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The RADIO CONSTRUCTOR

Volume 7
Number 11
JUNE
1954

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for the Radio and Television Enthusiast

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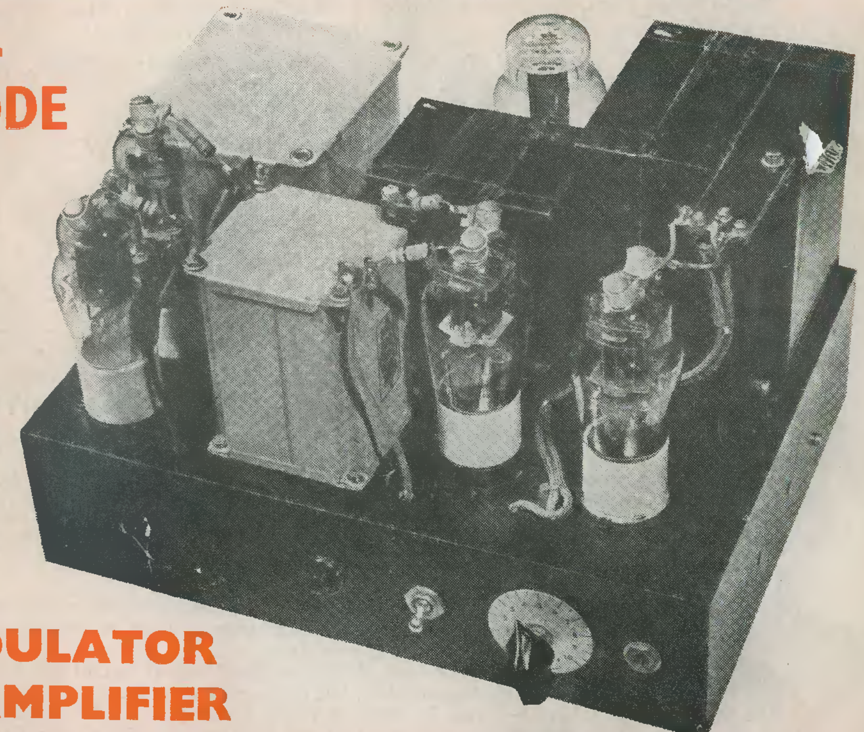

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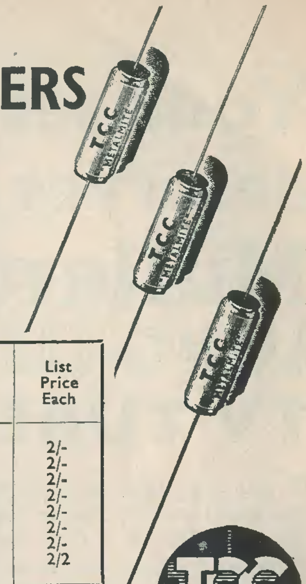

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The Radio Constructor

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CONTENTS FOR JUNE

VOL. 7 NO. 11

ANNUAL SUBSCRIPTION 18/–

JUNE 1954

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THE EDITOR invites original contributions on construction of radio subjects. All material used will be paid for. Articles should preferably 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 all relevant information should be included.

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

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

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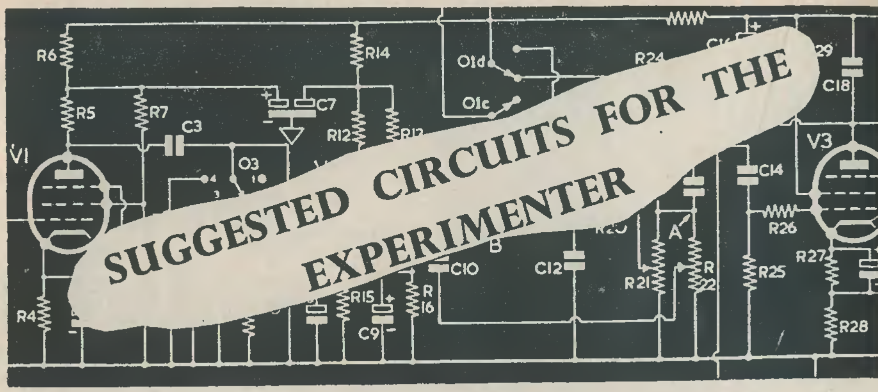

The circuits presented in this series have been designed by G. A. French specially for the enthusiast who needs only the circuit and essential relevant data.

No. 43 : ELIMINATING SCREEN BURN IN TV PICTURE TUBES

ONE OF THE PROBLEMS OF TELEVISION receiver design consists of the elimination of the stationary spot appearing on the screen of the cathode ray tube after the receiver has been switched off. This spot appears when a high value of EHT reservoir capacity (such as is given by modern graphite-coated tube bulbs), is employed in conjunction with permanent magnet focusing.

The unwanted spot is caused, of course, by emission from the still-warm cathode, combined with the EHT charge remaining on the reservoir condenser. The permanent magnet focusing assists in ensuring that the spot has a very small diameter; whilst the collapse of the time bases, after switching off, prevents any deflection voltages from being applied. A finely-focused stationary spot remains on the screen, therefore, until the tube cathode drops below emitting temperature, a process which normally takes some ten to twenty seconds.

It is possible for the stationary spot to cause screen burn.

Cures

Several methods of curing this trouble have been employed from time to time, but they have inherent disadvantages.

One method consists of so adjusting the ion trap magnet that the spot is moved just outside the screen area where it can do no harm. Such an adjustment can sometimes be achieved without impairing normal picture brilliance, although a compromise often has to be arrived at. The writer would like to state that this "cure" is extremely bad practice, and that it is not recommended.

A second method has been developed by some of the tube manufacturers themselves and consists of so connecting the electrodes of the tube that its grid is driven positive for a short instant after switching off. This causes a relatively high beam current to pass through the tube and discharges the EHT reservoir condenser. The tubes with which this scheme may be used are capable of handling the small excursions into grid current which occur; whilst the consequent discharge of the EHT condenser naturally prevents the formation of the spot.

This second arrangement has two disadvantages. Firstly, it can be used only for tubes employing cathode modulation. Secondly, the grid of the tube is not bypassed directly to chassis, but is connected to its decoupling condenser via a resistor whose recommended value is 22kΩ. When it is considered that a capacity of 3pF at 3 Mc/s has a reactance of only 18kΩ, it will be realised that the possibility of modulation degeneration, due to stray capacities between cathode and grid, assumes a considerable degree of importance.

An Alternative Approach

This month's circuit tackles the problem from a different angle. The basic arrangement is illustrated in Fig. 1, and it employs an unconventional ion trap magnet assembly.

The principle used consists of deflecting the spot safely away from the screen by a considerable amount after the receiver has been switched off. This is achieved by dispensing with the normal ion trap magnet, and using instead a similar assembly in which the permanent magnet has been replaced by an iron-cored coil. When the receiver is switched on a current is passed through this coil, energising its core to the same field strength as would have been achieved by the permanent magnet it replaces. The energised ion trap assembly then functions in exactly the same manner as does the permanent magnet version. When the set is switched off the energising current disappears; with the result that the ion trap assembly has no further deflecting effect on the beam, and the spot fails to reach the screen.

In Fig. 1, the coil of the energised ion trap magnet is connected in series with the entire HT feed to the receiver; and its field strength, whilst the set is switched on, is controlled by the variable resistor connected across it. In practice, the energising current may be obtained from any other alternative source of steady current in the receiver. It should be possible, in some cases, to dispense with the variable resistor. This could be done by providing the ion trap energising coil with the exact number of turns it needs for the particular current it passes.

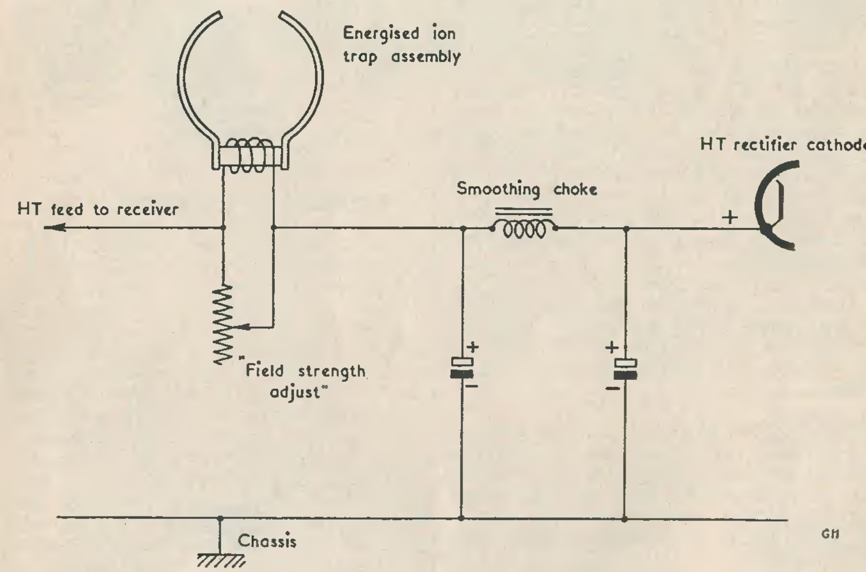

FIG. 1.

Practical Details

It is outside the scope of an article of this nature to give full practical details of the energised ion trap magnet. However, an outline of a suggested method of construction may prove to be of some value.

Assuming that the televisor with which the circuit is to be used is functioning satisfactorily, the existing ion trap magnet should be removed. This should then be stripped down and rebuilt, the permanent magnet being replaced by a similarly proportioned core of soft iron or similar material. If possible, a high-permeability metal, such as mu-metal, should be used for the core. An experimental coil may then be wound on this core.

[*cont. on next page*

CAN ANYONE HELP?

Dear Sir, Can any reader of your columns please help me regarding information and the circuit diagram of the receivers, type 78 (STR16) and type 76, and the various other sets in the complete equipment (transmitters types 53 and 51 and modulator type 76).—M. Littleworth, South Lodge, Peters Green, near Luton, Beds.

* * *

Dear Sir, I should be glad of any booklets or data on the following equipment:—Unit Indicator type 97, serial number 3437 having 14 valves and 517B CRT; A.P. (A501B) Panel Supply and Relay A/S 273 serial number PY3947; Panel Amplifying A.P. A106B, serial number 328.—R. W. Brown, 16 Cynthia Road, Oldfield Park, Bath, Somerset.

* * *

Dear Sir, I wonder if anyone could oblige me with some "gen" on winding coilpacks for the MCR1 receiver, to cover the amateur bands. As it stands, these bands occupy almost no space on the dial. If anyone could give me details of winding coils for 80, 40, 20 and even 15 metres if possible, I would be very grateful.—J. Cutler, 30 Stamford Road, Chorlton-cum-Hardy, Manchester 21.

* * *

Dear Sir, I would be very much obliged if any reader could lend or sell me the circuit data of the Ekco model PB179.—G. Nunney, 235 Portland Road, Hove 3, Sussex.

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Dear Sir, Would you ask in your columns if any reader can sell or lend me a Service Manual for the Ultra model 44 receiver? The set is about 20 years old, and consequently Ultra's stocks are all used.—R. A. C. Ward, 21 Woodfield Drive, East Barnet, Herts.

* * *

Dear Sir, Could any reader assist me in obtaining any information, circuits, etc., of ex-German Indicator Unit, Einsatzverstarker D.OB 103AO1 containing tube AEG HR2/100/1.5A, with a view to converting it to an oscilloscope for physiology experiments?—E. R. March, F.C.S., c/o The Technical College, Tavistock Road, Plymouth, Devon.

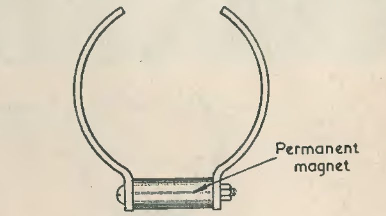
* * *

Dear Sir, I wish to thank you for publishing my appeal in the March issue. I also wish to thank a Mr. Haskins for a booklet which he sent me. Unfortunately I lost his address, but remember the Postal District was St. Albans. If you can squeeze this in a forthcoming issue I would be very grateful.—John Allen, 7 Chaucer House, Tabard Gardens, London, S.E.1.

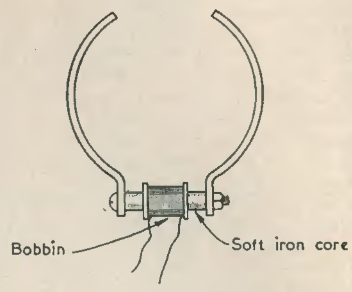
SUGGESTED CIRCUITS

cont. from previous page]

The assembly should next be replaced in the exact position on the tube neck as was occupied previously; and a variable, measured, current passed through the coil until the new ion trap assembly exhibits the same characteristics as did the original permanent magnet version. The core can then be wound to suit the current which will be finally passed through it by fitting it with a coil possessing the same number of ampere-turns as had the first, experimental, winding.



Conventional ion trap assembly



Energised ion trap assembly

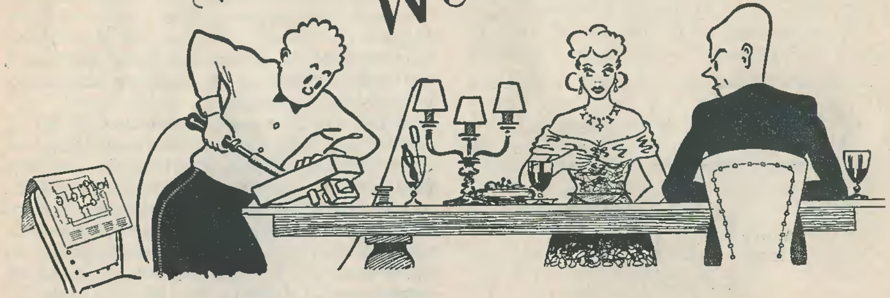
G12

FIG. 2.

The general appearance of the ion trap assembly, before and after modification, is illustrated in Fig. 2.

It is understood that the device described in the above article is the subject of Patent Application—*Editor*.

IN YOUR WORKSHOP



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

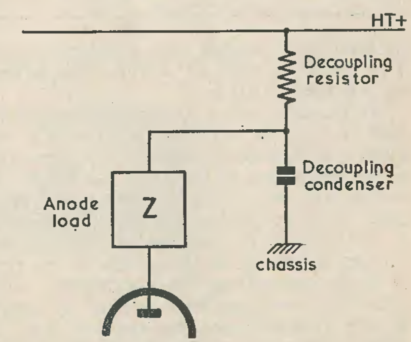
"IS IT BETTER," wrote a reader to me the other day, "when designing new equipment, to decouple each and every stage; or, instead, to use as little decoupling as possible? I ask this question because a friend and myself have both built similar receivers, mine fully decoupled wherever possible – his using hardly any decoupling at all. The results obtained are exactly the same!"

A question of this sort is rather like asking which is the better, butter or margarine? One, perhaps, costs a little less than the other and may not taste so well, but the nutritional value of both are just the same.

The Basic Decoupler

A typical example of the basic HT decoupling circuit is shown in Fig. 1. In this diagram, the anode of a valve feeds into an anode load. This is, in its turn, connected via the decoupling circuit to the HT positive rail of the equipment in which the valve is used. The anode load could be the primary of a coupling transformer, a resistor, a tuned circuit, or any other similar type of component or circuit arrangement.

