it to obtain maximum signal strength. There are two simple methods of connecting the aerial to the receiver; the first requires only a small additional capacitor whilst the latter necessitates an extra winding on the frame aerial in the set. From the performance point of view the latter method is to be preferred on the grounds of slightly better selectivity and sensitivity, but in some receivers the inaccessibility of the frame aerial will preclude its use.



TWO METHODS OF CONNECTING AN EXTERNAL AERIAL TO A PORTABLE RECEIVER



C596

With the first method it is simply necessary to connect the external aerial lead to the "live" end of the frame winding via a 100 pF capacitor, as shown in Fig. 1(a). The correct side of the frame can quickly be located, as it is the side which is connected to the tuning capacitor. The additional fixed capacitor may be secured at some convenient point just inside the back of the cabinet, and a plug and socket provided for the aerial lead.

The second method requires an additional winding which is positioned over the main tuned winding on the frame aerial. This extra coil consists of four or five turns of about 28 swg cotton covered copper wire, and is connected up as shown in Fig. 1(b). When completed, the coil should be given a coat of clear lacquer or glue to retain the wire in position.

A further improvement in the performance of a portable receiver can sometimes be effected by the use of a good earth connection. With battery receivers this connection can be made directly to the chassis, but with receivers which have provision for either mains or battery

operation, a 0.01 μ F, 1kV working capacitor must be connected in the earth lead.

Static Charge on Aerial

Whilst servicing my receiver I noticed that a slight shock was obtained when I touched one side of the aerial coupling capacitor. The aerial was connected to the receiver at the time and I assumed that the shock was due to a static charge having accumulated on the wire. If this assumption is correct, can such a charge damage the receiver, and can any precaution be taken to prevent such an occurrence?

F. Whitfield, London.

It is quite possible under certain weather conditions for a static charge to accumulate on a well insulated aerial; and if it is connected to a receiver which is fitted with a capacitor in the aerial lead the charge cannot readily leak away to earth. The worst damage that such a charge can produce is a breakdown in the aerial feed capacitor, but this is a most unlikely fault. It is however, more likely that a charge on the aerial may momentarily leak to earth at some point on the system causing a loud click from the receiver. Under more severe conditions a fairly continuous crackle may mar the reception. Fortunately the remedy for these charges is a simple one, merely requiring that a 1 Meg Ω resistor is connected between the aerial and the chassis of the receiver. The position of the resistor in the circuit is shown in Fig. 2. The value of the resistor is sufficiently high to prevent its affecting the sensitivity or the selectivity of the receiver, whilst being low enough to prevent any charges from remaining on the aerial.

Needle Scratch

Reproduction from recordings played on my radiogram is marred by rather loud needle scratch. Although turning the tone control to the position which gives minimum response at the higher frequencies reduces the scratch, it also reduces the quality of reproduction. Can you recommend a scratch filter which I can add to the system to reduce this annoying fault?

D. Myers, Lincoln.

In many radiograms the reduction of needle scratch is left to the normal tone control arrangement. This is not altogether satisfactory as the setting of the control which provides a minimum of scratch also provides a minimum of top response, and hence the reproduction sounds deep and muffled. The problem cannot be completely solved because the scratch covers a very wide band of frequencies, and its entire elimination would also eliminate much of the recorded intelligence. However, without modifying the radiogram at all there are some steps which can be taken to reduce the background noise. For example,

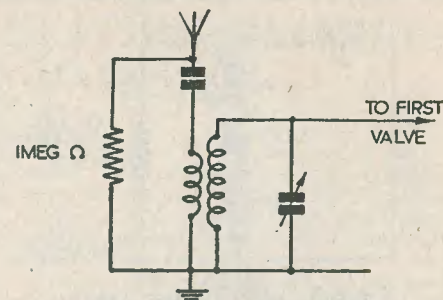


FIG. 2 CONNECTION FOR ANTI-STATIC RESISTOR

C597

the records must be kept free from dust and metal particles; it is a good plan to dust each recording with a felt pad before each playing. The use of thorn needles on new recordings will also reduce the scratch whilst at the same time minimising record wear. The grooves of older records will have become too abrasive to permit the use of thorn needles, the needles wearing at such a rate that one may not play one side without requiring resharpening.

The type and condition of the pickup can have a marked effect upon the degree of scratch. This is because the armature of the pickup will have a definite resonant frequency. At this frequency the pickup will have a peak response and thus the scratch noise will be loudest. This factor enables a very satisfactory compromise to be made in solving the problem of reducing the scratch without seriously attenuating the frequency response.

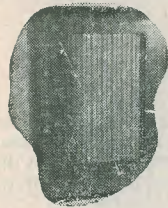
QUERY CORNER

"Rules"

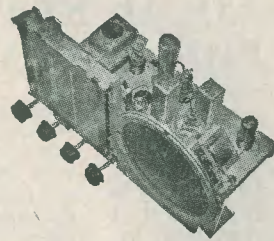
- (1) A nominal fee of 2/6 will be made for each query.
- (2) Queries on any subject relating to technical radio or electrical matters will be accepted, though it will not be possible to provide complete circuit diagrams for the more complex receivers, transmitters and the like.
- (3) Complete circuits 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.

ELPREQ PAGES

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We can offer you a really lovely loud-speaker fabric 'Somweave' at approximately a third of to-day's cost. It is 42in. wide, and our price is 12/- per yard, or panels 12" x 12" 1/9 each. This is also very suitable for covering rough wooden cases, for portable radiograms, amplifiers, etc.



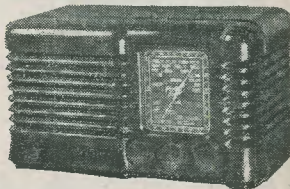
THE ELPREQ SUPERIOR FIVE

This is a long, medium and short wave superhetrodyne receiver for A.C. mains working, built by one of our famous manufacturers, fully aligned, tested and guaranteed. Complete as illustrated, less knobs. **COVERAGE:** L.W. 800-2,200 metres; M.W. 200-500 metres; S.W. 16-50 metres. **CHASSIS:** Heavy gauge cadmium plated steel, size 15 1/2 in. x 8 in. x 2 1/2 in. **DIAL:** 7 1/2 in. square, edge lit, glass, printed in three colours. **SPEAKER:** 8 in.

P.M. built on to chassis but easily removable. **TUNING:** two-speed tuning with nylon drive. **VALVES:** all by B.V.A. makers, ref Nos. 6K8, 6V7, 6R7, 6V6 and 6X5. **EXTENSIONS:** sockets are provided for pick-up and low impedance extension speaker. **TECHNICAL POINTS:** (a) I.F. filter; (b) delayed A.V.C. to 1st and 2nd valves; (c) controls to vary tone and volume; (d) tone correction; (e) high gain amplifier comprising triode section of D.D.T. and pentode gives undistorted output of 4 watts with good frequency response. **WARRANTY:** 12 months written guarantee included with each receiver. **CIRCUIT:** diagram is available free with chassis or separately price 1/9. **CABINET:** no ready cabinets are available at present but constructional details of an easy to make type is given free with circuit diagram. **PRICE:** complete ready to work £10/19/6. Non-callers please add 10/6 to cover carriage and insurance. **H.P. TERMS:** £3/13/0 deposit and nine monthly payments of 18/9 each (carriage extra as above).

PROFESSIONAL RADIOS YOU CAN MAKE

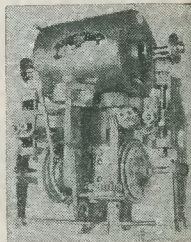
You will find that the building of our all-mains radio receivers is simplicity itself, and the more you make the less time each takes, everything down to the last nut and bolt is supplied, and everything fits together in a professional manner. When finished the receiver looks and plays as well as those being offered in



radio shops at anything between £10 and £14. The one illustrated above we call "The Occasional" in a choice of colours. Ivory, Walnut or Green, and the T.R.F. costs £6 to make. The other radio illustrated we call the "White Lady," this is an extra fine cabinet of pure white. The complete T.R.F. receiver costs about £6/5/0 to build. Constructional data for either set is available at 1/6 post free.

RAPID ACTION REVERSING MECHANISM

This consists of a shunt wound D.C. motor fitted with clutch at each end. A spring loaded arm keeps the drive engaged in the forward direction until hydraulic or other pressure causes the bellows to expand. This counteracts the action of the spring, engages the clutch on the other side and hence reverses the drive. The motor itself always rotates in the same direction, therefore reversing is almost instantaneous. If pressure control is not required the bellows can be replaced by a solenoid. These mechanisms (really beautifully made by an American company) have couplings for and are designed to take two (flexible) drives simultaneously, each drive, however, is independent of the other.



Motor details are 27 v.—1.5 amps., 5,400 r.p.m. approximate overall dimensions of complete unit 6in. wide x 7in. deep x 4in. high. Limited quantity only. Price 47/6 each.

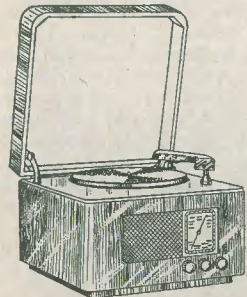


TABLE RADIOGRAM CABINET

Walnut finish, outside dimensions 9 1/2 in. high, 14 in. deep, and 14 1/2 in. wide. Designed to take our "Occasional 4" radio chassis and any non-auto gram unit. Price 49/6, carriage and packing 5/-.