To appreciate the functioning of the circuit of Fig. 1, let us first consider the instance in which the top end of the anode load is connected directly to the HT positive rail, as is done in Fig. 2. In this case it is possible, due to the absence of the decoupling components, for some of the voltages built up across the anode load to appear on the HT rail itself. This is especially true if the source of HT supply in the equipment has a comparatively high impedance such as would be given (in an extreme case), by a run-down HT battery. The voltages which should have been built up across the anode load then become built up across the anode load and the HT source impedance in series. This is illustrated in Fig. 2, in which the source impedance is shown as a resistor



E15

Fig. 1. The basic anode decoupling circuit

in series with the HT supply. According to the ratio between their values, a proportion of the voltages across both load and source impedance now appear across the source impedance only. This voltage could then be fed to other parts of the equipment via the HT rail itself and result in instability.

The basic decoupling circuit of Fig. 1 alleviates this trouble considerably; and can reduce the unwanted voltages appearing on the HT rail to negligible proportions.

Let us assume that the anode load of Fig. 1 is a resistor of 100kΩ, and that the decoupling condenser has a value of 0.1μF. The anode is part of a valve amplifying an AF tone at 10 kc/s.

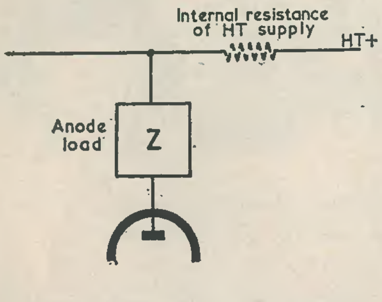


Fig. 2. Showing how an undecoupled anode load may act in series with the internal impedance of the HT supply to allow a proportion of the anode voltages to appear on the HT line itself

At this frequency, the impedance of the 100kΩ resistor remains substantially unaltered at its resistive value. The impedance of the condenser, on the other hand, becomes very small. At 10 kc/s the condenser impedance is, approximately, 150Ω. Thus, only a very small proportion of the 10 kc/s voltage appearing at the anode of the valve is built up across the condenser. Also, what little voltage does appear is applied to the series decoupling resistor (Fig. 1), which forms part of a further fixed potentiometer in conjunction with the series impedance of the HT supply itself. Due to the presence of the decoupling resistor and condenser, therefore, the voltage appearing finally on the HT rail is very much smaller than would occur in the undecoupled case of Fig. 2.

The decoupling circuit of Fig. 1 also prevents decoupling in the reverse direction. If, for instance, an unwanted voltage from another stage appeared on the HT line, the presence of the series decoupling resistor (whose value is high compared with the impedance of the condenser) would ensure that only a very small proportion of this voltage appeared across the decoupling condenser.

A Sense of Values

So much for the familiar essentials of the basic decoupling circuit. Let us now examine the impedances offered by condensers at different frequencies. This can enable us to get the "feel" of practical decoupling circuits, and to realise just how effective a particular value of decoupling condenser actually is in practice.

In our example just now we used an 0.1μF condenser, which had an impedance of approximately 150Ω at 10 kc/s. At this frequency it was quite a useful component. When we get down to the practical problems of decoupling, say, an AF amplifier, however, we find that the 0.1μF condenser is not of much use. At 1 kc/s, for instance, it has an impedance of 1,500Ω; at 100 c/s, 15,000Ω; and at 10 c/s 150,000Ω.

On the evidence of these figures, the 0.1μF condenser does not reveal itself as being particularly effective in an AF amplifier at all. This is entirely due to its high impedance at low frequencies. At 100 c/s it has an impedance of 15,000Ω, and commences to approach the value of the individual anode loads used in the amplifier. At 10 c/s, a frequency at which motor-boating may occur, it has a value of 150kΩ; and, in cases of fairly heavy feedback, might as well not be in the circuit at all for all the good it would do.

This may come as a surprise to one or two readers who have seen an 0.1μF decoupling condenser included in AF circuit diagrams and used in working AF amplifiers. However, the figures do not lie and they do show the shortcomings of a condenser of this small value when used in an AF amplifier. Furthermore, the use of a condenser of this value can actually introduce frequency distortion, since it causes the effective amplification of the AF circuits which it decouples to vary for differing AF frequencies.

Let us now examine the impedance offered by a 16μF condenser at audio and sub-audio frequencies. At 10 kc/s a 16μF condenser has an approximate impedance of 1Ω. Practically a dead short! At 1 kc/s it has an impedance of 10Ω, at 100 c/s an impedance of 100Ω, and at 10 c/s one of 1,000Ω. Over the audio range itself, therefore, the 16μF condenser has an impedance which is quite low and which should not introduce any serious frequency distortion. At frequencies at which motor-boating may occur, its impedance is still sufficiently low

to enable it to assist considerably in obviating feedback of this nature.

At radio frequencies, the large electrolytic condenser is not needed, and the 0.1μF component becomes more effective. At 500 kc/s, for instance, an 0.1μF condenser presents an impedance of approximately 3Ω. A condenser of this value would function perfectly for decoupling the 465 kc/s IF stages of a conventional sound receiver.

At 10 Mc/s, a condenser as large as 0.1μF is not always necessary. At this frequency, a condenser of .01μF, having an impedance of 1.5Ω, would usually be quite adequate. The 0.1μF condenser is still used sometimes around 10 Mc/s, however; especially so when it also forms part of a tuned circuit.

When we get to television frequencies around 50 Mc/s and above, the conventional type of paper condenser presents an undesirably large amount of inherent inductance in addition to its capacity. It becomes desirable, therefore, to use condensers of different design altogether. Fortunately, at these frequencies, decoupling condensers need not have a very high value of capacity, and so it becomes much easier to design and manufacture non-inductive condensers employing low-loss dielectric materials. At 50 Mc/s a condenser of .001μF has an impedance of 3Ω.

Getting Away With It!

Let us now revert to the original question of how much decoupling should be used in a piece of equipment.

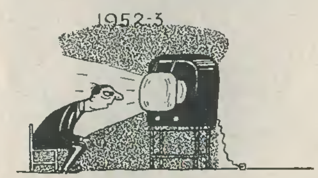
So far as higher frequencies are concerned, i.e. frequencies above, say, 10 Mc/s, every stage should be decoupled. This policy is not recommended only because of the question of feedback along the HT line, however. It is recommended also because the decoupling condensers themselves provide short paths for the completion of RF circuits.

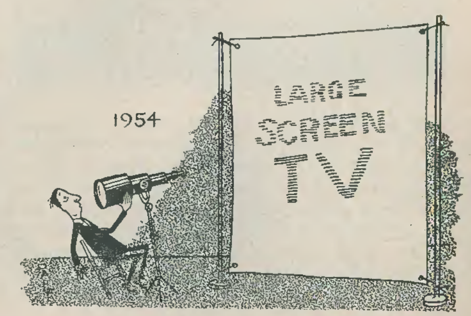
At frequencies below 10 Mc/s, and especially in the broadcast medium and long wavebands, decoupling becomes not so much a question of necessity as of good design. A set working on these frequencies may function quite well with hardly any decoupling circuits at all; it will, however, often work just a little better if decoupling circuits are fitted to each stage. The whole question resolves itself to a consideration of cost. Is the extra expense of decoupling components justified if the improvement in performance is only slight?

Fig. 3 shows an example of what one can "get away with" on the broadcast bands. This diagram illustrates a typical four-plus-one superhet. Only the cathode of the rectifier is included in the diagram, since the circuit can be either AC/DC or transformer operated. Single waveband operation is shown; although, with the addition of a conventional wave-change switch and the necessary coils, there is nothing to prevent the set from working on the normal long, medium and short wavebands.

Individual anode decoupling circuits, of the type shown in Fig. 1, simply do not exist in Fig. 3. The single electrolytic condenser, C16, is assumed to have a sufficiently low impedance to effectively short-circuit any voltages which might otherwise appear on the HT line. In practice the arrangement works very well; this being especially true when modern electrolytic components, which do not dry out or go "low-capacity" so readily as did those manufactured before the war, are used. The impedance of C16 at radio frequencies is higher than the value calculated from capacity and frequency alone, this being due mainly to the poor power factor of its dielectric at these frequencies. It is still sufficiently low, however, to function satisfactorily in practice.

Other economies have been effected at the screen-grids and cathodes. A single condenser, C3 (mounted at the frequency-changer), decouples the screen-grids of both V1 and V2. Another condenser, C4, similarly decouples both cathodes. The cathode of V4 is not decoupled at all, sufficient gain being obtained despite the negative feedback thus introduced. The cathode of V3 is taken direct to chassis, grid bias being supplied by the charging





effect of C14, in conjunction with the high-value resistor, R8.

Even the AVC line has only one decoupling condenser (C1), this also performing the function of completing the aerial tuned circuit.

The circuit of Fig. 3 is quite practicable; even though it has been reduced almost beyond the skeleton stage.

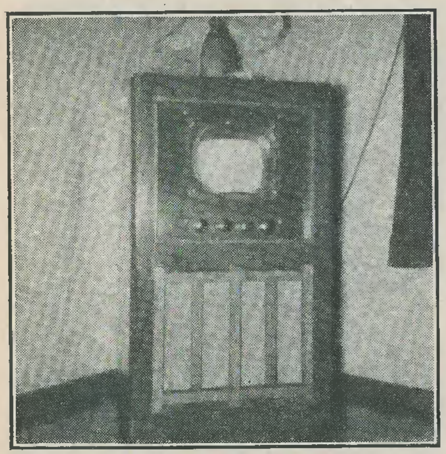
Ferrite Frames

I have received a query from another reader concerning the modern trend towards frame aerials wound on iron-core rods as opposed to the older type of frame aerial which occupied a large flat area inside the cabinet.

These iron-cored frame aerials are not entirely new, of course, and, if my guess is correct, are a development from the iron-cored "suppressed" direction-finding aircraft loops used during the war. In the American home-constructor market "Ferri-Loopsticks" (a trade name) have been advertised for some years now.

The cored frame aerial consists of a fairly long thick rod (8 inches by 3/8 inch affords a typical example) of iron-core material, on which are wound the aerial coils of the receiver. The inductance of these coils is exactly the same as would be given by conventional coils mounted on the chassis, and the long rod enables the coils to pick up energy in much the same manner as does a frame aerial. As an example of the core material used, ferrite rods, manufactured by Mullard, use the well-known Ferroxcube.

The great advantage of these cored aerials lies in the fact that they can be wound to a much higher value of Q than is given by the conventional open-wound frame aerial. This results in far greater freedom from second-channel interference and also makes trimming and padding considerably easier. Readers who have had the experience of lining up *some* portable receivers in the past will appreciate that last point!



The photo shows the televisor constructed from the original articles of "Inexpensive Television" *by reader W. G. Rowe of Liverpool. Good pictures were obtained from Sutton Coldfield on an indoor aerial; but valves had to be removed from both sound and vision units when Holme Moss came on the air, owing to too much gain! The photo was taken with a Brownie Reflex, with flashlight*

Tool Review No. 1

As I mentioned the other day I intend reviewing, from time to time, tools specifically designed for the radio engineer.

I don't think I can do better than start with the new "Bib" wire stripper, which has just been released to the shops by Multicore Solders, Ltd.

The first arresting point about this wire-stripper is its very low price: 3/6 retail. This price is reached by reason of the simple design employed. The stripper consists essentially of two flat strips of steel, pivoted together in something of the same manner as is a pair of shears. The wire-stripping process proper is achieved by means of two V-shaped notches which engage with each other sufficiently far to bite into the insulation without cutting or marking the wire itself. An adjustable stop is given by an eccentric disc mounted to one of the arms of the stripper. The other arm then bears against the rim of this disc.

I have tried the stripper in action on extruded plastic flex and on PVC and rubber-covered wires, and it strips the insulation easily and cleanly without nicking the strands. Furthermore, a single setting of the eccentric disc appears to cope with a surprisingly large amount of wire gauges.

As a further test I introduced the stripper onto a production line in a small factory, in place of a more complicated and much more expensive tool. The verdict of the girls who used the new stripper was that it was "just as good and just as quick."

I think that one of the more useful applications of this tool will be to the radio engineer who has to handle fairly thin flexible PVC wire. Such wire is notoriously awkward stuff to strip; yet this tool strips it very easily and with no "tugging" at all.

At its low price, the "Bib" stripper is excellent value, and I can recommend it as a worthy addition to the tool-kit of any practical radio engineer.

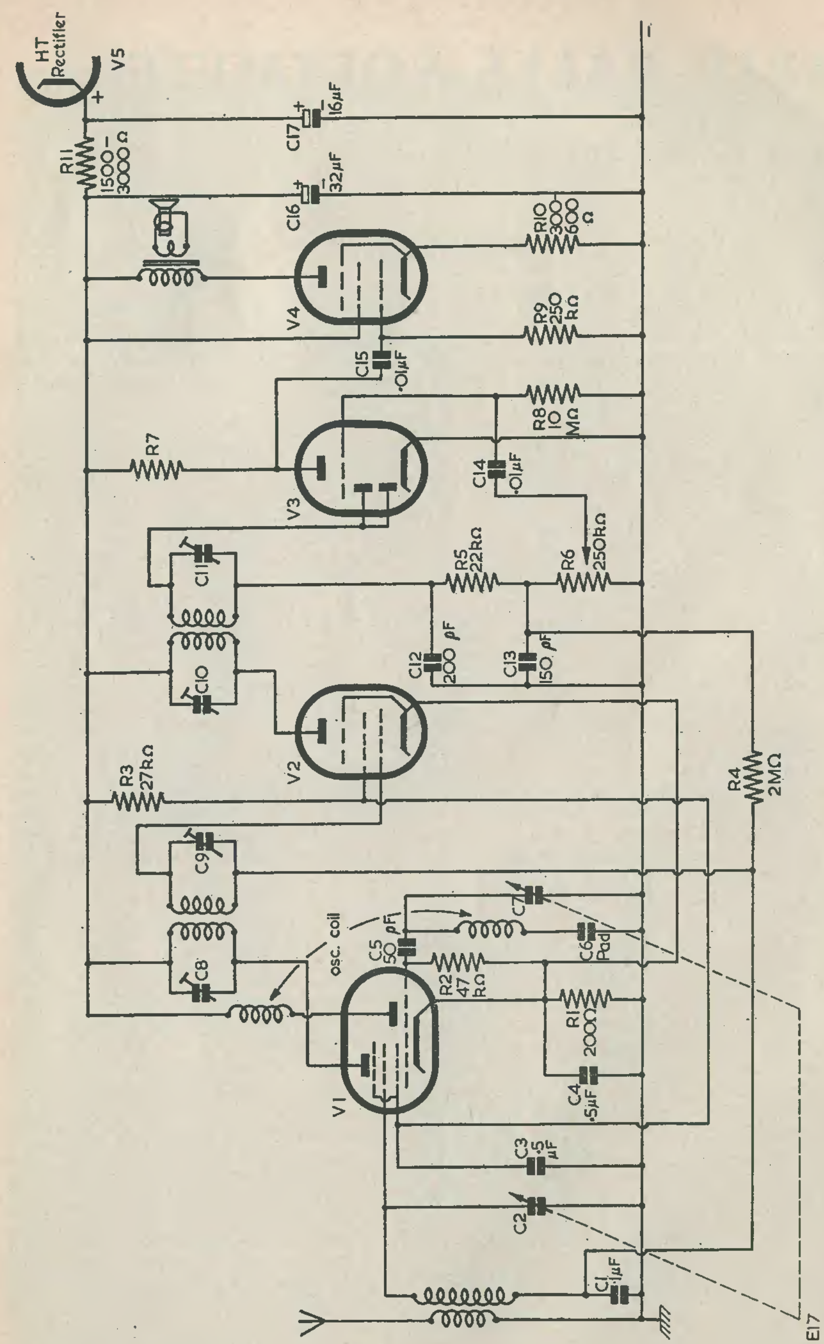


Fig. 3. A practicable superhet circuit in which decoupling has been reduced to a minimum. C1, C3 and C4 should be mounted close to the frequency-changer. If desired, the feedback oscillator coil may be connected to the frequency changer screen-grid instead of to the full HT voltage

STABLE VALVE VOLTMETER

for the home constructor

By **D. W. EASTERLING**

WHEN MAKING VOLTAGE MEASUREMENTS, it is desirable that the meter places negligible loading on the circuit under test. Infinite meter impedance is, of course, ideal, but not practical. On high voltage ranges, a good multi-range meter of 20kΩ/V sensitivity presents an adequate impedance, and is usually the most convenient to use. Low voltage measurements require a different technique, however, and by using a valve as an input transformer an impedance up to 10MΩ is easily obtained.

The Circuit

Fig. 1 shows the circuit to be described. Two cathode followers bridged by a micro-ammeter form a balanced circuit. The application of considerable negative feedback causes both valves to behave similarly, consequently the potential difference across the meter is zero and no reading is given. An EMF applied to either grid unbalances the circuit, the meter reading proportionately to the applied voltage. Variations in supply voltage or temperature will affect both valves alike, the ultimate effect on the meter being zero, hence the instrument's good stability.

With a simple power unit supplying about 250V HT, the maximum EMF which can be measured is about ±50V. It is conventional to provide a switched input potentiometer in order that higher potentials may be measured. In this case, both V1 and V2 should have identical input circuits.

To home constructors who rarely have extensive measuring facilities at their disposal, the conditions just mentioned are difficult to imitate. But two simple fixed potentiometers dividing by two are easily arranged, and by using preset resistors in series with the microammeter to determine the range, a sensitivity of ±5V full scale deflection with a maximum of ±100V FSD is possible.

Negative potentials are applied to the grid circuit of V1, and positive potentials to the grid of V2. Both input potential dividers are set by trial and error, using a dry battery or other suitable known source.

AC Probe

Alternating potentials are rectified by a small probe, which plugs into the main unit as required. This method allows the detector to be brought direct to the point of test, thereby avoiding lead losses.

A parallel diode V3 removes the positive half of each cycle, and the negative portion is passed to the grid of V1. An input capacitor is used for DC isolation, while another capacitor C4, together with resistor R10, filters out the remaining AC component.

A second diode V4 is connected across the input of V2 to balance out the standing negative voltage produced by the detector diode V3. This standing voltage, produced by diodes with very high value loads, is caused by the arrival at the anode of electrons released from the cathode at very high initial velocities. As this voltage will vary to some extent, a fixed bucking voltage is

COMPONENTS LIST

R1, 3, 9, 10, 11	2.2MΩ ½W
R2, 4	5MΩ ½W
R5, 6	100kΩ ½W
R7	33kΩ 2W
R8	47kΩ 2W
VR1	2kΩ wire-wound pot.
Ra (5V range) 100Ω max. – see text	
Rb (25V range) 22kΩ max. – see text.	
Rc (100V range) 220kΩ max. – see text.	
C1, 2	8μF 350V wkg. electrolytic
C3, 4, 5	0.01μF mica 1kV
V1, 2	6SN7 with octal holder
V3, 4	D77 with B7G holder
MR1	Selenium rectifier 250V RMS
T1	0-230V primary, 230V 30mA and 6.3V 1.5A secondaries
M	0-500μA meter
Range switch, single-pole, three-way.	
On-off switch.	

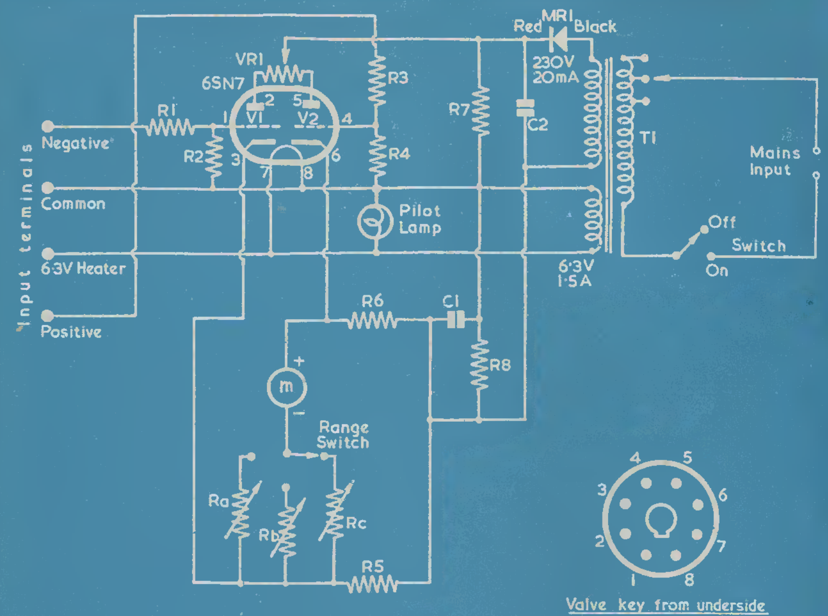


Fig.1
Circuit diagram of main unit

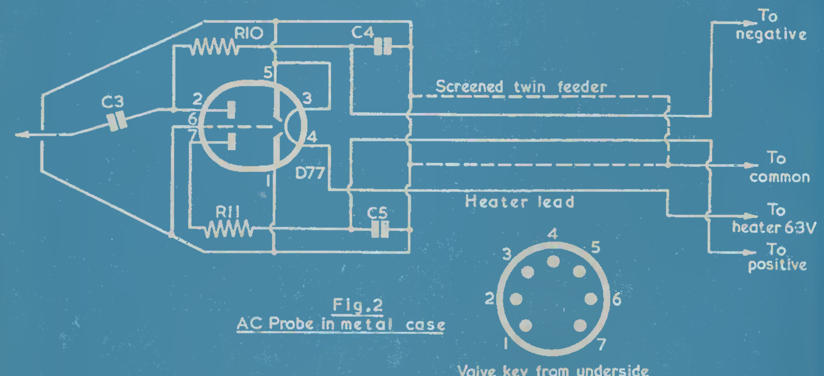


Fig.2
AC Probe in metal case

Fig.3
DC Probe in insulated tube

E14

not practical. V1 and V2 are the two halves of a 6SN7 double triode, completely balanced at no-signal condition by VR1. V3 and V4 are the two halves of a D77 (B7G).

The values quoted for the range resistors are only approximate. For fine adjustment it is advisable to arrange that each range resistor consists of two parts in series, one part fixed and the other variable.

R1 and R2 should be wired direct between valveholder and input terminals, the terminal bushes being of good insulation to maintain a high input impedance.

Layout and housing problems are neatly solved by using a plastic sandwich box. The top of the mains transformer protrudes through the lid, and is protected by a suitable shroud.

The mains transformer with a small selenium rectifier provides the power supplies. Note that the chassis is not common with the negative HT rail, and in consequence electrolytic capacitors with metal cans must be insulated from the chassis. The metal chassis may be fixed to the plastic box by the switch and potentiometer locking nuts.

The AC probe should be as small as possible, both for convenience in use and to avoid bulk capacitive effects at high frequencies. An old wet electrolytic capacitor case makes a suitable probe housing, connected to the main unit by a length of screened twin feeder. A separate external lead is used for the diode heater supplies.

DC Probe

This probe, illustrated in Fig. 3, is simply an insulated tube containing a 2MΩ resistor. This resistor serves to equalise the effect of R10 and R11 in the AC probe, and so maintain the calibration. Also, it is an AC stopper, thereby reducing the effect of the meter on the AC component in the circuit under test whilst still enabling accurate DC measurements to be made.

Calibration and Setting Up

Having checked the wiring, set to the maximum range, with all range resistors at maximum. Short the input terminals and switch on the mains. Allow a few minutes for the instrument to reach a stable temperature, making sure that no component is overheating.

Switch to the low (5V) range and adjust the zero control VR1. Note that the meter pointer remains stationary when switching to higher ranges. Now connect the AC probe, reverting to the 5V range once more. Zero should still be maintained; if otherwise, adjust R10 or R11.

The voltage scale, which is substantially linear, is made to coincide with the existing current scale by feeding in a known potential derived from a dry battery or other source, and adjusting the relevant range resistor. These adjustments should be made with the DC probe in circuit.

The meter scale is suitable for AC as well as DC voltages, but it should be noted that the reading indicated is for peak AC. $V_{RMS} = V_{Peak} \times 0.707$.

The instrument described allows readings of reasonable accuracy to be made from 0.2V to 100V DC, and AC over a frequency range of 20 c/s to some 2 Mc/s. Above 2 Mc/s the frequency response falls off, but good indication for comparative readings is obtainable well above 20 Mc/s.

No zero re-setting is necessary when switching ranges. Calibration drift was noted to be not more than 2% over a one hour period.

Rufus

THE RADIO CONSTRUCTOR

★

"That the Constructor . . . ? This article on printed circuits is a frost. I've stuck valves in every position and I can't get a sausage!"

LABORATORY EHT VOLTMETER PART 2

By **W. G. MORLEY**

Concluding an accurate instrument which can be built from stock components and which may be calibrated in the constructor's home.

In last month's article we dealt with the circuit and the theory of operation of the EHT voltmeter. We shall carry on, in this concluding article, to a description of its construction and calibration.

The Chassis

The layout and construction of the chassis are not at all critical, and individual constructors will, no doubt, have their own preferences. As a guide, the layout adopted by the writer is shown in Fig. 4. This diagram illustrates the positioning of the principal components, and may be examined in conjunction with the photographs. It should be noted that the EHT test lead is not taken to a plug or socket; a long fly-lead being connected, instead, direct to R1. This method of taking out the test lead obviates any troubles which might be caused by corona or flashover. (When the writer's meter is, later, put in its cabinet, the test lead will be taken out through the side).

The front panel layout adopted by the writer is shown in Fig. 5. This diagram is, again, meant only for guidance, and individual constructors may decide to use layouts more suited to their own ideas and the components they have on hand. It should be noted that the DM70 is fitted behind a rectangular

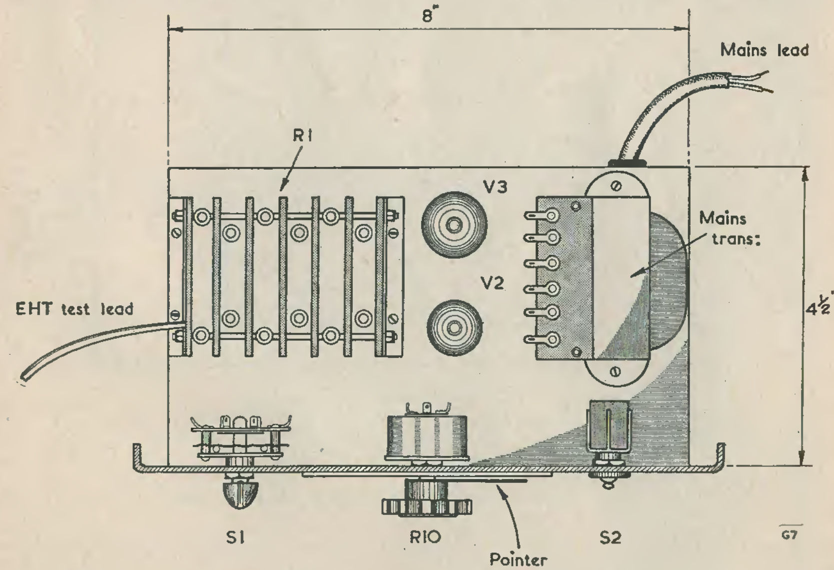


Fig. 4. The layout adopted by the writer

cut-out on the panel, the balance-indicating wire being mounted directly against the glass of the valve.

General Points

Readers examining the photographs may have noticed that the writer has mounted all his resistors on tag-strips. This policy is to be advocated as, in an instrument of this type, insecurely mounted resistors should most definitely not be used. It is better to be extravagant in the use of tag-strips rather than have a completed job which is mechanically unsound. Spare valveholder tags should not be employed for mounting resistors. This is especially true in this instance, as the valves specified have internal connections taken to some of the unused pins.

Care should be taken also to ensure that no leakiness across any insulation can occur. For this reason it is advisable to use good and reliable components for S1, R10, and the tag-strips. Leakiness will introduce errors.

The range switch, S1, can be of the normal wafer type as is used for wave-change purposes, since the voltages appearing at its contacts are not excessive.

The DM70 may be mounted with a simple clamp, as shown in Fig. 6. Care should be taken to avoid bending the leads of this valve too abruptly during the process of connection, as damage may otherwise occur. Also, these leads should not be soldered too close to the point where they leave the glass envelope. The filament leads should be wired so that they correspond to the numbers designated in Fig. 1. If they are

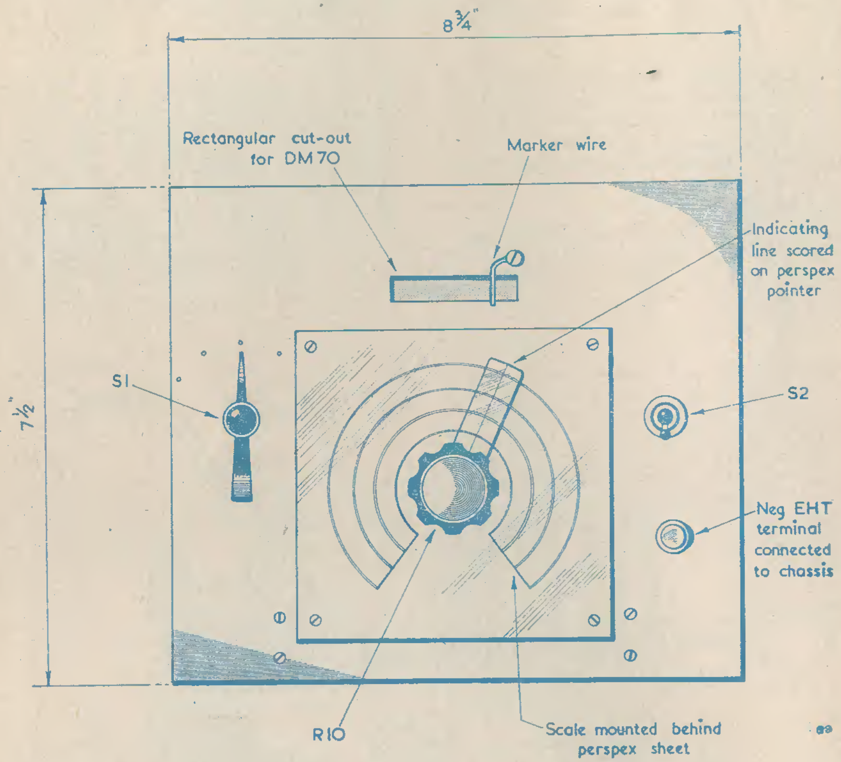
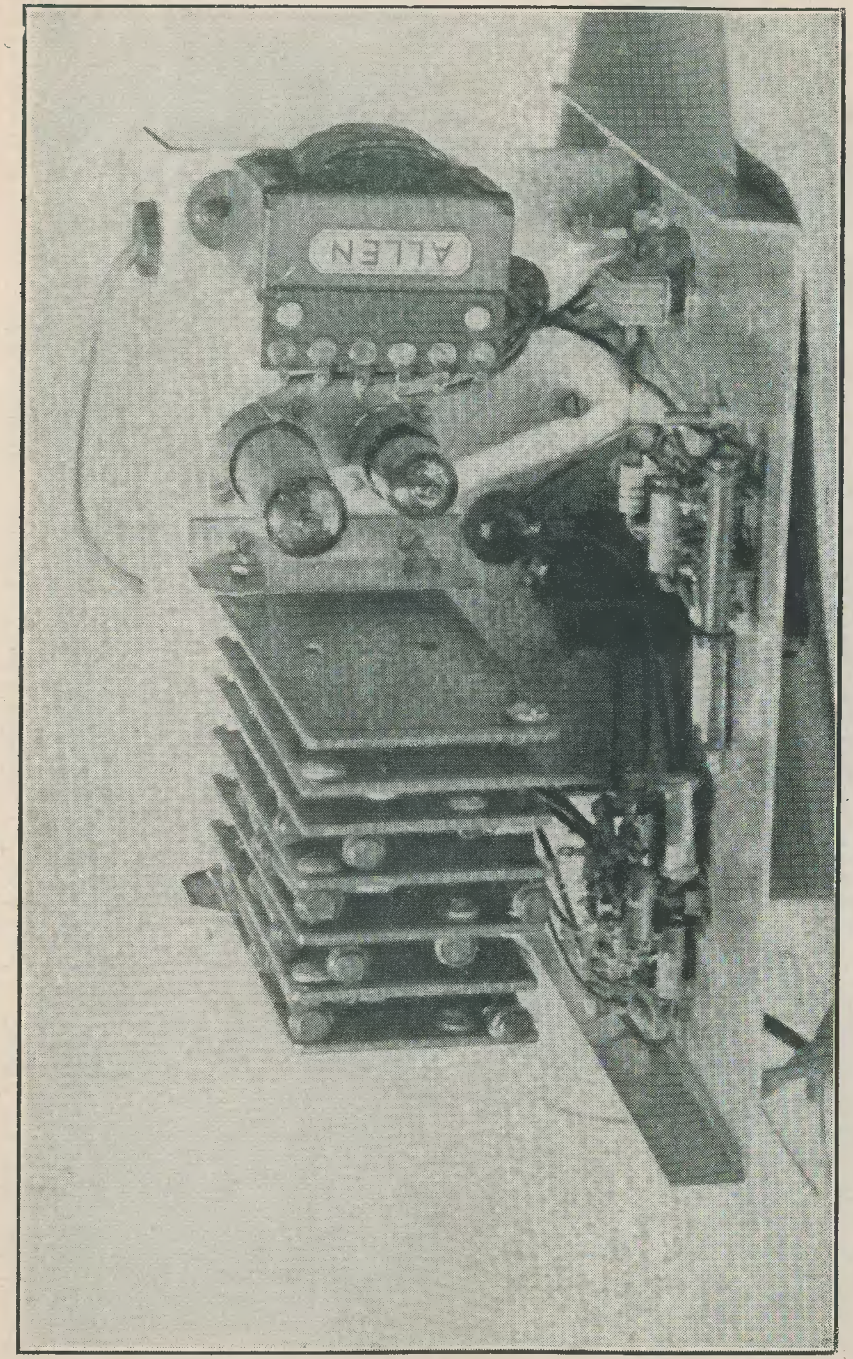