DEMOBLED VALVES

Gives the commercial equivalents of many thousands of Service valves, an invaluable publication recently revised.



Price 2/3.

RADIO CHEMICALS CLEAR CEMENT

Almost instantaneous drying for coil winding and al repairs, 1/6 per tube.



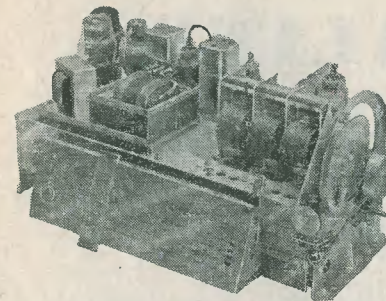
"ENAMACLEAN." For safely removing the enamel off the finest wires, 2/- per tube.

BLANK CHASSIS

Made of 18 S.W.G. Aluminium.

Size	Price
10" x 8" x 2 1/4"	7/-
10" x 5 1/2" x 2 1/4"	6/6
10" x 9" x 3"	7/3
12" x 9" x 2 1/4"	7/3
14" x 9" x 2 1/4"	7/6
14" x 10" x 3"	8/-
16" x 10" x 3"	8/3
16" x 8" x 3"	8/0
11 1/2" x 10" x 3"	...
16" x 12" x 3"	...
19 1/2" x 8" x 2 1/2"	...
20" x 10" x 3"	...
21 1/2" x 9" x 2 1/4"	...

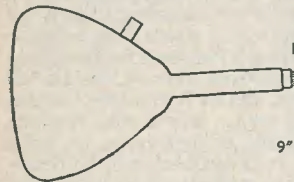
ONLY £10/19 6d.



7 VALVE, 5 WAVEBAND RADIO CHASSIS

A famous set by a famous manufacturer. Undoubtedly a serious listener's receiver. Among many special features are a H.F. stage and tuning indicator. Tunes up to 11-metre band. Price new less all valves, less speaker, £10/19/6 carriage and packing 15/- partly returnable, A.C. Mains and car battery models are available. H.P. Terms £3/13/6 deposit and 10 monthly payments of 16/9.

THIS MONTH'S SNIP. MAGNETIC T.V. TUBES



9" G.E.C. Flat Ended, Heater 6.3v. From 55/-.

These Tubes have had very little use, and will probably give years of service.

TYPE 1 Have no faults whatsoever, and have only had the smallestest use—Price £5/15/0 each.

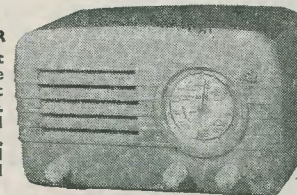
TYPE 2 Have small ion burns, otherwise in good condition, Price—£3/15/0.

TYPE 3 Have large ion burns but are useful as spare, or when first testing out a circuit, or doing repairs, etc., Price—£2/15/0 each.

NOTE:—Callers to our Ruislip branch can see these tubes demonstrated but whether you see it or not, we guarantee a 'working' tube. If not calling please add 7/6 each tube for packing and postage.

CONSTRUCTORS' PARCEL, SPECIAL OFFER

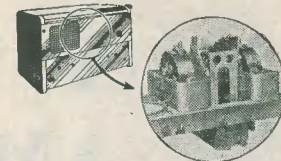
Modern design, bakelite cabinet in Ivory, blue or brown, complete with metal chassis punched out for speaker and 5 valves, etc. Parcel also includes moulded perspex windows, matched set, of knobs, scale and hardboard back. Price 27/6 carr. and pkg. 2/6.



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

ELECTRONIC PRECISION EQUIPMENT

WINDMILL HILL, RUISLIP MANOR, MIDDLESEX AND AT FLEET STREET, LONDON, E.C.4.

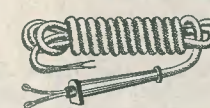


IMPULSE MOTOR

With drive mechanism to which two additional switches have been coupled. Mounted in totally screened box measuring 8 3/8 x 3 1/4 x 6 1/2 in. Price 25/- each.

APPLIANCE LEAD

As fitted to H.M.V. appliances, it is 9ft. long, made of almost indestructible non-kink flex with rubber end support; ends are all prepared and bound. Price 2/9 each, 30/- doz.

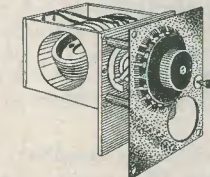


SPEMET

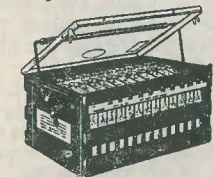
Made from polished aluminium, an excellent material for fronts of cabinets or for special cabinets you are making, and for air conditioners, etc. Close mesh 8 holes to the inch. 24in. x 12in., 10/-; 12in. x 12in., 5/3; 6in. x 6in., 1/9. Wide mesh 4 holes to the inch. 24in. x 12in., 9/-; 12in. x 12in., 4/9; 6in. x 6in., 1/6. Postage and special packing 1/6 extra for any quantity up to 12 sheets. Over 12 sheets post free.



VARIOMETER ASSEMBLY



As illustrated this is useful for experimental circuits, crystal sets, etc. Price 3/9 each.



MILNES H.T. UNITS

120 volts 60 m/a., you charge these from a 6 v. car battery. Price 67/6 each—callers only or carriage at your risk.

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

A QUALITY AMPLIFIER

by D. NAPPIN

Many constructors may have felt the necessity for an amplifier which is a cut above the normal run of single ended output stages, either in power output or fidelity.

There are many amplifiers on the market which possess very impressive specifications. They are also, however, very expensive. Some firms have, therefore, produced cheap amplifiers, possessing single ended output stages and little or no negative feedback. They are, in general, no better than the "gram" amplifier of the average commercial set.

The constructor wishing to build such a quality amplifier, but having a shallow pocket, is thus brought to the alternative of home construction. Many constructors fight shy of quality amplifiers on account of their belief that special components are needed, and that such circuits are notoriously unstable.

Before describing the circuitry of the writer's amplifier, a few paragraphs will be devoted to audio amplifier design with regard to quality reproduction.

Requirements of a Quality Amplifier

It is obvious that, for a quality amplifier to justify its name, the output signal must be a faithful reproduction of the input.

As any complex input signal can be resolved into a number of sine waves, it will be seen that for the output signal to be similar to the input, these sine waves must retain their relative amplitudes, and phases. Thus, the amplifier must have a flat frequency gain characteristic from the lowest frequency to be handled to as high a limit as possible, with a constant time delay over this range. The need for a constant phase shift is often glossed over by saying that the ear is not phase conscious. This is true in respect to continuous waves, but when sounds of a transient nature enter the scene, variations in phase shift can considerably alter the audible sound.

The actual angular phase shift at any given frequency should be reduced, for a reason to be outlined later.

The human ear is insensitive to sounds above about 16 kc/s, thus a response extending to 20 kc/s will be satisfactory. The lower frequency limit can be about 20 c/s.

Satisfaction of these Requirements

A linear frequency response can be most easily obtained from an amplifier by the application of negative feedback. In this, a certain percentage of the output voltage is fed back to the input, but in phase opposition to it. That such feedback improves the frequency response can be proved thus—Consider an amplifier of gain A, and let B equal the fraction of the output fed back. For e volts between the grid and cathode of first valve, eA volts output and eAB volts feedback will be developed. Thus, an input of e(1+AB) is required to develop eA volts output. Therefore, Gain =

$$\frac{eA}{e(1 + AB)} = \frac{A}{1 + AB}$$

But if A and B are large,

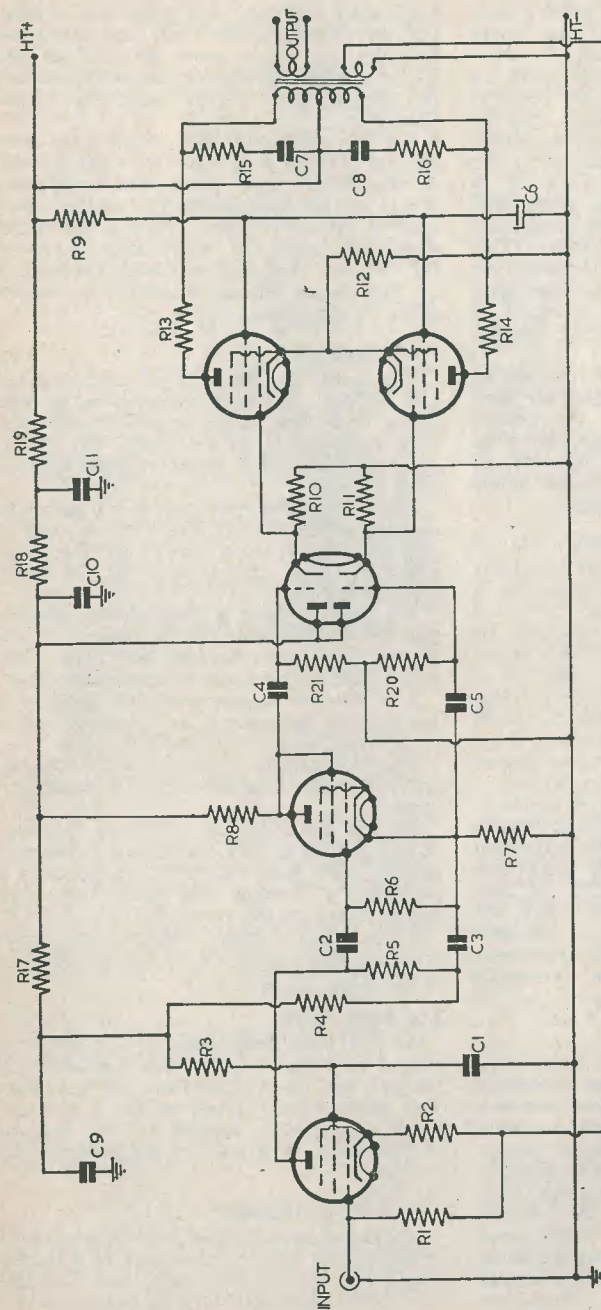
$$\frac{A}{(1 + AB)} = \frac{1}{B} \text{ approx.}$$

However, although the gain A may be frequency conscious, the feedback factor B is not, its characteristic depending solely on the components in the feedback loop, which can easily be made entirely of resistors which are aperiodic. But we have proved that if A and B are large, the gain depends only on B and is itself rendered non-frequency-conscious.