Fig. 5. The front panel layout used in the prototype



Above chassis view of prototype—compare with Fig. 4 connected the other way round, indications of balance will not be quite so sensitive. The filament of the DM70, incidentally, does not give any noticeable glow when it is connected to its source of supply.

Calibration

The calibration of the instrument is very simple, once the procedure of doing this has been understood.

The reader is asked to refer back to Fig. 1. As has already been described, the bridge

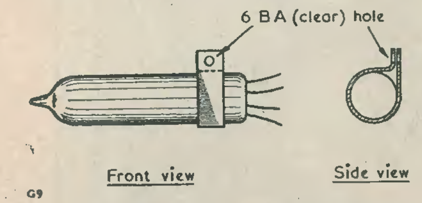


Fig. 6. Making the clamp for the DM70

is adjusted by varying the cathode voltage of the tuning indicator against its grid voltage. The cathode voltage is, of course, varied by R10; whilst the grid voltage is that appearing at the arm of S1(a). The effective

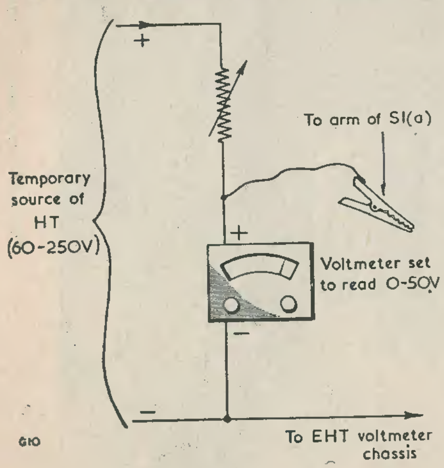


Fig. 7. Setting up the voltmeter for calibration

bridge thus formed is balanced when the grid voltage of the DM70 is several volts negative with respect to its cathode.

Referring to the right hand side of the bridge circuit, it will be seen that switches S1(b) and S1(c) vary the voltages applied across R10. Working from the regulated 150 volt point at the anode of V2, it will be at once apparent that, in position 'a', the voltage at the top end of R10 is approximately 50 whilst that at the bottom end is zero, with respect to chassis. In position 'b', the voltages are approximately 50 and 20 respectively. In both positions 'c' and 'd' they are approximately 50 and 30. In all positions the currents taken through R9 from V2 are approximately equal. The adjective "approximate" is used to qualify the voltages and currents obtained here because the resistors employed in this network are not close-tolerance.

On the left-hand side of the bridge, resistors R2 to R5 are, however, accurate within 1%. Assuming that R1 has the correct value of 298MΩ, it will be seen that the arm of S1(a) taps into voltages which are exact fractions of the EHT applied. In position 'a' it taps off 1/150 of the total EHT; in position 'b', 1/200; in position 'c', 1/300; and in position 'd', 1/400.

From the above, it may be seen that we can now calibrate the meter by the simple process of applying a low voltage to the arm of S1(a) and balancing the bridge to that voltage.

Fig. 7 shows how this is done. A source of HT, say a receiver power supply or an HT battery, is connected via a variable series resistor to the arm of S1(a). A voltmeter is connected between the arm of S1(a) and chassis. The variable resistor is then adjusted until the voltmeter gives a desired reading; the bridge is balanced, and the scale calibrated at once *in the terms of the EHT which would apply such a voltage to S1(a).*

Thus, with S1 in position 'a', we could start by setting the variable resistor of Fig. 7 such that the voltmeter gave a reading of, say, 40 volts. We then balance the bridge. This calibration setting is then equal to 40 volts applied to the arm of S1(a) or to 6kV, (40×150), applied to the top of R1. Thus, by using this method, R10 may be calibrated directly in kV.

The corresponding values of low voltage against EHT voltages for the four settings of S1 are set out in the table accompanying this article.

Extending The Range

In its present form, the EHT Voltmeter, when completed, is capable of reading EHT voltages up to 19.5kV. Although this is more than adequate for normal television work, it is anticipated that some constructors will wish to extend the range sufficiently far to measure the EHT used in projection receivers; that is, up to approximately 25kV.

It would be inadvisable to attempt to do this using the existing 298MΩ series resistor, as the current taken at the higher voltages would be a little too large for the relatively poor regulation of the EHT power supplies commonly encountered, and readings would correspondingly tend to be slightly low.

An alternative solution would consist of using an external additional series resistor. This should, preferably, have a value of 150MΩ and could be mounted in an insulated container. If this were used in conjunction with the EHT voltmeter on range 'd', all readings obtained would be multiplied by 1.5. Thus, a reading of 15kV would correspond to an actual voltage of 22.5kV, a reading of 18kV to a voltage of 27kV; and so on.

Some constructors carrying out specialist work may need to use the voltmeter with EHT circuits from which very little current indeed may be taken. Using the values specified in Fig. 1, the voltmeter takes a current of 50μA at 15kV, this being more than adequately low for normal use. If, however, lower current consumption is required, this may be obtained by multiplying R1, R2, R3, R4 and R5 by a single factor. Thus, if the values of these resistors were doubled, the meter would consume half the current whilst giving the same readings. It must be emphasised that this will give R1 a value which is large and which will cause this resistor to be rather cumbersome in its final form; and that the advantage gained is somewhat offset by the extra amount of trouble involved in its construction.

TABLE SHOWING CALIBRATION POINTS

Range	*Calibration Voltage*	*Corresponding EHT*
a	13⅓	2kV
	20	3kV
	26⅔	4kV
	33⅓	5kV
	40	6kV
	46⅔	7kV
b	20*	4kV
	25	5kV
	30	6kV
	35	7kV
	40	8kV
	45	9kV
	50*	10kV
c	30*	9kV
	33⅓	10kV
	36⅔	11kV
	40	12kV
	43⅓	13kV
	46⅔	14kV
	50*	15kV
d	30*	12kV
	32½	13kV
	35	14kV
	37½	15kV
	40	16kV
	42½	17kV
	45	18kV
	47½	19kV
	50*	20kV

Figures marked with an asterisk apply to readings which may be outside the range selected due to differing resistor values within the tolerances specified

A NEW G.E.C. TRANSISTOR

The General Electric Co. Ltd., has introduced a new germanium transistor, the GET2, which is available for home constructors as well as for equipment manufacturers. The new transistor is a low voltage operation version of the GET1, which is still available only to equipment manufacturers, and will provide home constructors with a readily obtainable transistor for experimental work.

The connections, dimensions and operating precautions which apply to the GET1 transistor also apply to the new GET2. The ratings and characteristics of the two types are different, however. Since low voltage operation is the special feature of the GET2, the knee of the curve is important, and this is checked at I_c=5.5mA, I_e=3.0mA, instead of at I_c=2.0mA, I_e=1.0mA, as with the GET1. The collector current at I_e=0 is measured at 10 volts instead of 30. To ensure good gain the minimum limit for alpha is 2.5 instead of 2.0. Maximum collector voltage, V_c, is –30 volts; the maximum collector current, I_c, is 15mA DC; the maximum operating temperature, T_{op}, is 35°C.; and the maximum collector dissipation, p_c, is 75 mW.

The new transistors are listed at 37*s* 6*d* each, but the price to equipment makers is only 21/– nett.

ALL-TRIODE MODULATOR OR AMPLIFIER

By **J. N. WALKER** G5JU

IN AN EARLIER ARTICLE,* the writer described a transmitter using the VT61 double triode valve, and it was there mentioned that this particular valve, which is readily available at low cost, has other applications in amateur radio equipment. In the present article, details are given of a modulator suitable for anode (or anode/screen) modulation of a transmitter running at inputs up to about 36 watts. Again all valves except the rectifier are type VT61 or its equivalent, and reference should be made to the previous article for information concerning the variations of this valve.

To make the unit self-contained a power supply is included, but this can, of course, be omitted where a suitable power supply is already available. As before, the modulator is simplified as much as possible, although this time there are not many refinements which can be added. It would be useful to have a meter permanently fitted to read the anode current of the final valves, and there are offered surplus meters which will fill the bill nicely. The meter should have a full scale deflection of 150 or 200mA. The unit will, perhaps, look more presentable and will be better protected if it is housed in a cabinet, but this is a matter of personal choice.

At the outset, it will be appreciated that the use of triode valves throughout leads to extraordinarily good quality, whilst another advantage is good overall stability. Precautions are taken against the introduction of RF voltages into the modulator and also against parasitic oscillation. As a result, the equipment is very docile, with full gain or otherwise.

The one drawback to the use of triodes is that the gain per stage is less than with pentode valves, and it is not recommended that any attempt be made to alter the natural characteristics of the amplifier, as a reduction of gain will result.

* March 1954. *The "Simplex Two" Transmitter.*

LIST OF PARTS AND VALUES

1	Chassis, Cat. No. 727, Eddystone
2	Insulators, Cat. No. 695, Eddystone
1	Knob and Scale, Cat. No. 842, Eddystone
4	Valveholders, American Medium 7-pin
1	Valveholder, International Octal.
4	Valves, VT61, 4074A, 2C34, DET19, etc.
1	Valve, 5R4GY, Brimar.
1	Mains Transformer (normal input) 300-0-300V 150mA, 6.3V 4A, 5V 3A outputs, Parmeko
1	Smoothing Choke, 20 Henrys, 50 or 60mA, Parmeko
1	Modulation Transformer type UM1, Woden
1	Driver Transformer type DT1, Woden
1	Panel Fuseholder (with 1A fuse), L356, Belling-Lee
1	Switch, SP or DP on/off.
1	Gain Control (R8), 0.5MΩ potentiometer
1	Jack

Tag strips, screened wire, ¼" top cap connectors, etc.

Resistors (all ½ watt except R10)

R1, R6	47kΩ
R2	1MΩ
R3	560Ω
R4	400Ω
R5	100kΩ
R7	6.8kΩ
R9	220kΩ
R10	1,000Ω 1 watt
R11	47 or 100Ω
R12, R13	22Ω
R14, R15	47Ω
R16, R17	12Ω

Condensers

C1	500pF Mica
C2	50μF 12 volt, Electrolytic
C3	50μF 350 volt, Electrolytic
C4	0.01μF Metalmite
C5	0.1μF Paper 350 volt or more
C6, C7	16μF 450 volt Electrolytic.

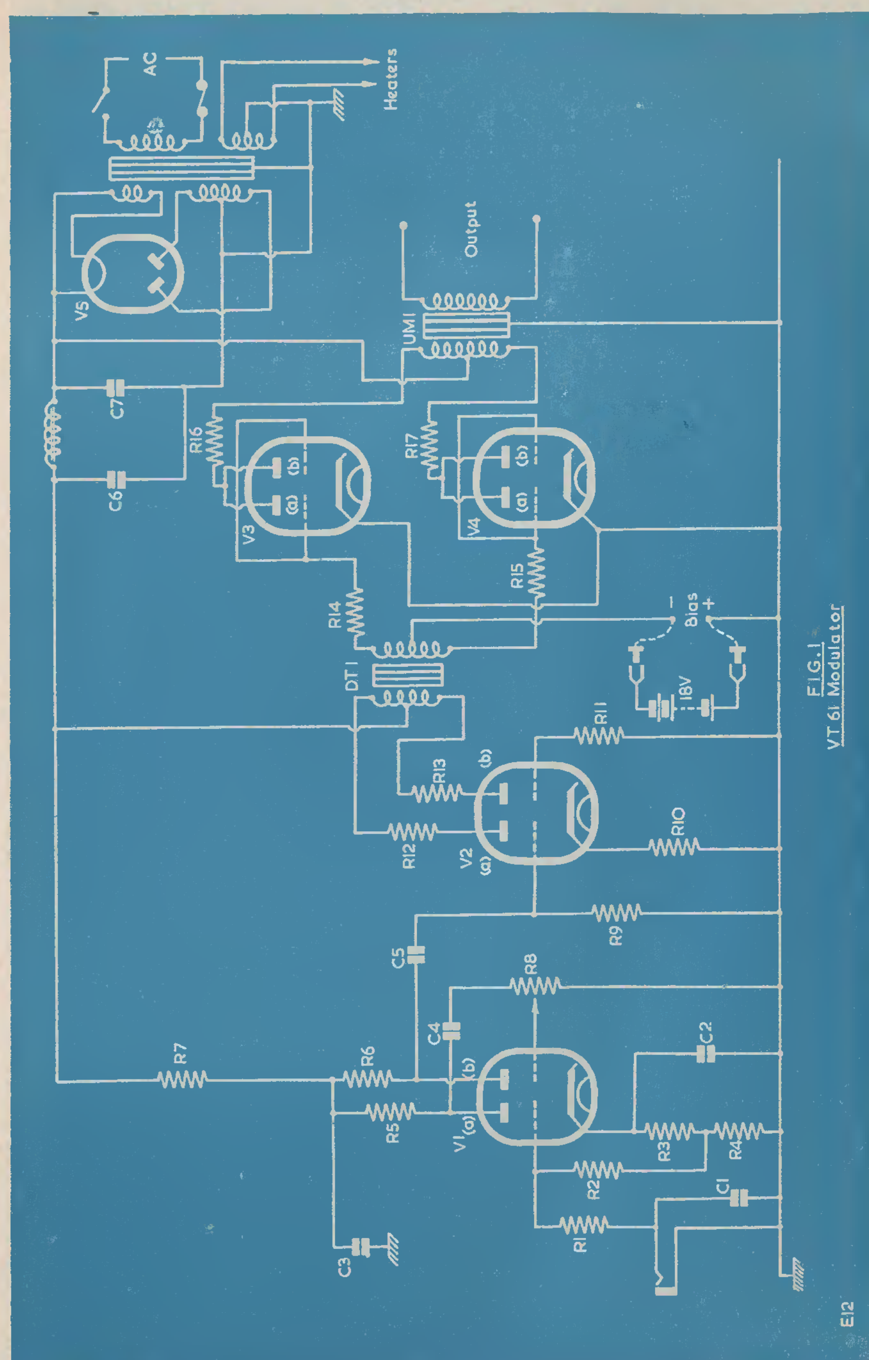


FIG. 1 VT 61 Modulator

The Circuit

The two sections of the first valve are used as independent voltage amplifiers. It is assumed that a crystal microphone is going to be employed, and the output from this is taken to the grid of the first section through an RF filter. The gain control is interposed between the output from the first anode and the grid of the second triode section. If both the grids were to be taken to chassis, through resistors, the full bias developed across the common bias resistor (about five volts) would be applied to both sections. The first stage would then be over-biased and gain reduced, so the cathode resistor is split into two parts and the first grid leak R2 is taken to the junction, the actual bias then being about two volts.

The second valve is a push-pull driver, the circuit being of the self-balancing type. The full output from V1 (b) is applied to one grid (it matters not which), whilst the other grid is earthed via a stopper resistor. The drive for the second section comes from the floating cathode, and it is important therefore not to connect a by-pass condenser across the cathode resistor R10. No decoupling is necessary in the anode circuit, but anode stopper resistors are essential.

The driver transformer is a standard component with an overall step-down ratio to feed the grids of the final valves. One valve by itself, used with the two sections in push-pull and with fixed bias, is rated to deliver a maximum audio output of 12 watts, the mode of operation then being Class AB_2 – that is, grid current flows during the voltage peaks and power must be available from the driver stage. Actually there is sufficient power to drive two valves, each with the sections connected in parallel, and by this means a greater audio output is obtained. If the power unit could deliver a maximum HT current of over 200mA with fairly good regulation, no doubt the full 24 watts would become available. However, the mains transformer is not a large one and, as described, the modulator gives a measured maximum output of 18 watts, with the two final valves drawing a maximum current of about 140mA. As the earlier valves take some 24 or 25mA, this means a total of 165mA at peaks. Beyond this figure, the fall in HT voltage tends to counteract any possible increase in audio power.

Anode stoppers are again necessary and grid stoppers also are fitted to this stage. The output valves operate with a fixed bias and to simplify matters, two grid bias batteries in series, giving 18 volts, are actually used. They can be expected to have a long life in this application, but old batteries with a high internal resistance should not be used.

The standing anode current is then about 25mA. The load for a single valve (two sections in push-pull) is quoted as 7,000 ohms, and about half this value is right for two valves. As is to be expected with triodes, the load impedance is not critical and the power output is well maintained over the range 3,000 to 4,000 ohms, whilst distortion is very low.

The power unit is of the conventional type. The 300-0-300 volt transformer delivers about 330 volts HT at minimum current drain, but the excess of 30 volts need cause no concern, as all the valves operate well within the maximum dissipation figures. Current for the final valves is drawn direct from the reservoir condenser C7 and the supply for the other stages is taken from the smoothing condenser C6. The heaters are balanced to earth and both hum and noise are negligible.

Construction

With four iron-cored components, the chassis has to carry some weight and an Eddystone diecast chassis measuring 12″ by 9″ is ideal for the purpose. The layout is logical, the stages following one another in line. The driver and modulation transformers are kept away from the mains units, to avoid the possibility of induced hum, and doubtless the aluminium chassis is helpful in this respect also, compared to a steel chassis. The drawing Fig. 2 gives details of the actual positions occupied by the various parts, and whilst this layout need not be followed exactly, it should be borne in mind that the valves themselves take up a fair amount of room and adequate clearance must be allowed around their envelopes.

As with other valves, various types of valveholders exist and the holes must be made to suit the ones used. Two different types have been employed in the modulator illustrated, and both required holes 1⅜″ diameter. It is best to make a complete cut-out for the modulation transformer, to enable the tag numbering to be seen, but clearance holes will suffice for the mains transformer, filter choke and driver transformer.

Means have to be devised for making firm connections to the anode top caps. In the case of the first two stages (that is, V1), a small paxolin sheet is fitted with three 6BA bolts to act as terminals and it is then bolted to a vacant hole in the top of the mains transformer. The leads to the two top caps are thus kept very short, this being advisable to minimise pick-up. From the outer terminals, screened leads are taken down through the chassis in tidy fashion to the appropriate anode load resistors. The screening is anchored on top to the centre terminal and earthed below the chassis.

Whilst perhaps not essential, screened leads are again used for the connections to the driver anodes. Here small standard tag strips are bolted to the holes in the top of the driver transformer and act as convenient anchorages for the leads and for the stopper resistors. The same method is used for the anodes of the final valves, but screened wire is unnecessary. Two lead-through insulators, fixed to the side of the chassis at the rear, form the output terminals.

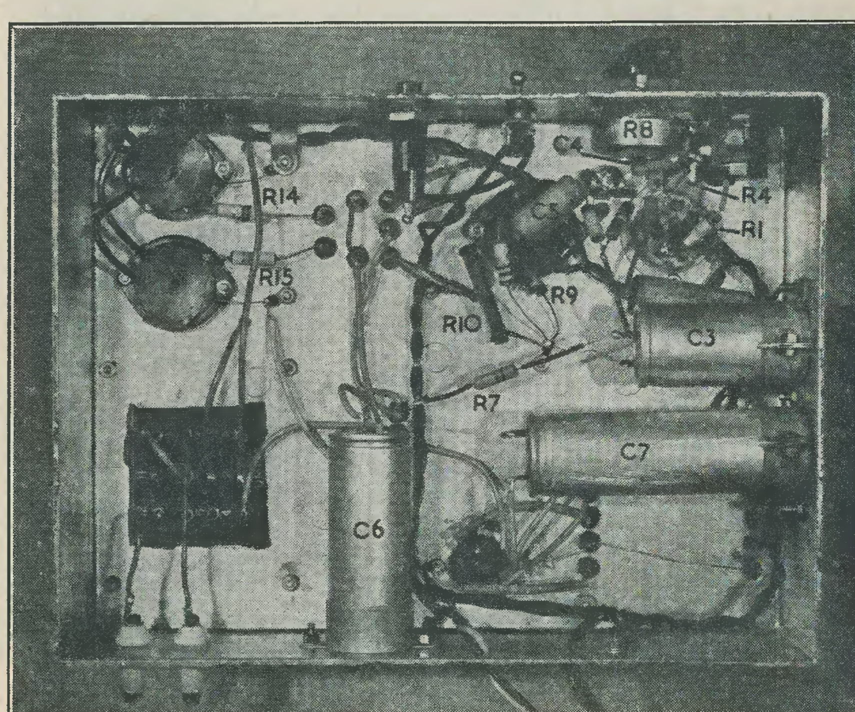
Wiring is quite straightforward and no screened leads, other than those already mentioned, are called for. The heater leads should be kept away from the wiring and components generally. If the heater winding on the mains transformer has no centre tap, an artificial winding can be formed by placing two resistors (47 to 100 ohms each) across the heater supply and earthing the centre junction.

Two distinctively coloured leads are brought out for the grid bias supply, but a non-reversible type of twin plug and socket could well be added here.

Testing

The manufacturers of the modulation transformer supply a chart giving details of the combinations of impedance to be obtained. In the present instance, the anodes of the final valves are taken to tags 2 and 5, whilst 3 and 4, connected together, form the HT centre tap. To match into a load of 7,000 ohms, the output terminals are taken to tags 7 and 12, joining together 8 and 9.

A milliammeter reading to 100mA or more should be inserted between the modulation transformer and the HT supply point, and a check made to ensure the grid bias voltage is actually present at the valve grids. After switching on, the milliammeter should read a standing current of some 25mA, and a voltage of 19 or so should be found across the driver cathode resistor R10.



Under-chassis layout

Full testing can only be carried out with the aid of auxiliary apparatus such as an audio frequency oscillator and an oscilloscope, but it can be said that the frequency response is excellent. There is a falling-off below 200 c/s because of the modulation transformer characteristics, but this is no bad thing when it comes to modulation of the transmitter.

The microphone should be of a sensitive type – the writer uses an *Acos* hand microphone which works excellently, but one of the deaf-aid kinds would prove suitable. If a moving-coil microphone is preferred a matching transformer becomes necessary, and there will be no difficulty in finding room for the small potted type offered by *Woden*. The connections will then have to be altered, of course, the primary of the transformer being connected to the jack.

There is no reason why a carbon microphone should not be used if desired. Again a matching transformer will be required, and the energising voltage is best obtained from a small three volt cell. It is assumed that switching the modulator on and off during periods of transmission will be effected by a switch on the microphone.

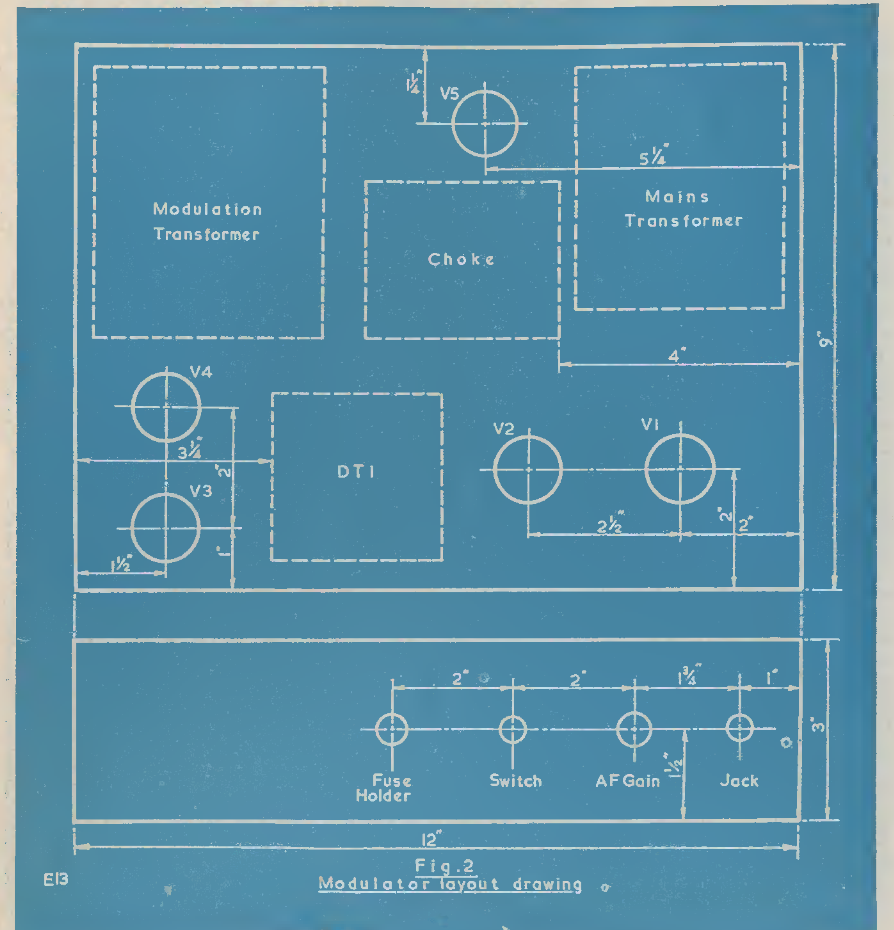


Fig. 2
Modulator layout drawing

A simple test can be made with a 7,000 or 7,500 ohms wire-wound resistor connected across the output, with a testmeter, set to read up to 400 or 500 volts AC, in parallel. On speaking into the microphone, both the voltmeter and anode milliammeter will rise in accord. At full output, the latter will read up to 140mA and the voltmeter should indicate peaks exceeding 350 volts. Another rough test is to place a 15 watt, 230 volt lamp across the output – it will light up during modulation even though there is an unavoidable mismatch in the impedance it presents.

The milliammeter is then removed, the HT wiring completed and the modulator is ready for use.

Possible Refinements

A few refinements have already been mentioned, and there is one major improvement which it is thought desirable to mention here. The design has been simplified by the inclusion of what is, in effect, a standard amplifier or broadcast receiver type of mains transformer. It is rated for a maximum of 150mA and generally the load is within this rating. Admittedly on full peaks the current rating is exceeded, but this occurs only intermittently and in use the transformer runs cool.

Where it is desired to obtain the full output of which the modulator is capable, the constructor may consider the use of a larger transformer, giving say 400-0-400 volts at up to 250mA. A choke input filter system is then used, bringing the output voltage to something like 300 volts and having the advantage of excellent regulation. Ample HT current becomes available at full peak output, and a further improvement can be obtained by substituting a type 83MV rectifier for the 5R4GY specified. The only drawback will be the finding of room for the larger components, but room can probably be made available at the expense of cramping other parts.

Use as a High Fidelity Amplifier

It occurs to the writer that the unit described, whilst not primarily designed for the purpose, lends itself admirably to use as a high fidelity amplifier, either with a radio unit or with a medium impedance pick-up. The only modification necessary is to change the modulation transformer for an output transformer, preferably of the high quality type (which means a primary winding possessing high inductance) and having an overall ratio of about 35 to 1.

Up to 5 watts or so, the amplifier will be running in a Class A mode, giving extremely good quality, and there is ample reserve of audio power to take care of peaks. The actual reproduction, listened to on a speaker of suitable type and capable of handling at least 10 watts, should be first class.

DUTCH R.A.E.N.

We understand from Evert Kaleveld, PAØXE, that the Dutch G.P.O. Authorities had a meeting recently with Dutch radio amateurs, to discuss future emergency communication plans. A large gathering took place at which some 100 PAØ's were present. Coffee and sandwiches, etc., were provided and the Dutch Postmaster General welcomed those present.

The following decisions were made. An emergency network will be set up on 1,875 kc/s with a power limit of 10 watts, CW or phone being permissible. The country is to be divided into 12 districts, each with its own control station. A general HQ station is to be set up at the Hague. Portable units will work with their own district HQ, and district HQ's will work with the general HQ at the Hague. In an emergency, only those districts affected will be called on. It is hoped to have from 8 to 10 mobile units in each district. Special identity cards, telegram form pads, etc., are to be provided by the Dutch G.P.O.

It is interesting to note that the Dutch have chosen a frequency within the 1.8 Mc/s band for their Emergency network. This has been done because tests have indicated that this frequency is much better than 3.5 Mc/s for short coverage work at all times of the day or night.

Radio Miscellany

RECENTLY WHEN READING an American Radio text-book I was surprised to find that no mention was made of either Heaviside or Appleton in the chapters on propagation. A hurried reference to a number of other U.S. books, including the A.R.R.L. Handbook, was made, and in each case the result was the same – the names of both men and their work were conspicuous by their absence. It seemed most extraordinary, especially as in Great Britain both names are familiar not only to the enthusiast but to the man in the street. The American books refer to the Ionosphere, perhaps occasionally Upper or Lower, but never as Heaviside or Appleton, and scant attention seems to be given to the early study of the bending, or refraction, of radio waves round the earth's curvature.

Maybe the principle of the explanation seems very ordinary to us nowadays, but it was quite a time in coming and not always readily accepted.