The application of negative feedback can also be proved to reduce phase shifts, but it will inevitably reduce gain.

Application of Feedback

To ensure quality, it is essential that AB be large, i.e., that heavy negative feedback be applied to a high gain amplifier. This appears simple enough, but at frequencies where the phase shift over the amplifier and feedback loop is greater than 90° the feedback becomes positive.



COMPONENT VALUES

R1	100kΩ	1 watt	HS	R10	4.7kΩ	1/2	C	R19	10kΩ	2	C	C4	0.1μF	750V Paper
R2	2.2kΩ	"	C	R11	4.7kΩ	5	C	R20	100kΩ	1/2	C	C5	0.1μF	750V Paper
R3	1MΩ	"	C	R12	1000Ω	1/2	C	R21	100kΩ	1/2	C	C6	8μF	450V Electrolytic
R4	47kΩ	"	HS	R13	27Ω	1/2	C	R22	100kΩ	1/2	C	C7	0.005μF	1000V Mica
R5	250kΩ	"	HS	R14	27Ω	1/2	C	HS	High Stability	2	C	C8	0.005μF	1000V Mica
R6	500kΩ	"	HS	R15	4.7kΩ	2	C	C1	2μF	350V Paper	C9	2μF	2μF	750V Paper
R7	47kΩ	"	C	R16	4.7kΩ	2	C	C2	0.01μF	500V Mica	C10	2μF	2μF	750V Paper
R8	47kΩ	"	C	R17	25kΩ	2	C	C3	0.1μF	500V Paper	C11	2μF	2μF	750V Paper
R9	33kΩ	"	C	R18	5kΩ	2	C							

If the amplifier loop gain is greater than unity at any frequency where the phase shift is 180° , oscillation will ensue.

Such a frequency will in most cases be supersonic, and cannot thus be detected aurally. However, the oscillations may be of considerable amplitude; in fact, the writer has found about 4 kV developed across the output transformer primary. Thus it is seen that to ensure stability the phase shift should not exceed 90° at any frequency where the loop gain exceeds unity. (This is not the true condition for stability, the actual condition being that the frequency and phase response, plotted as a vector of magnitude and phase, does not enclose the point +1 [Ref. 1]).

Phase shift can be kept small by employing large coupling condensers, avoiding all iron-cored components except for the output transformer, and minimising stray capacities. The output transformer can, however, if badly designed, produce considerable phase shifts. Thus it will now be treated.

The Output Transformer

It can be proved (Ref. 2), that instability will result if the output transformer has a high leakage inductance.

Leakage inductance can be reduced by sectionalising the windings of the transformer. Phase shift can also occur if a reactive load is connected across the secondary winding from which the feedback is taken. Thus, the feedback should be taken from a tertiary winding, as the output transformer must be included within the feedback loop.

The transformer should have a generous core section to keep the magnetic flux through the transformer well clear of the saturation region, and to allow the primary inductance to be sufficiently high to maintain the bass response. A stalloy core can be used, but the thinnest possible stampings of mumetal or radiometal are preferable. Transformers wound to the Williamson or Baxendall specification are ideal.

The Output Stage

The output stage in most reproducing systems produces most of the harmonic distortion in the system. Thus, it is necessary that the output stage shall operate in push-pull, as this balances out even harmonics. Push-pull also has the desirable property of cancelling the DC flux in the output transformer and thereby increasing the primary inductance. It is somewhat of a vexed question whether triodes or tetrodes should be employed as output valves. Triodes have the disadvantage of comparative

inefficiency and need high grid drive voltages, but are, however, inherently less distorting. Tetrodes are much more economical, and by the application of heavy negative feedback can give as good a performance as triodes (Ref. 3).

For low distortion, the output stage must operate in Class A or AB1 for, if grid current is allowed to flow, peaks will be clipped due to voltage drop across the source impedance of the driver stage. Thus a low source impedance must be maintained. Loss of HF across the grid cathode capacitance of the output stage, enhanced by Miller effect, is minimised.

Phase Splitters

The most obvious type of phase splitter and, indeed, that used by many early amplifiers, was the centre-tapped transformer. Such components are intolerable for quality equipment and other means of phase splitting must be found.

There exist for this purpose three main circuits, which are (1) The cathode coupled amplifier (long tailed pair), (2) the paraphase (see-saw) circuit, and (3) the "concertina" circuit.

The first of these is theoretically suitable, but the outputs tend to be unequal unless the cathode resistor is made very high. This will reduce the gain due to current feedback.

The see-saw circuit provides good gain but is also unbalanced, of necessity, so as to provide drive for the second valve.

The "concertina" provides equal outputs and will handle large inputs, but it is degenerative.

As this third type is a cathode follower, it will possess a very high input impedance. A very high gain may be obtained from a pentode by making this input impedance the AC load on the valve (Ref. 3).

The choice of phase splitter from these types is, more or less, a matter for personal preference.

The Input Valve

As the total loop gain of the amplifier should be high, it is obvious that much of the gain will be obtained from the first stage. This stage should therefore be a pentode. Feedback is best applied to the cathode of this valve, in series with the cathode bias resistor.

The Writer's Amplifier

Above has been outlined, with little recourse to maths, the main requirements of a quality amplifier. The circuit used was decided upon by consideration of these points.

The input valve is a Ken-Rad 6SH7—this make has been found less microphonic than the RCA valve.

Feedback is applied to the cathode of this valve by direct series connection of the feedback winding on the earthy side of the unbypassed cathode resistor. The output is taken from the anode of this valve and fed, using the Jeffery circuit, to a triode-connected 6SH7 acting as a phase splitter. The outputs are taken from the anode and cathode across equal loads, through condensers, and are fed to the grids of a pair of cathode followers in the shape of a 6SN7.

Drive for the output valves is obtained by direct coupling of the cathodes of the 6SN7 to the grids of the output valves—6F6's. The cathode load resistors have about 15 volts DC developed across them, thus the output valves have a higher bias resistor than usual. The output valve anodes are transformer coupled to the speaker.

The transformer has on it a tertiary winding, arranged as in the diagram, to provide feedback. The anode-to-anode load of the output valves is $10,000\Omega$, thus for 36 dB gain the output from this tertiary winding must be $1/80$ th of the anode-to-anode voltage. Therefore the transformer provides a ratio of 80-1 to the feedback winding, which has thus an impedance of

$$\frac{10,000}{(80)^2} = 1.5\Omega$$

The gain of the amplifier without feedback can be proved to be, by calculation, about 86 dB. It is thus seen that the feedback is $(86-36) = 50$ dB.

The bias resistor of the output stage, which is common to both valves, is unbypassed, but this does not introduce degeneration as the currents in it are equal and opposite.

The valves can be driven into grid current without serious distortion, owing to the low source impedance of the driver valves, but in that case the cathode resistor must be bypassed.

It can be shown that the output impedance of a cathode follower is

$$\frac{1}{gm}$$

In the case of the 6SN7, $gm = 2.6 \text{ mA/V}$, thus the impedance is

$$\frac{1000}{2.6} \Omega = 385\Omega$$

As the gain is 36 dB, for 10 watts output the anode-anode voltage will have to be $\sqrt{RW} = \sqrt{10000 \times 10} = 100\sqrt{10}$. Input

required to develop these volts =

$$\frac{1000\sqrt{10}}{80} = 4 \text{ V approx.}$$

To obtain this input from radio or gramophone pickups, a preamplifier will be needed. This will form the subject of a later article.

The hum level can only just be detected with one's ear about 3 inches from the speaker. Some people may have qualms as to the stability of the amplifier but, so far, no instability has been detected.

Power Supplies

Little purpose is served by a detailed description of the power unit which uses, in the writer's case, a 500 V transformer and double smoothing together with a 5R4GY rectifier.

At 600 V HT, the amplifier takes about 70 mA, but it will operate, with reduced power output capabilities, on 350 V.

References

1. The Nyquist Criterion of Stability. J. C. West. *Electronic Engineering*, May 1950.
2. High Quality Amplifier Design. P. J. Baxendall. *Wireless World*, January 1948.
3. Push Pull Phase Splitter. E. Jeffery. *Wireless World*. August 1947.

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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 inclusion in this section.

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

LARGE SCREEN T.V.

THE RADIO CONSTRUCTOR'S 16" TELEVISOR

PART THREE

It was stated in an earlier article that the design described here lends itself to modification to suit individual requirements.