When Marconi first made his successful trans-Atlantic experiment (in 1901) a good many people, scientists among them, were sceptical that the signals were really received. Remember they were simply S's – three dots in the Morse Code – and a few were inclined to think they either "heard things" or imagined they did. It is surprising just what you imagine you can hear when you are listening intently enough ! On the face of it from the so-called hard-headed, common-sense point of view, there did appear to be some ground for improbability. It was obvious that a pile of water between the transmitter and receiver rose to a height of some 150-odd miles. In view of this it was felt to be unthinkable that these new-fangled wireless waves could have either travelled under water nearly all the way, or else climbed up that mountain of ocean and slid down the other side. It seemed perfectly logical to the sceptics that the curvature of the earth would prove to be an impassable barrier to long distance use of radio waves which, of necessity, must travel in straight lines. Thus the physicists who foretold that the experiment was doomed to failure, regarded the claimed result with some suspicion.

A study of the scientific papers of the period suggests that Marconi had no idea of how it happened. In fact, he disregarded theory and in pushing on with his experiment met with much criticism from the purists who felt that they, at least, had theory on their side.

"Earth" Currents

As further experimental transmissions were made the scientists and mathematicians noted that the strength of the signals were usually out of proportion to their theoretical calculations. It was, too, quickly recognised that identical – or even the same – transmitters operating in dry parts of the world had a lesser range than when used in England. Also, the ranges were noted to increase during the hours of darkness. These facts led to inadequate explanations involving earth currents being put forward.

It is difficult to discover exactly when the first suggestion that ionization of the upper atmosphere as a possible answer was first put forward. However, it was appropriate that the layer should be called after Dr. Oliver Heaviside who had done much good work in investigating this explanation.

Appleton, after whom the upper layer is called, calculated their height by measuring the corresponding changes in reception strength of signals of varying wavelengths. It was in the course of these experiments that he discovered there was a second layer also causing reflections. There may well be, and probably are, other layers which have different effects on certain frequencies which may help to explain the largely unpredictable pattern of VHF propagation, when understood.

Nevertheless, it is remarkable that the work of both men should remain unrecognised in several popular U.S. handbooks although, of course, we can at any moment expect to hear a Russian claim that Popoff thought it all out long before either of them !

Action

I was greatly surprised to see G2MI's attack upon my "unjustness" and "inaccuracy" which was published in *R.C.* last month.

It was, incidentally, the only letter received on this subject. From his letter he seems to have the impression that the idea of a network of radio amateurs operating in an emergency started in 1950 – he quotes nothing earlier. It began over thirty years before that, and a really big scale job was performed in the Florida hurricane in 1926. The article he quotes (1952) certainly congratulates Jamaican and Italian amateurs on their efforts in times of disaster, and does go on to suggest that we should do something about it. No concrete suggestions are offered. To quote his own words, "the Lynmouth disaster was yet to come." *After* this *and* the floods of the winter of 1953 – a longish interval – he wrote another Editorial.

Surely that is a roundabout way of agreeing with me that everybody was more than a little sluggish in doing anything about it. To quote G2MI's letter, he writes: "the truth is that the R.S.G.B. has for more than four years tried to get an emergency service started." To speak of an interval of four years to begin to organise experienced and well-equipped amateurs for a sudden emergency makes me think someone has a queer idea of what the word emergency means.

I can only interpret the rest of the letter as strongly implying that I have been awarding the credit unfairly. My modesty forbids that I should be so presumptuous as to proffer judgment on this point. It seems, by his letter, he stakes his own claim. All I said was that Dr. Arthur Gee campaigned for it and I am sure he would not wish to claim credit for an idea that was then already over a quarter-of-a-century old and had been talked about by every amateur for years. Great hustlers, we Britishers, what ?

A Bob a Nob ?

We no longer dare answer the door at Centre Tap Villa – all because, in a weak moment, I decided to join in the Spirit-of-the-Thing. It happened like this. At the rear of our delightful domicile we have what the Estate Agents glibly describe as a spacious garden. I have tried to convert it into an Aerial Farm, but it also boasts a dustbin and as magnificent a crop of weeds that can be found anywhere in the south of England.

Recently I declared a chemical war on the weeds and the scorched earth is hardly likely to worry a non-gardener for several seasons. Naturally, I had to clean up a few old tin cans and motor tyres which must have been deposited there by an ill-mannered neighbour. Perhaps he thinks it a form of reprisal – he blames me for every little crackle he hears on his radio ! The very morning I finished the back-aching part of the work, one of the local Scouts turned up in search of a Bob-a-job prospect. Actually there wasn't much left to do – but it gives one a feeling of virtue to do a good turn, so I engaged him.

He was a wee, bright-eyed, eager lad of about nine, and he set to valiantly collecting enough unsightly items, formerly hidden by the weeds, to fill the dustbin, and for

Centre Tap talks about THE IONOSPHERE — R.A.E.N. BOB-A-JOB WEEK

good measure scooped out a few half-bricks the builder left behind. In fact I was quite pleased with my bob's-worth; he was a nice lad and addressed me respectfully as "Sir" in addition to working cheerfully.

In the afternoon I answered a ring of the bell and to my utter astonishment I found my Scout standing on the doorstep. He told me he had had his dinner and was now ready to give me the benefit of another bob's-worth !

I hadn't the heart to turn him away, so I let him help me to Spring clean the radio den – a job he tackled with enthusiasm, although he seemed to think it an awful waste to throw away some of the really out-moded junk. Thus he did part of the dustman's job by carting away many of the bits and pieces. I don't suppose for a moment the dustman would have paid his bob for being helped. In any case, the lad's mother no doubt made him put it in his own dustbin when he got it home. Women are like that. Thus the dustman would have had the final disposing of it, so he couldn't be said to be properly liable for the shilling fee.

I nearly had heart failure when I saw my Scout turn up again in the evening ! This time he brought his young brother with him to let me have the benefit of two-bob's-worth at one go.

So now you know why I daren't answer the door. I'm terrified I shall find the whole blooming troop standing on the doorstep. Anyway, my den is not getting another purge like that for years.

CONVERTING THE 182A UNIT TO A 'SCOPE

PART 2

By **A. BLACKBURN**

Preliminaries

First and foremost, remove all valves, and the CRT, and then:

1. Remove 1,000 c/s transformer and choke from the CV118 side of the chassis, and clip off all leads associated with these components.
2. Remove the vertical plate on the CV118 side holding the potentiometers and tagboards.
3. Remove everything from the front panel except the brilliance control (knob marked B) and the focus control (slotted spindle).
4. Remove the international octal valveholder at the rear of the chassis on the CV118 side.
5. Remove 0.01μF 2.5kV vertically mounted condenser at the front of the chassis on CV118 side.
6. Remove 0.1μF waxed condenser lying horizontally on a tagboard on VR91 side above the chassis at the panel end. Replace with a high quality 0.02μF (C_2 in Fig. 2).
7. Remove cables held in a clamp attached to 0.01μF condenser clamp above CRT holder.

On the underside of the chassis:

8. Remove 25kΩ potentiometer with spindle extending to the front panel marked G.
9. Remove the coil mounted on the VR91 side of the chassis and place in the position indicated in Fig. 10 (L_1).
10. Remove small tagboard mounted on the edge of the VR91 side of chassis.

The Front Panel

A strip of aluminium 7½″×2⅜″ is needed to cover the holes from which the sockets were removed. Drilling details for this strip are given in Fig. 11. After drilling, it should be clamped to the front panel and the panel drilled through the strip. The remainder of the panel should then be drilled in accordance with Fig. 13. In some cases it will be found necessary to distort existing holes on the front panel to make them line up with the required holes in the aluminium strip.

The gain control hole needs a bush to carry the control spindle. This can be had by breaking up an old potentiometer and using the bush through which the spindle passes, as marked on the right of Fig. 8.

When the prel.minary mechanical work has been completed, the components may be mounted as shown in Fig. 7 and the photographs, Figs. 6 and 8.

Above Chassis Construction

Fig. 7 shows the layout of the larger components above the chassis. On the CV118 side the EHT transformer T_2 and EHT smoothing condensers C_{27} and C_{28} are mounted at the rear. The British 4-pin valveholder replacing the original octal (see Preliminaries — 4) is for the EHT rectifier, V_9.

On the same side, at the front end of the chassis, a bracket to support the Y amplifier gain control potentiometer R_{26} is mounted approximately 3″ from the front panel. The 25kΩ potentiometer removed from the underside of the chassis (see Preliminaries — 8) should be mounted on this bracket, details of which are contained in Fig. 12.

On the VR91 side, no mechanical modifications are required, to the chassis proper, but some component changes are needed on the tagboards which will be described later.

The large metal bracket supporting the CRT holder should be drilled to line up with the two supporting holes in the terminal panel (Fig. 15). The top of this panel should be flush with the top of the metal bracket (see Fig. 6).

A small tagboard should be attached to the clip holding the high voltage 0.01μF condenser C_{34} on the CRT holder bracket. This fixing is shown in Fig. 14.

Most of the important details of layout can be seen from the photographs, Figs. 6 and 8.