To enable readers to deviate from the original design, and still maintain electronic requirements, the dimensional outline of the tube is given in Fig. 8. This also shows the disposition of associated components, and will further assist in clarifying construction. Taking a mental picture of the whole, constructors should find it quite simple to plan to fit any cabinet they may possess.

The items concerning this section are deflection coils, focus coil, five-pin small shell duodecal socket and single field ion trap magnet.

It may appear lacking in continuity to give details of the ion trap in this article, but after careful consideration it was decided to firmly establish the importance of this component in the minds of those embarking on this conversion.

Figs. 8 and 9 show clearly the position of the ion trap magnet, and the following is the recommended procedure:—

(1) Space the focusing device about $\frac{1}{2}$ " back of the deflection coil windings, and position it co-axially with the tube neck. Next, position the ion trap magnet on the neck so that its poles are roughly aligned with grid No. 2.

(2) Apply operating voltages with scanning to the tube. Adjust Brilliance Control to just above black-out point.

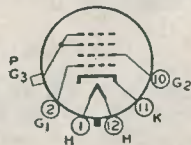
(3) Then, promptly rotate the ion trap magnet and move it slightly backward and forward until the maximum raster brightness is obtained. Re-adjust Brilliance Control to give average picture brightness. Move the ion trap magnet backward and forward noting both positions at which brightness is diminished, and then locate it halfway between these positions.

It is important that this adjustment be made with low anode current and without delay after the operating voltages are applied. Operation of the tube with the ion trap magnet improperly positioned may damage the tube. If the anode voltage supply is not of the limited-energy type, damage may occur very quickly.

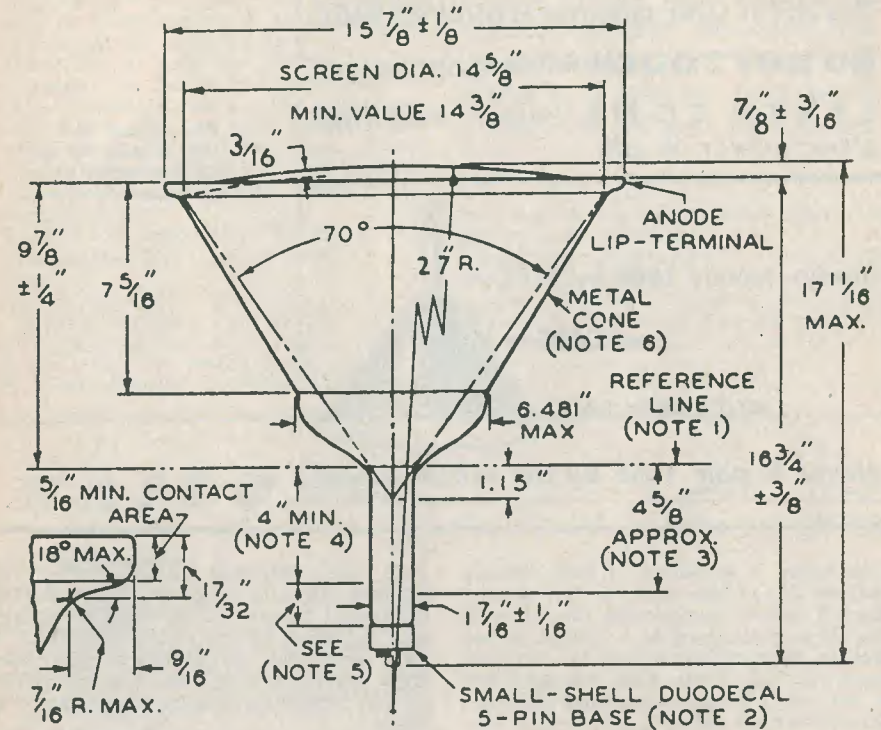
(4) Focus the pattern by adjusting the focusing field strength. Then, rotate the deflecting yoke to align the raster with the tube mask. Centre the raster by adjusting the DC through the deflecting yoke. If such adjustment is not provided, centring may be obtained by moving the focusing field slightly off centre or by tilting the focusing field. The latter method generally produces the most distortion. If a corner

SOCKET CONNECTIONS : Bottom View

- PIN 1 : HEATER
- PIN 2 : GRID No. 1
- PIN 10 : GRID No. 2
- PIN 11 : CATHODE
- PIN 12 : HEATER
- METAL-CONE LIP : ANODE, GRID No. 3



DIMENSIONAL OUTLINE



DETAIL OF LIP

Note 1: With tube neck inserted through flared end of gauge (described in publn. EV/102) and with tube seated in gauge, the reference line is determined by the intersection of the plane CC₁ of the gauge with the glass cone. (Does not concern Radio Constructor design, but given for academic interest).

Note 2: Socket for this base should not be rigidly mounted; it should have flexible leads and be allowed to move freely. Bottom circumference of base shell will fall within a circle concentric with cone axis and having a diameter of 2 1/4".

Note 3: Distance from reference line for locating centre of ion trap magnetic

field. Direction of field of the ion trap magnet should be such that North Pole is adjacent to vacant pin position No. 8 and South Pole to Pin No. 2.

Note 4: Location of deflecting yoke and focusing coil must be within this space.

Note 5: Keep this space clear for single field ion trap magnet.

Note 6: Metal cone and glass face operate at high voltage. Any material in contact with the cone or the face must have insulating properties adequate for 15,500 volts.

CAUTION—HIGH VOLTAGE

This METAL CONE operates at HIGH VOLTAGE

DO NOT TOUCH while in operation

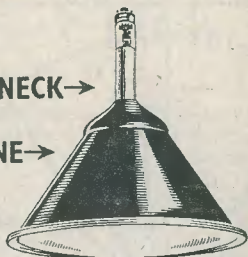
EARTH CONE before touching after power is off.

Always handle tube by NECK →

and CONE →

or by cone only

Never handle tube by the NECK alone



We suggest that this warning be cut out and pasted in a prominent position.

of the raster is shadowed, it may be due to excess DC in the yoke, or to incorrect alignment of the components on the tube neck. It may be possible to obtain minor correction by re-adjustment of the ion trap magnet. If not, rotate both the tube and the ion trap magnet approximately 180° and repeat Steps 3 and 4.

(5) Vary Brilliance Control through the expected operating range to observe whether shadowing occurs. If a shadow appears near the edges of the raster, first check to make sure that the deflecting yoke bears firmly against the bulb cone: and then eliminate any remaining shadow as explained in Step 4.

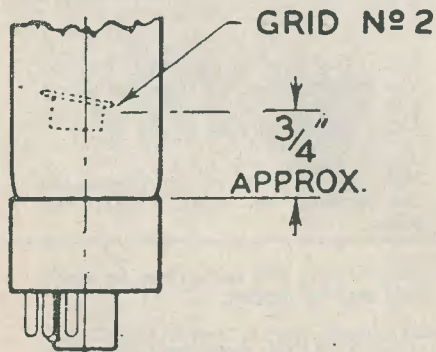
The above text is abstracted from the English Electric publication EV/102, and has been amended to suit grid modulation requirements. Readers intending to use cathode modulation should consult the publication in its original form.

There are two generally used method of diverting or avoiding the destructive ions which discolour the screen phosphor: the aluminised screen, and the ion trap or beam bender. The latter is the one with which we are concerned.

Note 1. The ion trap magnet should have magnetic polarity indicated by an arrow. When placing the component on the tube neck, ascertain that the arrow is pointing towards the base of the tube.

Note 2. Avoid dropping, or striking this component a sharp blow. This kind of accident may easily cause demagnetisation.

In the type of tube used in our conversion, the gun is off-centre, usually at an angle of



LOCATION OF GRID NO. 2 IN TUBE NECK

75° relative to the axis. Consequently, the beam is out of line with the aperture: the beam is comprised of both ions and electrons.

Fortunately, it so happens that the electron stream is more responsive to a magnetic field than are the unwanted ions.

Therefore, by correctly placing the ion trap magnet on the neck of the tube, the beam we require to activate the screen may be bent back into line with the tube axis so that it passes through the aperture. Meanwhile, the unwanted stream of ion particles is more or less destroyed on contact with the second anode.

Readers will appreciate that this is only a bare outline, but it is sufficient for our purpose.

Note 3, associated with Fig. 9, should be carefully studied. The intensity of the beam is such that, unless it is rapidly brought into line with the aperture, the gap itself will suffer damage. Reference will again

NEXT MONTH'S ARTICLE IN THIS SERIES WILL GIVE COMPLETE CIRCUIT DIAGRAM AND DESCRIPTION OF THE TIME BASES SPECIALLY DEVELOPED FOR USE IN THIS TELEVISOR.

be made to this point before readers take the plunge and switch on.

Tube connections for the duodecal base are shown in Fig. 10.

Note: This base should not be a fixture, but simply be pushed onto the pins. This will allow for expansion, and so forth.

(To be continued.)

MAILBAG

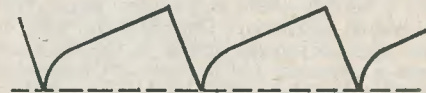
Frame Non-Linearity

Dear Sir,—I believe that some of our readers may be interested in a little discovery I have made concerning the Miller Frame Time-base, which is generally afflicted with acute non-linearity. By the addition of one resistor, price 4d., I have completely cured the bad pulling-up of the top dozen or so lines. Unfortunately, this can only be done on those circuits, such as the "Inexpensive Televisor," which employ a push-pull amplifier separate from the actual timebase valve. As some may consider the cure is worth the price of a 6SN7 valve, I reproduce below the complete circuit of the amplifier.

The distorted waveform applied to the second half of the 6SN7 is as shown in diagram MB6.

To correct the non-linearity, a voltage curve similar to the scanning stroke curve must be subtracted from the scanning stroke, so that a straight line may be left. Such a curve is presented by a triode whose grid voltage is moving positive from cut-off.

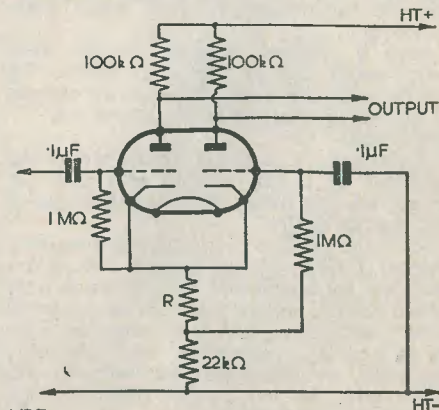
By the addition of the resistor 'R' to the amplifier circuit (diagram MB7), the second triode just cuts off at the beginning of each scan, and moves positive from cut-off as the scan progresses.



MB6

In my set, the best value for 'R' is 2 kΩ, but as many conditions may affect the value a variable resistor had better first be tried.

This is the only modification necessary, and I hope it may relieve the suffering of the many home constructors who have had their friends laugh at seeing a bald man's head rush to the top of the screen.—John S. Reynolds, (Devizes, Wilts.)



MB7

AWAY FROM THE "FOUR PLUS ONE"

by F. L. BAYLISS, A.M.I.E.T.

PART TWO

Intimate Listening

In a small receiver, designed and built for, perhaps, the bedside table, one's private den or workshop, or for occasional use in the garden room, or solarium, the main requirement in the writer's opinion is quality of reproduction.

In the places where such a receiver is used one naturally gives the received programme individual attention. Consequently, one or two watts of power output is usually more than is necessary for intimate and enjoyable listening, and the quality should be remarkable—far above usual—to the same end.

If, however, one is to have receivers dotted here and there about the house, the cost must be kept low. This consideration tends to limit the number of valves used in the circuit but, with careful design and modern high-efficiency valves, this need not be a drawback.

In Fig. 1 the writer presents a circuit eminently suitable for such a receiver, employing only two valves, yet being a selective, sensitive superheterodyne with triode push-pull output.

Such a receiver, designed in the usual way, would use at least six valves. So, has the economy been effected at the expense of reproduction in any way? Let us see.

The Circuit—V1

Aerial input is taken via the mains-isolating capacitor C1 to an ordinary MW and LW aerial coil, and thence to the control grid of V1, heptode section.

V1 is the Mullard triode-heptode frequency changer ECH21, chosen because the triode-grid does not extend into the heptode section.

The heptode section functions as combined mixer and oscillator, the latter between g2 g4 and g3. Note that, used normally, g3 would be connected externally to the triode grid. In this circuit, however, such a connection is omitted.

The oscillator coil L2 is a standard 465 kcs MW and LW component padded by C4 and C5. Trimmers may be added if necessary, but have been omitted from the circuit.

Transformer T1, a normal 465 kcs IFT with a reaction winding added to the secondary, tunes the heptode output and feeds it to the triode grid via a Westector. The Westector demodulates the signal and provides AGC voltage (undelayed) to the heptode grid, and demodulated signal to the triode grid.

The triode section functions as audio amplifier and also supplies reaction from its anode to the reaction winding (50 turns of 36 swg enamelled wire) of the IFT via the preset capacitor C10.

RF is not by-passed after demodulation since it is required for reaction; C11 should be set to give maximum reaction without oscillation, or distortion resulting from near-oscillation.

The Westector must be connected the way shown to give correct AGC polarity.

The audio output from the triode is taken via R9 and C13 to the primary of an LF transformer, and will be dealt with under the following sub-heading.

Thus, so far, we have normal superhet practice, compressed perhaps, and with the IF amplifier replaced by reaction, but powerful, efficient, sensitive and selective, none the less; yet we have used only one valve and a Westector.

We will now consider the intervalve and output section.

The Circuit—V2

Although modern practice has long since discontinued the use of intervalve transformers in mains-receivers, good components can often perform a useful function and this circuit is a pertinent case.

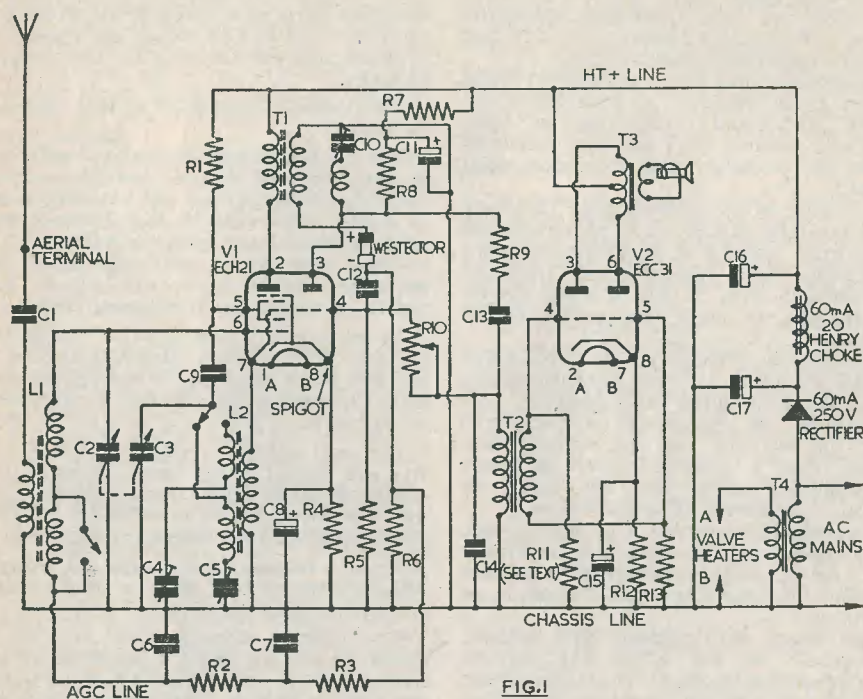


FIG. 1

(If difficulty experienced in obtaining oscillation, reverse connections to pins 6 and 7. Then, connect 100 pF between pin 6, now osc. grid, and winding, and 47 KΩ between pins 6 and 8).

LIST OF COMPONENTS FOR FIG. 1

R ₁	33 kΩ, ½ watt.	C ₁₆ C ₁₇	16 + 16 μF 450 VW. Electrolytic.
R ₂ , R ₃	250 kΩ, "	L ₁	MW and LW Aerial Coil.
R ₄	1.5 kΩ, "	L ₂	MW and LW Osc. Coil.
R ₅ , R ₆	500 kΩ, "	T ₁	465 kcs IF Transformer.
R ₇ , R ₉	10 kΩ, "	T ₂	MU-Metal or Nickel-Iron Push-Pull Intervalve transformer. (See text).
R ₈	100 kΩ, "	T ₃	Push-Pull Output transformer (Ratio given in text).
R ₁₀	2 MegΩ, potentiometer.	T ₄	200-250 volts input, 6.3 volts, 2A output, Filament transformer.
R ₁₁ , R ₁₂ , R ₁₃	See text, please.	V ₁	ECH21, Mullard.
C ₁	0.002 μF Mica.	V ₂	ECC31 or 32, Mullard or 6SN7, 6N7, American.
C ₂ , C ₃	500 pF Two-gang tuning capacitor.		60 mA, 20 Henry Choke.
C ₄	600 pF Preset.		60 mA, 250 volt, Selenium Rectifier.
C ₅ , C ₁₀	300 pF Preset.		3 Ω m/c. Loudspeaker.
C ₆ , C ₇	0.02 μF Tubular Paper.		WX1. or WX2. Westector.
C ₈ , C ₁₅	25 μF, 25V. Electrolytic.		
C ₉	0.001 μF Mica.		
C ₁₁	8.0 μF, 450V. "		
C ₁₂	0.1 μF Tubular Paper.		
C ₁₃	2.0 μF Mansbridge Paper.		
C ₁₄	100 pF Mica.		

The transformer T2 should be a mu-metal or nickel-iron cored push-pull component having a 1:1 or 1:2 ratio (each half) and a centre-tapped secondary winding.

Alternatively, and this is the method shown in Fig. 1, an ordinary 1:3 intervalve transformer (nickel-iron cored) may be used, with two resistors, R₁₁ and R₁₃ connected across the secondary and the centre point earthed.

It cannot be over-stressed that T2 should be a first-class article. It is possible to get quite small nickel-iron transformers having a sensibly level response and frequency characteristic from 50 c/s to 8,000 c/s for ten shillings, or much less on the ex-WD market.

The Varley "NICORE" or "NICLET" ranges are ideal and are indistinguishable in results from good R-C coupling. For a small set, the arrangement is better, both from the economy and space-saving viewpoints, than a cathode-follower or other phase-splitting valve, and not nearly so critical in adjustment of circuit values.

The coupling capacitor C₁₃ has a value (2.0 μF) making its resonance with the primary of T2 below the audio-frequency range, thus avoiding objectionable bass "boom" or resonance.

C₁₄ filters out residual RF voltages, ("stopped" by R₉) whilst R₁₄ provides variable negative feedback and manual volume control at one and the same time, by feeding back between 30% and 100% of out-of-phase voltage from the anode circuit of the triode to the grid; the feedback will also tend to level the response curve previously slightly upset by the reaction.