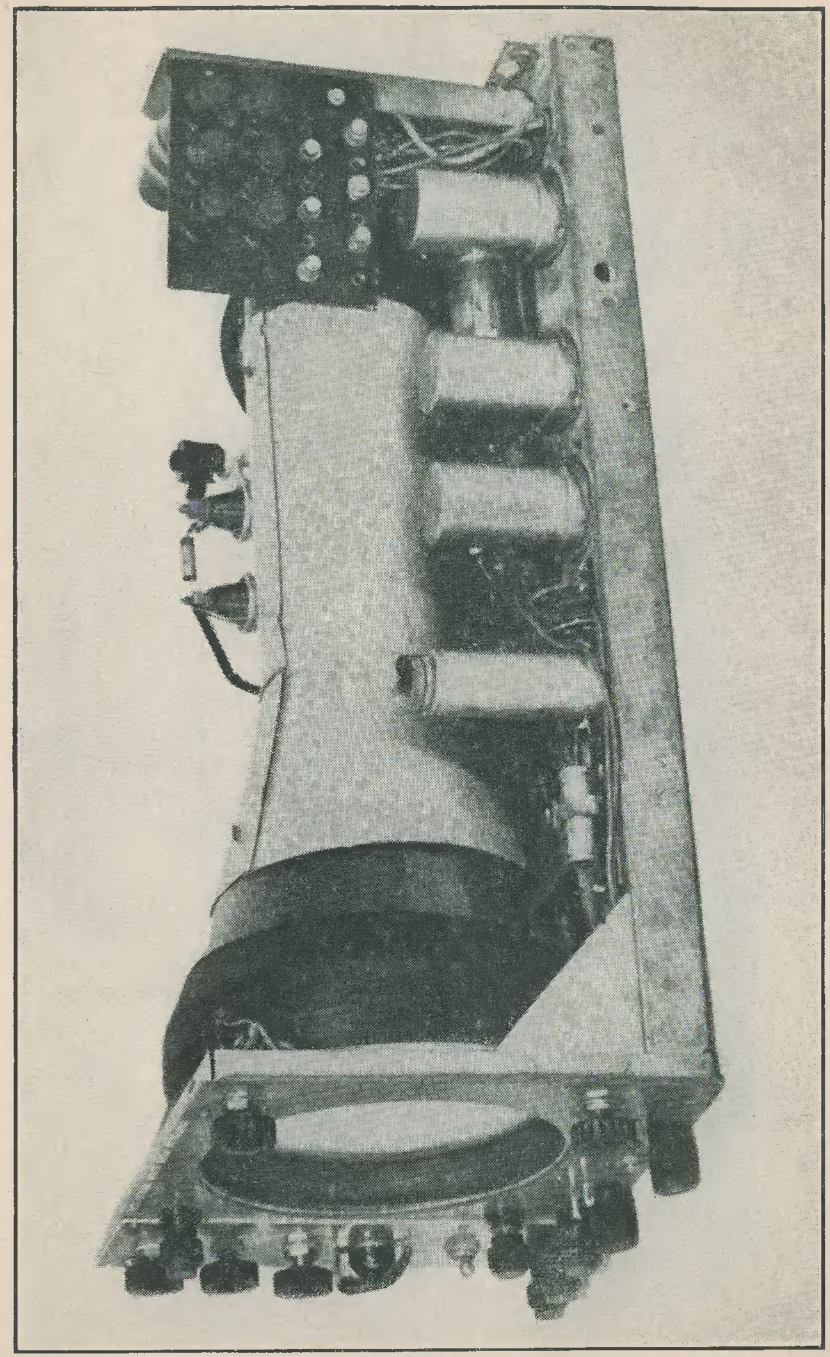


Fig. 6. Left-hand side of prototype

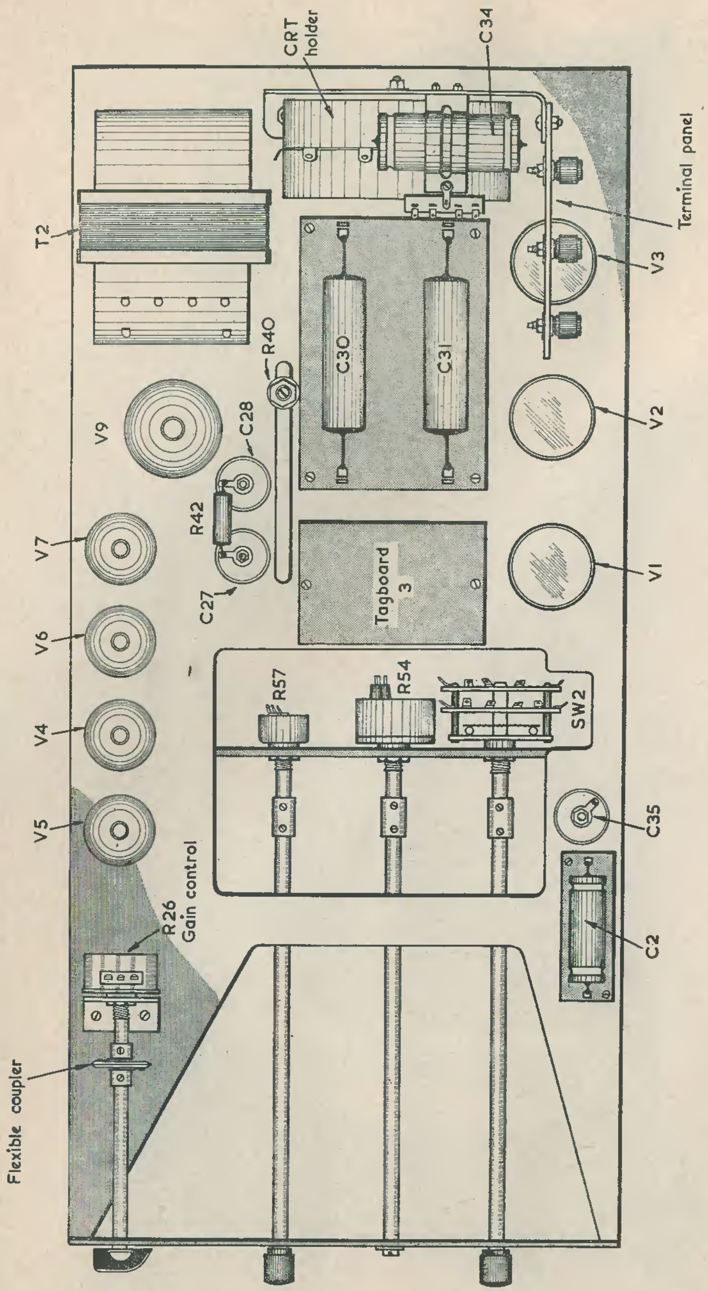


FIG.7. ABOVE-CHASSIS LAYOUT

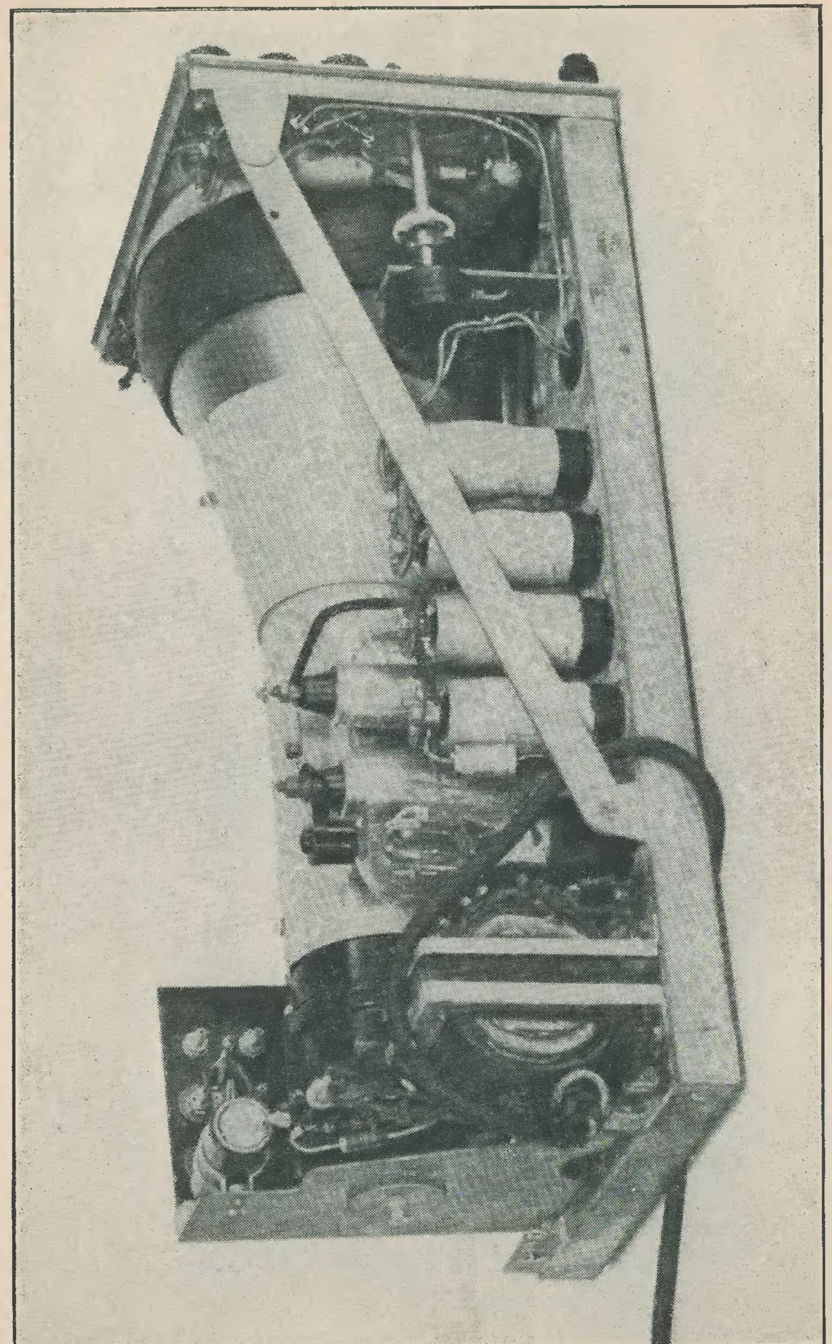


Fig. 8. Right-hand side of chassis

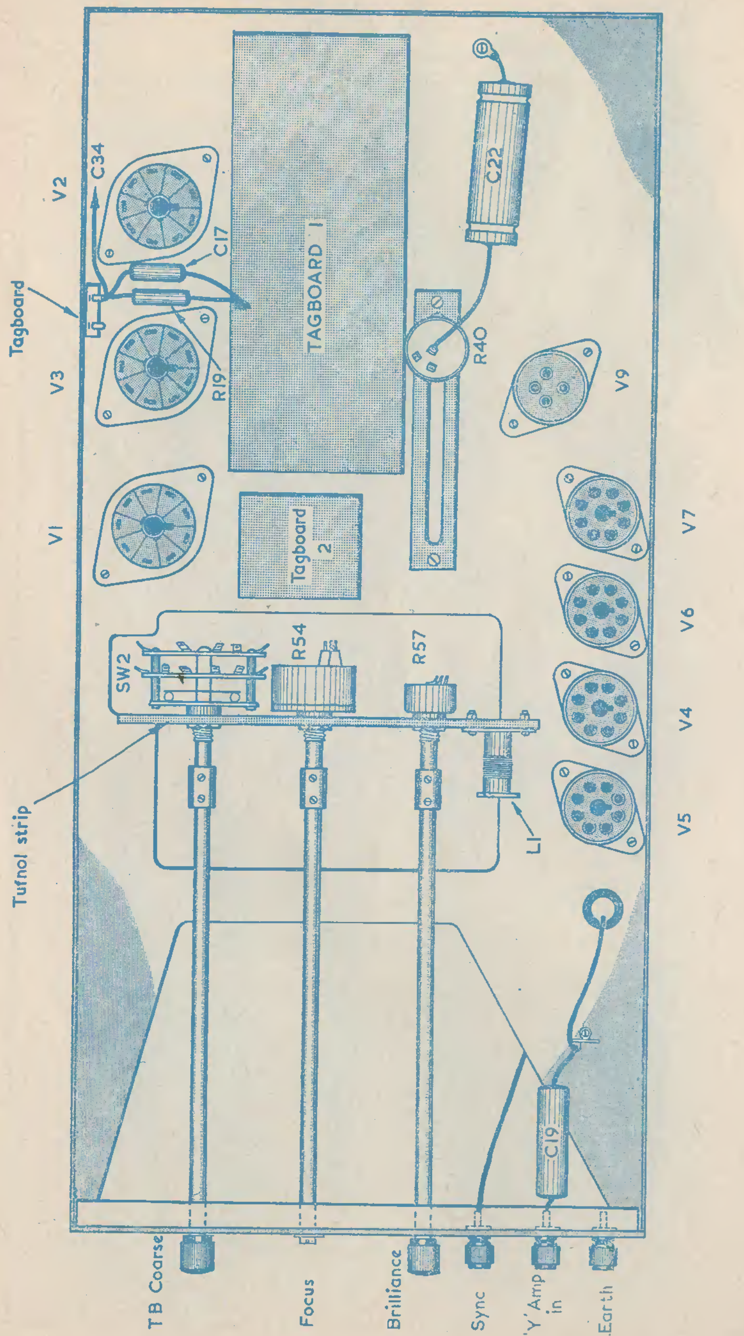


FIG. 10. UNDER-CHASSIS LAYOUT

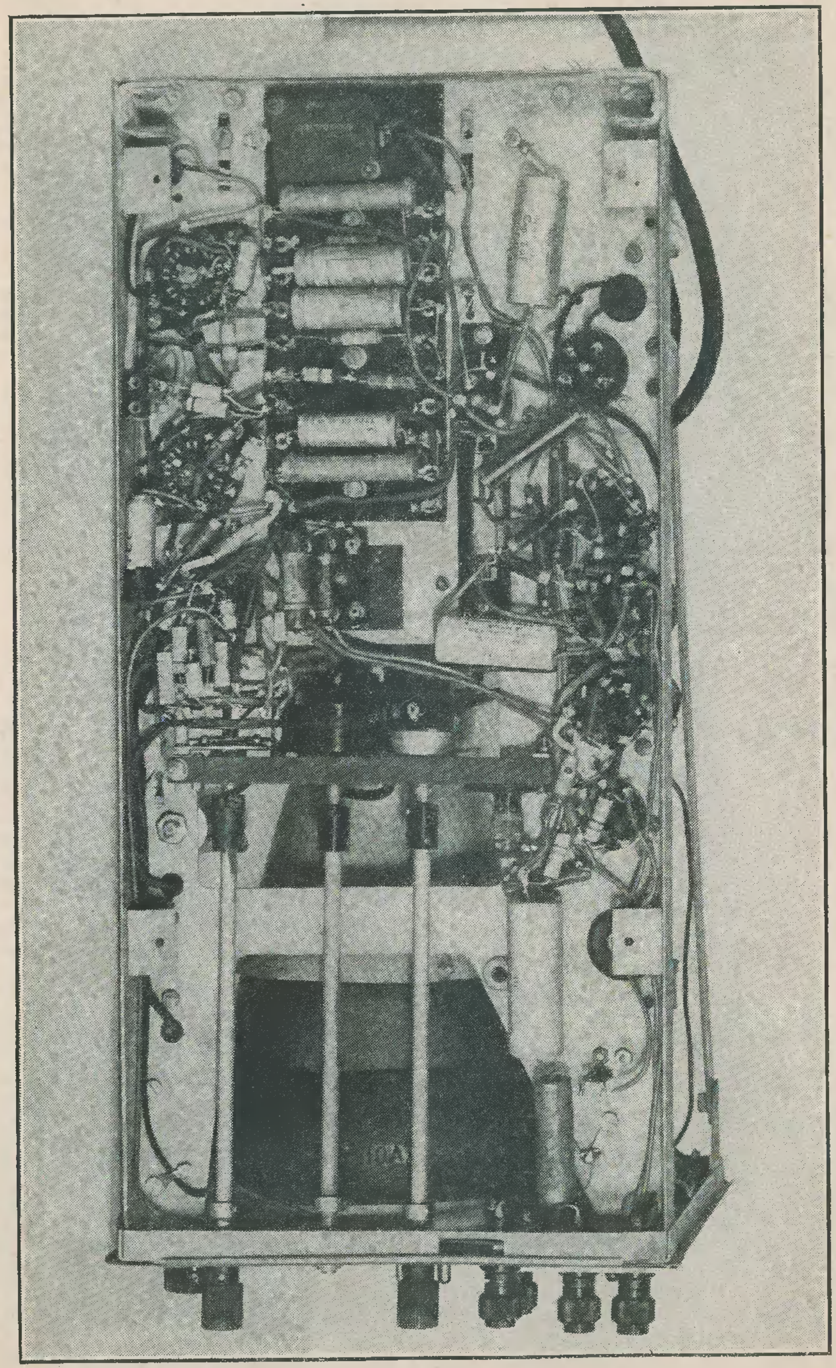


Fig. 11. Under-chassis wiring—compare with Fig. 10

Below Chassis

In place of the 25k Ω potentiometer removed from the transverse Tufnol support, a two-pole 7-way wafer switch should be substituted. This is the time-base coarse frequency control SW_2. The small tagboard approximately in the centre of the chassis should be unbolted, turned through 90°, the chassis drilled and the tagboard bolted down. This tagboard is just behind the focus potentiometer, R_{54}, in Fig. 10.

A small ½ watt potentiometer R_{40} (see Fig. 3) should be mounted at the rear end of the long slotted hole on the CV118 side of the chassis. The spindle of the potentiometer should be above the chassis.

A small tagboard containing one tag should be mounted on the edge of the VR91 side of the chassis between the middle and rear valve. The holes originally used to retain the coil serve admirably for this purpose.

It is necessary to remove 650 turns from the coil. With the slug fully in, this should give an inductance of approximately 500μH. This inductance value is not very critical. The coil should then be mounted horizontally on the transverse Tufnol strip which holds the focus and brilliance potentiometers. The mounting of this component is shown in Fig. 10. An additional tagboard is required close to the coil, and is shown on the same figure.

Power Supply

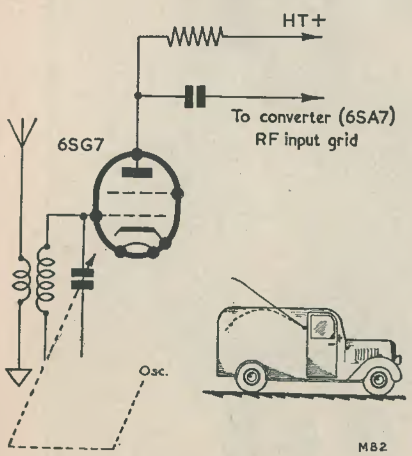
The power supply, as already mentioned, is a separate unit. Its size is, of course, dependent upon the type of components used in its construction. The chassis used in the author's model is 9″ × 5″ × 2½″ deep. The layout, not being critical, may be left to individual taste.

If the use of the power supply is not to be entirely restricted to the oscilloscope, it is suggested that an output socket be fitted to the chassis and the 'scope power lead plugged into it. Terminals could be added to facilitate use of the unit for other purposes.

[*to be continued*

Henry's Radio Ltd., inform us that they can supply the 182A Unit and all materials needed for its conversion, as described in this series. A demonstration model has been constructed exactly as the prototype, and this can be seen by any interested reader at 5 Harrow Road, London, W.2.

From our Mailbag



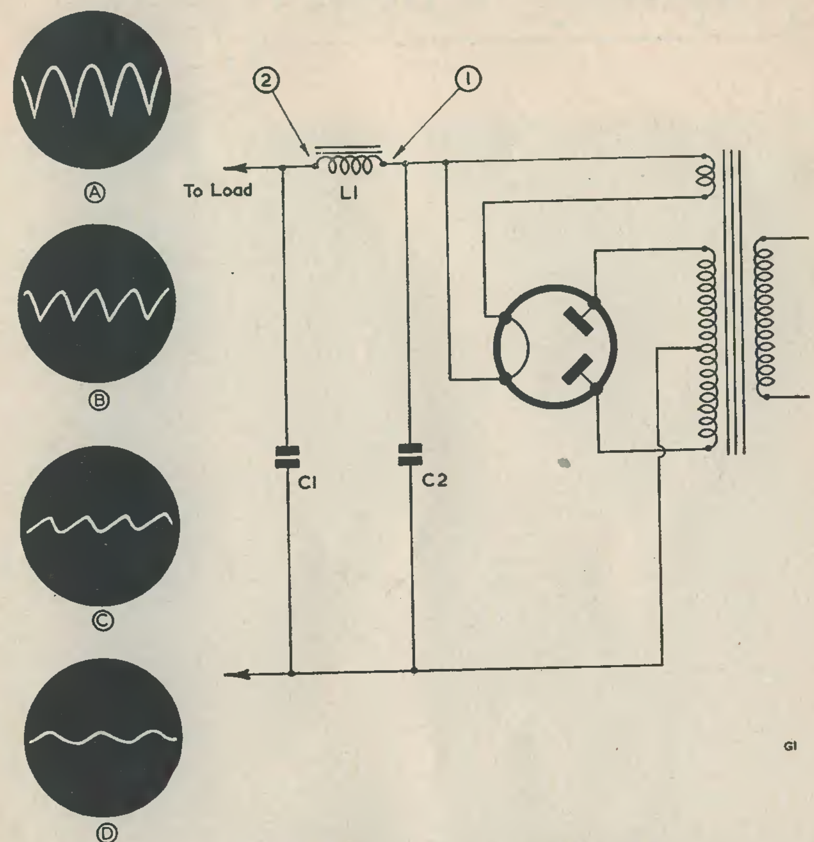
Dear Sir,

Some time ago I was confronted with the problem of building a radio for my Fordson 10*cwt* Van out of the junk box. I had no three-gang condenser nor appropriate coils, and used a two-gang condenser with an aperiodic RF stage before the converter. Results with high transconductance RF pentode (6SG7) were excellent, and the performance is at least equal to commerical receivers. A further advantage is that additional wavebands can be easily incorporated and I built the receiver with medium and 2 short wavebands. A screw, locking the variable condenser shaft after the desired station is tuned in, enables adequate short wave reception even when driving. The power supply was, as in your article,* placed under the bonnet, as in this way interference suppression is greatly simplified. I used a vibrator and 0Z4 rectifier, although a surplus converter was available, in order to avoid the unusually heavy drain on the battery of the latter. For the aerial a 7 foot flexible steel rod of about 3.5*mm* diam., one side fixed on the side of the Van and the other free, was found excellent and unbreakable. When not in use, the aerial may be bent and the free end fixed through a small hook. Yours faithfully

M. G. Diallinas, Iraklion, Crete.

* *Inexpensive Car Radio*—Radio Reprint No. 1

OSCILLOSCOPE TRACES



No. 9. THE FULL-WAVE RECTIFIER

The circuit depicts a full-wave rectifier and the points of connection for the oscilloscope.