V2 itself is a low-power double-triode and there is a fairly wide choice of valves for this position. The ECC31 shown has a common cathode, whereas the ECC32 has separate cathodes.

The American types 6SN7 or 6N7 may also be used.

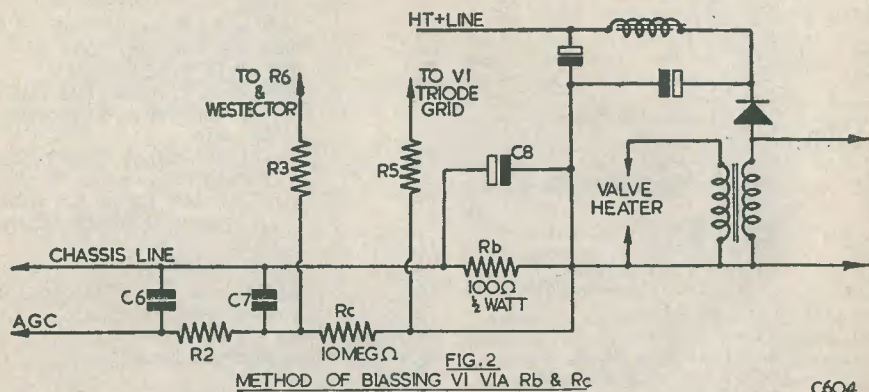
Now, if a push-pull intervalve transformer is used, R₁₁ and R₁₃ will not be required, since the secondary tap will be taken direct to chassis. The value of R₁₂, however, may be experimented with advantageously and it is a good plan to use screwdriver-adjusted potentiometers for this resistor, and for R₁₁ and R₁₃ if an ordinary transformer is used.

By varying R₁₂ from 200Ω to 1000Ω, the valve is taken up from class AB₂ to class A and then on to class AB₁, its best performance being determined by the ear at maximum volume level.

The most suitable values for R₁₁, R₁₂, and R₁₃ will depend largely upon the impedance of the secondary of the transformer used, so use, if possible, 500 kΩ variables for R₁₁ and R₁₃, with a 1 kΩ wirewound variable for R₁₂.

As it is not advisable to run V2 entirely without standing bias, insert a fixed resistor of 200Ω in series with R₁₂.

By carefully adjusting these resistors it should be possible to get a full three or four watts output in either class AB or AB₂, and two watts in class A. The golden rule is, use as much bias as possible commensurate with good quality and sufficient volume for your needs. Remember, too, that as you approach class AB₂, R₁₁ and R₁₃ must be lowered in value, as R₁₂ is lowered.



C604

The output transformer has a centre-tapped primary and should have a ratio of 60:1 each half, i.e., 120:1 over all, for valves ECC31 and 32, and 6SN7. The 6N7 need be only 60:1 over all, 30:1 each half; both sets of ratios are to a 3Ω speaker.

Power Supplies

For economy, simplicity, and compactness, a filament transformer is specified to supply the 6.3 volt valve heaters and a selenium rectifier to provide the HT current.

The receiver should not be earthed, except through a high-voltage (1kV) paper capacitor, and will function equally well without the earth connection.

Adjustments

When the receiver has been finally adjusted and tuned (padded and trimmed, reaction nicely set, V2 bias set for best results) a milliammeter in the HT+ lead should show a reading of between 35 and 45 mA (rather higher—to

60mA—if a 6N7 is used), giving a total power dissipation of 20–25 watts.

Thus, at forty hours reception of tip-top quality signal for one unit of mains current, the circuit is unique—representing, in fact, an original achievement in compression and economy, presented by no other circuit.

Note on the ECH21

This is an all glass B8G-base valve, with the cathode connected to the metal spigot.

In their valve reference manual, Messrs. Mullard show both the positive-cathode-bias and negative-grid-bias systems, in the valve's various uses.

Cathode bias is shown in Fig. 1 but if there is any likelihood of the spigot shorting to the chassis (since the former is part of the valve-base ring) omit the bias resistor and capacitor, connect the spigot to chassis, and bias the valve via the resistor R_b as shown in Fig. 2.

BOOK REVIEW

"APPLICATION OF THE ELECTRONIC VALVE IN RADIO RECEIVERS AND AMPLIFIERS," Volume II. By Dr. B. G. Dammers, J. Haantjes, J. Otte and H. van Suchtelen. 450 pages, 343 illustrations. Price 45s. Distributed in England by Cleaver Hume Press Ltd., 42a South Audley Street, London, W.1.

This is Book V in the Philips Technical Library and is the second volume of the trilogy devoted to the application of valves in receivers and amplifiers. (Book IV, Vol. I, deals with R.F. and I.F. amplification, frequency-changers, etc., while Book VI, Vol. III, now in preparation, will consider feedback, volume control, volume expansion and compression, etc.)

In this particular Book the A.F. amplifier, power amplifier and rectifier stages are dealt with, and as one would expect, the team of expert authors cover practically every aspect of the subjects adequately. They have succeeded in producing in particularly lucid form what can be regarded as one of the best reference books of its kind. It is confidently recommended to designers and technicians: even when allowance is made for the mathematical treatments which by their nature must be "above" the ordinary reader, the book is invaluable to the man who takes a keen and progressive interest in his radio work.

There is a great wealth of material dealing with output stages, and the discussions on Class B and Class AB stages are of unusual length. Similarly, the pages devoted to distortion contain a lot of information which is both educational and startlingly interesting.

Although the section on rectifiers is shorter by comparison, it is no less informative. The authors are to be congratulated here in bringing out so much which is not generally known, in a limited space. The table at the end of the section gathers together all the items required to design a rectifier and smoothing stage, and gives references to the parts of the book covering each stage of the design.

The format is clear and pleasing to the eye, and the book is indeed a model of the printer's and book-binder's arts. Some criticism can perhaps be levelled at the editing, for one finds decimal points shown in both the English and Continental styles, sometimes even in the same group of expressions. To quote one instance, on page 7 one reads, "The voltage drop across R_a is $0.8 \times 220 = 176$ V and across R_{g2} $0.16 \times 1000 = 160$ V...." Similar inconsistency is seen in the way that thousands are designated, for one finds them

shown as 5000, 5,000, and 5 000. This is particularly noticeable on page 56 where expressions are shown as:

$$\sqrt{\left(18\,000 + 11 \times \frac{3250}{5}\right)^2 + \left(11 \times \frac{3250}{5}\right)^2} = 684. \quad 10^6$$

and soon afterwards:

$$\left(18,000 + 11 \times \frac{3250}{5}\right) + \left(11 \times \frac{3250}{5} + \frac{2}{n^2}\right) = 1386. \quad 10^6$$

The use of the full point instead of \times for the sign of multiplication in the right-hand expressions is also to be deprecated here.

For such a fine book, the rather short index does not strike one as being fully in keeping with the general impression of extensiveness.

"TRANSMITTING VALVES." By J. P. Heyboer and P. Zijlstra. 308 pages, 256 illustrations. Price 35s. Distributed in England by Cleaver Hume Press Ltd., 42a South Audley Street, London, W.1.

A rather unique volume entirely devoted to transmitting valves and the theory of the circuitry with which they are associated. This is Book VII of Philips Technical Library and is a companion volume to Book V reviewed above.

It should have a wide appeal to engineers who are concerned with the design of transmitters, for its pages contain considerable information on the use of the specialized transmitter valve as amplifier, modulator, oscillator and frequency-changer. For a book of high technical standard there is a fair amount of general information which makes quite entertaining reading. The design and construction of transmitting valves is given adequate space, and some of the problems encountered, and the reasons for using certain materials, are lucidly explained.

The chapter on special phenomena such as grid emission, internal discharges, A.C. filament supply and hum, to mention a few, reveals some of the detailed study performed in the laboratory.

Apart from its interest to the professional engineer, the book can be commended to hams and other students, of transmitting technique. It is presented in the same fine style as its companion volumes, and having regard for its overall value it is not unduly expensive. One is impressed by the neat type-face employed, the clarity of the diagrams, and the general freedom from errors. This book has already received favourable comment from the technical fraternity the world over, and the fact that it has done so secures its niche in the field of electronics. A pleasing and most interesting volume in all respects.

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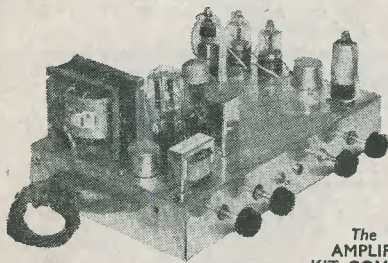
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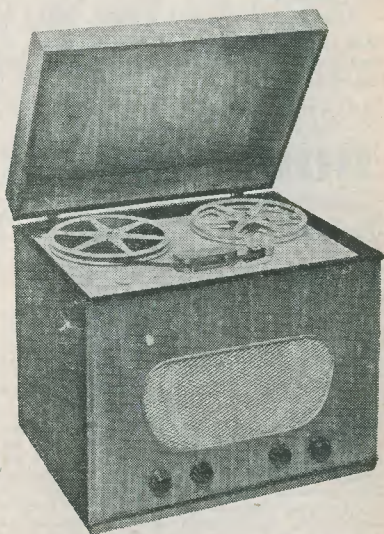
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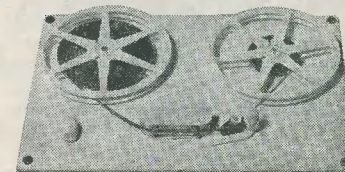
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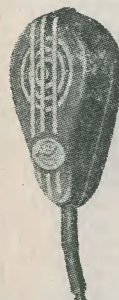
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KIT REVIEW

The PREMIER BABY ALARM KIT

(Premier Radio Co., 207 Edgware Road, London, W.2.)

This is a complete kit of parts, down to cabinet, speaker, and microphone which might normally be legitimately considered as accessories. Small items such as nuts, bolts, soldering tags, wire and sleeving are also included. The price of 69s. 6d. does, in fact, cover everything needed except tools.

The circuit is shown in Fig. 1, and consists essentially of a two stage amplifier

using two 12SH7 or 12SG7 valves. Operation is from AC mains, but the bulk and cost of a mains transformer is avoided by series-connecting the heaters and using capacitance feed; an article on this subject will appear shortly.

A moving coil earpiece is used as a micro-

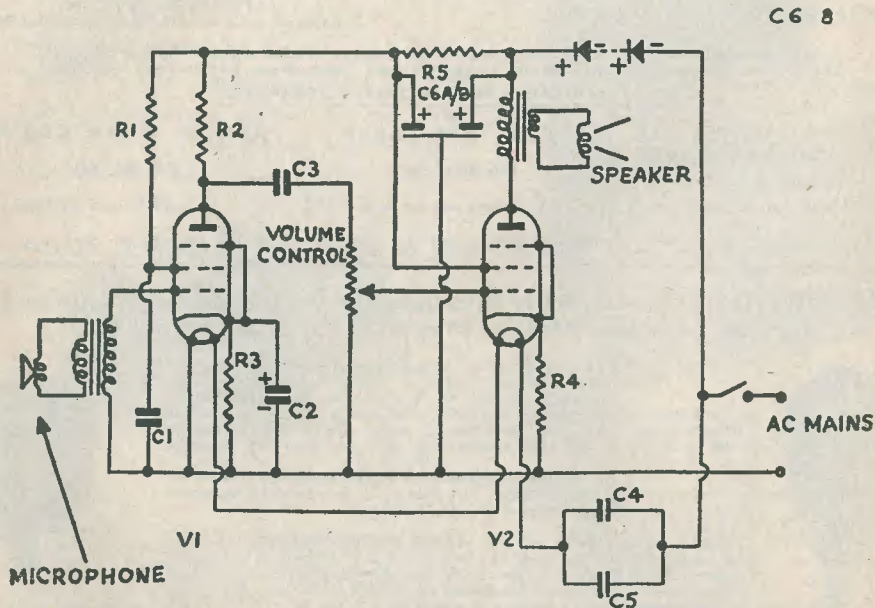


Fig. 1. Circuit of the Premier Baby Alarm Unit.

R1	2.2 Meg Ω
R2	470 k Ω
R3	3.9 k Ω
R4	100 Ω
R5	27 k Ω
Volume control with switch.	

Component Values

C1	0.005 μ F
C2	0.5 or 1 μ F
C3	0.005 μ F
C4	1 μ F
C5	1 μ F
C6A/B	16-16 μ F 350V electrolytic

phone, and is connected via a step-up transformer to the grid of V1. This stage is wired conventionally, and is resistance-capacitance coupled to the output stage V2. The grid leak of V2 takes the form of a potentiometer for volume control purposes. A measure of negative feedback is provided in this stage by omitting the capacitor across the cathode resistor. The HT supply is obtained by half-wave rectification of the

mains through a metal rectifier, with resistance-capacitance smoothing.

The Baby Alarm could, of course, be used for other purposes. As it stands, it would operate efficiently as a record player with a moving coil pick-up. Slight modification to the input stage would enable other types of pick-up to be used. Other possibilities, such as a burglar alarm, will occur to the reader.

COMPONENT REVIEW

BURGOYNE Record/Playback and Erase Heads

(Mail Order Supply Co., The Radio Centre, 33 Tottenham Court Road, London, W.1.)

These Burgoyne Record/Playback Heads are of the half-track type, allowing an hour's recording on a standard 1,200-ft. reel. The frequency response attainable at 7 $\frac{1}{2}$ " per sec. with tapes such as *Scotch Boy*, and a suitably compensated amplifier, is 50-9,000 c/s.

They are of the high impedance type, and are suitable for coupling directly into the grid of the first amplifier stage without any intermediate transformer (less chance of hum pickup) and they may be fed directly by a condenser from the anode of the tape modulator. The impedance at 1,000 c/s is 1,000 Ω . The grid load using an EF37A pre-amplifier is 470 k Ω .

The heads are totally enclosed, and the screening is fully effective in preventing hum pickup: in addition to this, the construction

employs a double gap, front and rear, which gives cancellation of hum pickup on the head.

The Erase Head is provided with a radio-metal laminated stack, and the gap width is set to 0.005", making for high efficiency in the transfer of erase currents to the tape. Here again the head is of the half-track type.

All heads are arranged for single-hole fixing, and the tape height is carefully controlled by means of the slot set on the head casing. The finish is heavy chromium plating, in order to present the least possible resistance to the passage of the tape and so minimise wear.

The Burgoyne heads are being exclusively distributed by M.O.S. (full address above) who invite trade enquiries. Retail price of either type is 39s. 6d.

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Mainly for the Beginner . . .

CIRCUIT SYMBOLS

By H. E. SMITH, G6UH

Are you able, without any hesitation, to follow a circuit diagram, and obtain a complete mental picture of the components shown in the circuit? Do you get confused between a tuned circuit and an RF choke? The following notes are intended primarily as a guide to the beginner in recognizing circuit symbols, and any circuits

given are symbolic and not necessarily operational.

Some of the more commonly used symbols are shown in Fig. 1.

The fixed capacitor (condenser) "A" may be of very small dimensions, even smaller than a postage stamp; it may be tubular, varying in size from one inch in length by

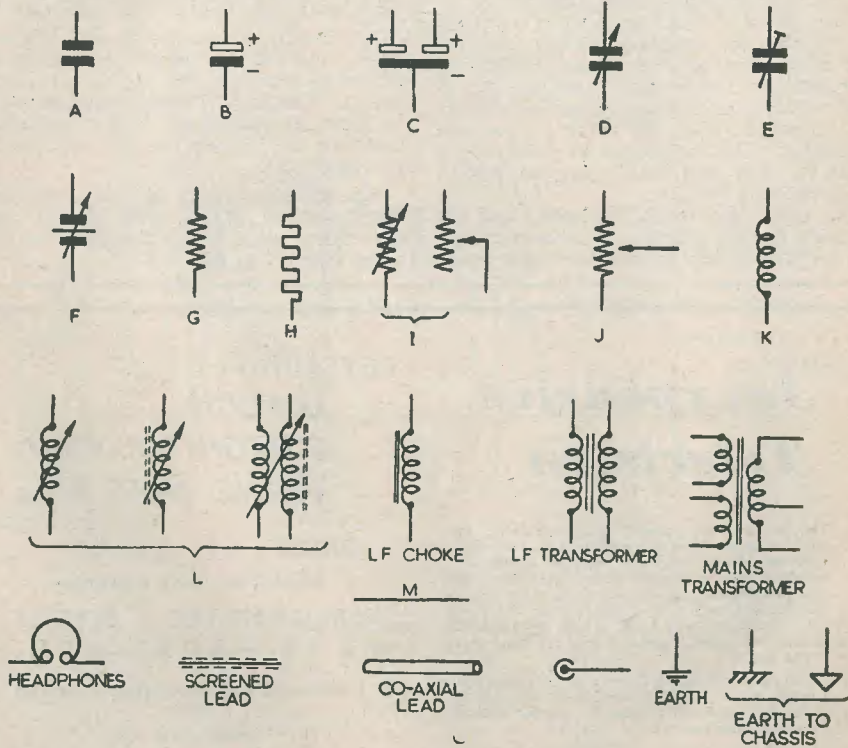


FIG. 1

C593

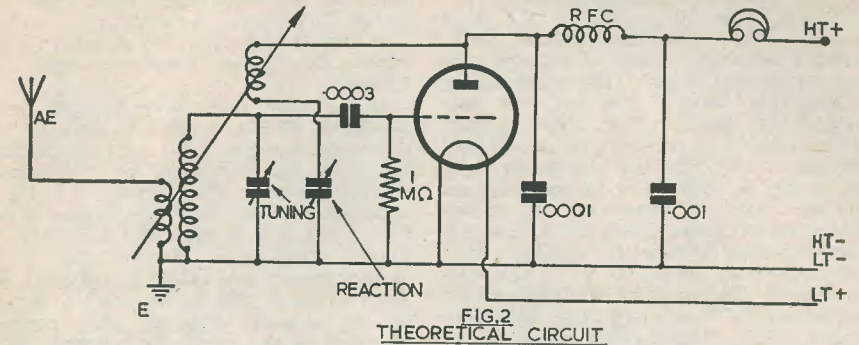


FIG. 2 THEORETICAL CIRCUIT

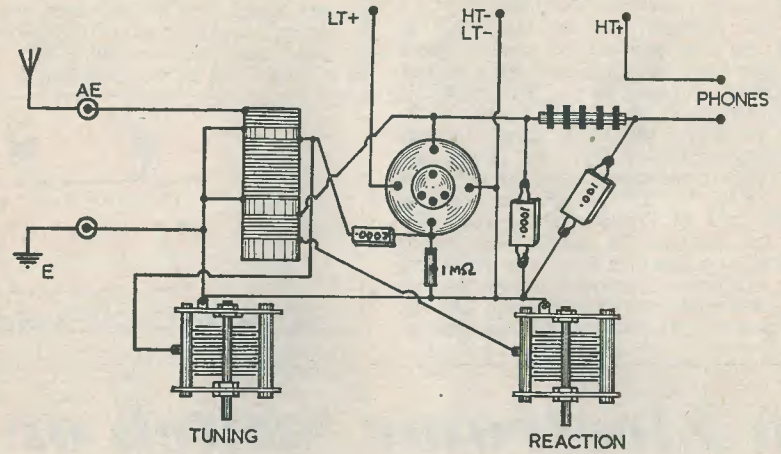


FIG. 3 LAYOUT OF FIG. 2

C594

a quarter of an inch in diameter, to three inches in length by one inch in diameter. On the other hand, it may be a high voltage paper dielectric smoothing type of up to six inches square. All these various types are indicated by the same symbol, but a clue to the physical size is always given on the circuit diagram as the value in $\mu\mu\text{F}$ (or pF) or μF is always stated. Taken by and large (although there are wide variations) the various types of capacitors may be grouped as follows:—For stated values of from 5 to 500 pF, the physical size will rarely exceed 1" by $\frac{1}{2}$ " for a working voltage of 350. From 500 to 10,000 pF (0.01 μF) the size will usually not exceed $1\frac{1}{2}$ " long by $\frac{1}{4}$ " wide. In some cases, values of between 0.002 and 0.01 μF will be found to be of the tubular type. From

0.01 μF to 1.0 μF . These are almost invariably of the tubular type, and rarely take up more space than 3" by 1".

Capacitors of the larger types vary tremendously. An 8.0 μF paper dielectric type, designed for operation at 1000 volts, may be 7" or 8" high, by 5" wide and 3" long. These types are seldom found except in specialised apparatus and transmitters. In receivers and simple equipment we usually find an electrolytic capacitor. This is depicted by "B" in Fig. 1. Once again, these vary in size. A 25 or 50 μF low voltage type, used as cathode by-pass, may be only $1\frac{1}{2}$ " long and $\frac{1}{2}$ " wide. The normal smoothing types are usually 4" to 5" high and approximately $1\frac{1}{4}$ " wide. Some types contain up to 3 separate capacitors in the one case;

these are shown in circuit diagrams as "C" in Fig. 1. This takes care of the fixed capacitors. Now for the variable ones. There are three main types of variable capacitor commonly in use. The main tuning capacitor (the one that operates from your tuning dial) is shown as "D". The trimmer, padder, tracker, or pre-set type is normally shown as at "E", and the split stator type, used mostly at VHF for tuning balanced push-pull circuits, is shown as "F". Fixed resistors are drawn as shown at "G", and if a non-inductive resistor is specified it is usually drawn as shown at "H". The variable resistor "I", not to be confused with the potentiometer "J", usually has two connections only, while the potentiometer (volume control) normally has three.

For the beginner, the inductor "K" is perhaps the most confusing symbol of them all, for this same symbol is used for a variety of purposes. It may be an RF choke, a self resonating coil, part of the tuned circuit, a filter, or if two are drawn close together, a transformer (RF or IF). RF chokes are usually plainly indicated on circuits by the letters "RFC." "L" shows the various methods used to indicate the purpose for which the inductor is used. The dotted lines always indicate that a dust iron core is used, and when an arrow is drawn through it, the dust iron core is variable. LF and Mains transformers "M" are always depicted

with two or three straight lines drawn close to the inductance, denoting an iron core. The several variations are shown in Fig. 1 which also shows other commonly used symbols.

Let us now, for a little exercise, analyze the circuit of Fig. 2 which is given for demonstration purposes only, and is not supposed to be a highly efficient or recommended circuit. Examine the symbols in Fig. 2, and then compare with the layout drawing Fig. 3. It will be seen that the rotor of a tuning capacitor is always taken to the earthed side of any circuit in order to avoid hand capacity effects, and as in the case of the reaction capacitor, any possibility of shock if the spindle is touched. Where ganged capacitors or switches are shown in circuit diagrams as two separate components, they are usually joined together by a dotted line, as shown in Fig. 4.

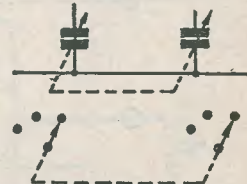


FIG. 4
GANGED CAPACITORS & SWITCHES

An Electronic Switch or Capacitance-Relay

By D. H. SULLIVAN

This circuit is designed, when a hand is held near a metal plate, to operate a relay which can be used to set off an alarm, or

switch on a light such as in a window display or perform other functions of a like nature.

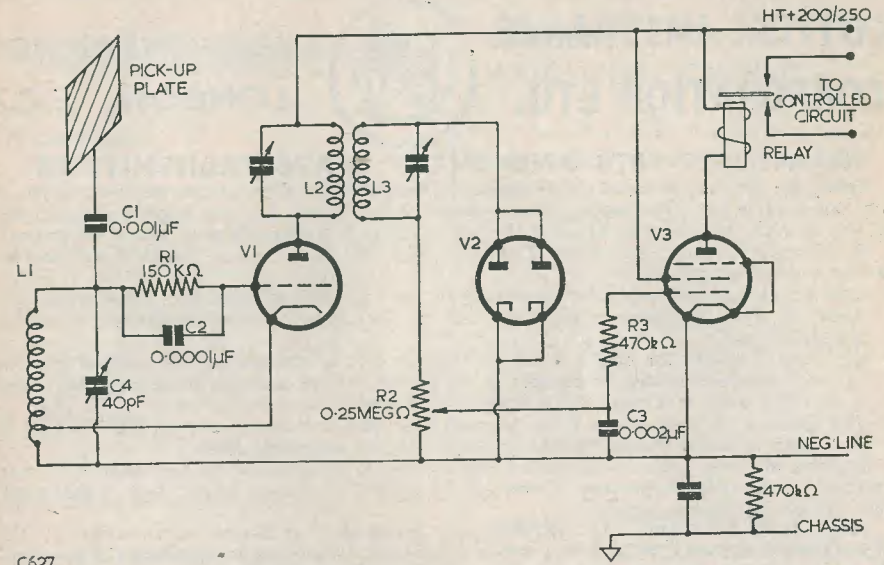
The principle of operation is as follows:— V1, together with L1, R1, C2 and C4 comprises an electron coupled oscillator, the RF component appearing across L2 in the anode circuit. Here it is coupled via L3 to a demodulator V2, where it is rectified and thence applied as cut-off or near cut-off bias to V3.

To set up the device, proceed as follows:— Turn R2 to minimum.

Tune L2, L3 to the same frequency as L1, as indicated by a 20,000Ω per volt meter across R2.

Advance R2 slowly until the relay just opens.

SUGGESTED VALVE LINE-UP			
Supply	V1	V2	V3
AC only 6V.	6J5	6H6/EB34	6SH7/6SG7
AC only 12V.	12J5	12H6	12A6/12SH7
AC/DC	12J5	12H6	12A6 Rect. 35Z5



C627

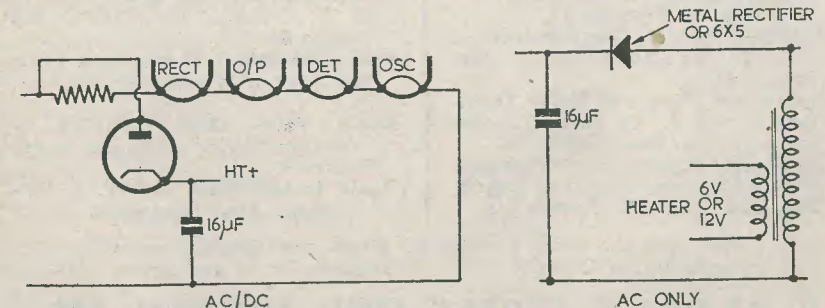
When the hand is brought near the metal plate, which is connected to the oscillatory circuit via C1, the frequency of the oscillator is altered. This causes, in turn, a drop in the bias voltage applied to V3, and a rise in its anode current, which operates the relay.

Construction can follow conventional lines. The frequency used can be any one convenient, provided it is not too low, and pre-

ferably not in the broadcast bands as it is inclined to radiate a little.

In the writer's set, L1 consisted of 250 turns of 28 swg on a 3/8" former, tapped 50 turns up from the earthy end for the cathode. L2 and L3 were each 200 turns of the same wire, tuned by 40 pF trimmers.

Power supplies and valve types are left to the individual, but the suggestions in the accompanying table may be of interest.



C627A

Figs. 1 and 2: Circuit with alternative power supplies

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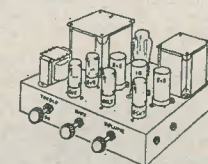
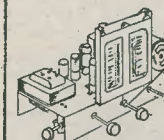
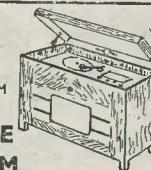
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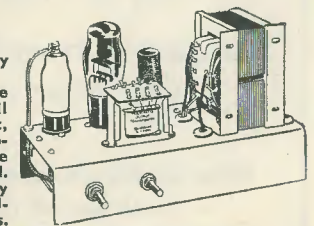
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