Trace **A** shows the ripple waveform to be expected at point **1** when C_2 is removed. Then, of course, the smoothing circuit is of the choke-input-to-filter type. When C_2 is connected, the waveform is modified to that shown in **B**.

Connection to point **2** will give waveform **C**. The amplitude will be somewhat greater in the case of choke input than for condenser input.

If the ripple at point **2** is considerable, and hum trouble is experienced in the receiver, its amplitude can be decreased by *either* increasing (1) the inductance of the choke, or (2) the capacity of C_1, or both.

C_2 will also slightly decrease the ripple, but the maximum value of capacity should not exceed that recommended by the manufacturer of the rectifier. The frequency of the ripple is, of course, 100 c/s.

The type of trace shown in **D** is the result of connecting to point **2** with the choke short-circuited. It will be seen that this trace is rather more sinusoidal in form than that shown in C, and is of greater amplitude.

It is assumed that Y amplifier gain is kept constant for all these traces.

Query Corner

A Radio Constructor Service for Readers

Converter for R1224

I wish to extend the range of my R1224 receiver to cover the 20 metre amateur band. Can you advise me regarding a suitable circuit?

D. Thompson, Perivale

There is still a considerable amount of interest shown by readers in battery powered communication type receivers, and of those available on the Government surplus market the R1224 is one of the best. Its waverange can, of course, be extended by a modification to the original coil pack, but many constructors prefer to use a converter rather than alter the existing set. The converter which is described below is suitable for use with most receivers, be they straight or superhet. The addition of the unit to a straight set converts it to a superhet, whilst if it is added to a superhet the final arrangement is known as a "double-superhet."

The converter has been designed with a view to offering the best possible performance consistent with a reasonable degree of simplicity both in the circuit and tuning alignment. Whilst there are many circuits which are basically more simple, there is little doubt that they do not reach the same standard of performance. A two stage arrangement is employed, the first valve functioning as an RF amplifier with a controlled degree of feedback, whilst the second valve is a normal triode hexode frequency changer. Anode decoupling has been used in both stages to ensure a high degree of operating stability, but this feature is not solely a function of the circuit design as much depends upon mechanical layout. All leads which carry an RF voltage should be short and rigid, as this avoids unwanted coupling and makes for good tuning "resetability." The relatively low value of 75pF has been used for each section of the three-gang tuning capacitor, providing a form of fine tuning which is unattainable with the higher values. It is convenient to use three separate capacitors of the type suitable for ganging, as this leaves more space between sections for screening. A high gain unit of this type is particularly susceptible to microphony, thus rigid vaned capacitors are required. Vibrating vanes are a prolific cause of microphony. A good quality slow motion dial assembly is a necessity if any serious short wave listening is contemplated; one having a reduction drive of about 100:1 will be most satisfactory. Providing the points already mentioned are borne in mind the layout should present no difficulty, but a suggested arrangement is shown in Fig. 2.

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, London, W.9.

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

RF Regeneration

The sensitivity of the RF stage can be appreciably increased by the use of a small amount of positive feedback. If carefully applied this is a refinement which is well worth including in the circuit. The feedback is taken from the anode of the valve back to the aerial circuit, and is achieved merely by the use of a short lead which is twisted two or three times round the aerial lead in wire. The number of turns will vary from converter to converter, but sufficient turns should be added to cause the valve to oscillate, then one or two turns are removed so that complete stability is achieved over the entire tuning range. The polarity of the feedback will depend upon the connections to the aerial coil, and if oscillation cannot be obtained, or if it is erratic, the leads to the aerial coupling coil should be reversed.

Tuning Coils

The coils are wound on Denco ½" diameter formers with dust iron cores. Winding details are as follows:

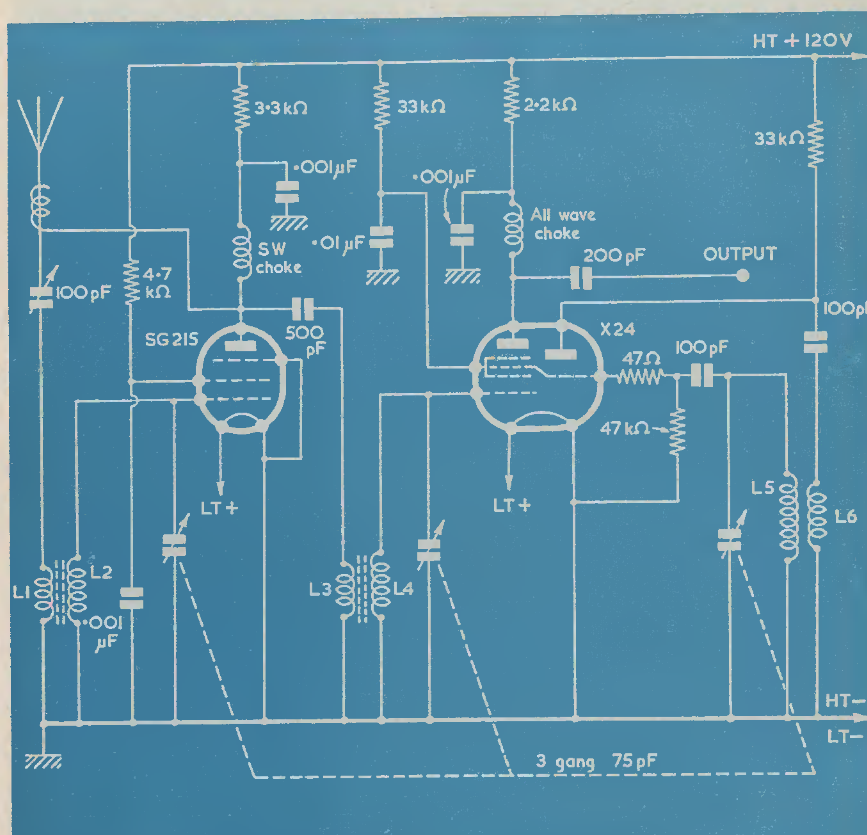


FIG. 1. THE 20 METRE CONVERTER CIRCUIT

L2, L4, L5 — 16 turns of 34 swg enamelled copper wire. Winding space ⅝".

L1, L3 — 7 turns of 34 swg enamelled copper interwound at earthy end of L2 and L4

L6 — 7 turns of 34 swg enamelled copper closewound ⅛" below earthy end of L5.

When winding the coils, care is required not to scratch the enamel as this may lead to shorts between turns. Using these coils the tuning range is 15 to 27 metres. The choke in the anode circuit of the hexode is a standard all-wave component.

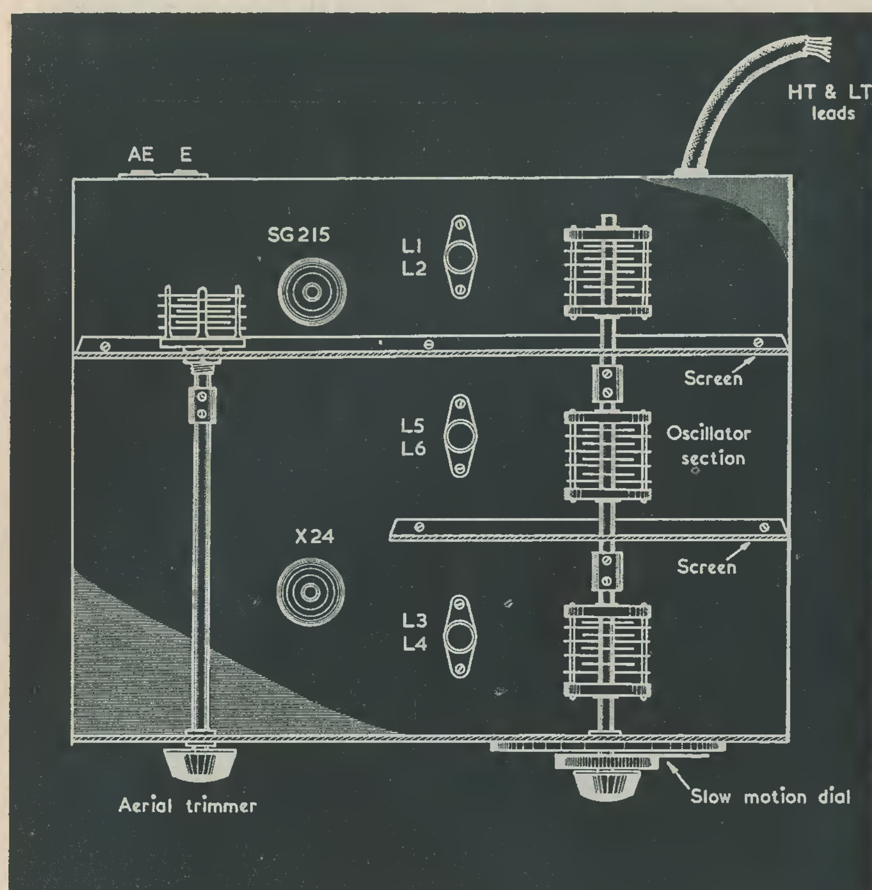


FIG.2. SUGGESTED UPPER CHASSIS LAYOUT

Operation

Having completed the assembly and checked the wiring, the unit is ready for aligning. First the receiver with which it is to be used is tuned to a frequency of between 1 and 1.6 Mc/s; a point on the dial where there is no signal is best chosen. Then with a short lead between the output terminal of the converter and the aerial socket of the receiver the equipment is ready to be switched on. The oscillator section of the frequency changer is best operated at a higher frequency than that of the incoming signal so the dust core should not be screwed as far into this coil as in the others. The converter is then tuned until a signal in the 20 metre band is heard. The dust cores in L2 and L4 are then adjusted for optimum response. The position of the core in L5 will determine the exact frequency coverage of the unit. Should the unit appear to be completely dead, it may be because the oscillator is not functioning. If this is so, try reversing the leads to L6. The aerial coupling capacitor is controlled from the front panel and its adjustment will be found useful in increasing sensitivity on very weak signals.

Finally, we must thank Mr. Medcalf of Greenhithe for some of the data on this unit, and in providing such a good report on the results he obtained.

Valve Heaters

I have a tape recorder in which an ECC40 is used. On switching on the heater lights up very brightly but goes down to normal as the other valves warm up. Is this likely to reduce the life of the valve and if so, is there any remedy?

G.W.P., Harrow

This effect is by no means rare and usually occurs in valves which have reasonably low heater current. Those who have worked with modern television receivers will have noticed that the EB91, 6AL5 class of valve invariably exhibit the effect, but in very few cases does it result in a reduction in heater life. It is well known that as the heater wire warms up so its resistance increases. Some valves have a short length of heater wire between the bottom of the cathode tube and the main lead out which is not in thermal contact with anything. This length warms up very quickly and as its resistance increases so it takes a disproportionate amount of the total heater wattage, causing it to light up brightly. However, the heater is normally operated a long way below its normal fusing temperature, and this short term overload on part of the heater wire does not seriously reduce its life.

CLUB NEWS

Details for insertion in this section should reach us not later than the 8th of the month before publication.

THE ACTON, BRENTFORD AND CHISWICK RADIO CLUB (G3IIU)

Club meetings are held each Tuesday evening at the AEU Rooms, 66 High Road, Chiswick, W.4, from 7 to 10 p.m., when the club transmitter is on the 80 and 160 metre bands CW.

All "Radio Constructors" in the area are welcome, amateur or not, and whatever their interests. Morse classes are held for all interested in obtaining the GPO pass certificate in respect of the amateur licence.

The club has a large "flea-power Tx" following, and is affiliated to the QRP Society, also the RSGB.

Membership details can be obtained from the Secretary G3IGM, or by a visit to the club room any Tuesday.

TORBAY AMATEUR RADIO SOCIETY

At the Annual General Meeting – presided over by G2GK – the Minutes were read by the Secretary, G3GDW, and were adopted.

The Chairman, G2GK, referred to the excellent state of the Society, and the good work performed during a successful year, culminating in the excellent result of the "Hamfest" held last October.

The Treasurer – G2GM – produced his report for the year, and all the Officers of the Society were thanked by the Chairman.

Congratulations were given to our President – G5SY – on his reaching 44 years in Amateur Radio. In answer to this, G5SY recalled that many years ago, his 28 Mc/s CW signals were the first heard in New Zealand from any British Amateur station.

The Officers of the Society were re-elected for 1954, with the addition of G4RD as Hon. Auditor.

WARRINGTON AND DISTRICT RADIO SOCIETY (G3CKR).

Newcomers are cordially invited to meetings in the Club Room, at the King's Head Hotel, Winwick Street, at 7.30 p.m. on the first and third Tuesdays in each month.

Hon. Sec., G. H. Flood, 32 Capesthorne Road, Orford, Warrington.

SOUTH MANCHESTER RADIO CLUB (G3FVA)

Ladybarn House, Mauldeth Road, Fallowfield, Manchester 14.

Hon. Sec., M. Barnsley, G3HZM, 17 Cross Street, Bradford, Manchester 11.

We meet every Friday in the above headquarters at approx. 9 p.m. Lectures are arranged once a fortnight and our future programme is as follows:—

June 4th Clamp Tube Modulation, by M. Denny, G6DN.

June 18th Transistors, by W. L. Robinson.

The other Friday evenings are used to work the Club transmitter and also construct a new one; some test gear is available.

During the course of the next few months we are also arranging a series of very simple lectures for the benefit of those who are just taking up the hobby of Amateur Radio, and if any person wishes to come and join us we will be only too pleased to welcome him. Details of membership of the Club can be obtained at the above addresses.

ROMFORD AND DISTRICT AMATEUR RADIO SOCIETY

Hon. Sec., N. Miller, 10 Rom Crescent, Romford.

Meetings of the Society have continued on every Tuesday evening at 8.15 p.m. at R.A.F.A. House, 18 Carlton Road, Romford. Attendances at meetings are encouraging but new members will be warmly welcomed.

The club transmitter (G4KF) is on the air from the above QTH and the morse classes continue. Steady progress is being made with the equipment and arrangements for NFD.

NORWOOD AND DISTRICT GROUP–R.S.G.B.

The April Meeting was well attended, the primary item of the evening being an impromptu discussion about the proposed new Amateur Licence. A number of personal views were expressed, and the general view was that the new regulations will be quite favourable.

At the Meeting to be held on Saturday, 19th June, there will be an inquest on the previous Saturday's N.F.D. effort, followed by a general discussion. All local members and friends are invited to attend – Windermere House, Westow Street, Crystal Palace.

A Junk Sale is being arranged for the July Meeting.

Let's Get Started

13 : QUALITY AT RF

By **A. BLACKBURN**

UP TO NOW IN THIS SERIES, the functions of RF and AF stages in a receiver have been carefully divided – the RF (or IF) stages providing selectivity and range, and the AF stages dealing with the audio, to provide adequate volume with reasonable quality of reproduction. In actual fact, quality may be considerably affected by the RF and IF stages.

Ignoring the possibility of distortion brought about by incorrect use of the valves, the real cause of the trouble is in the tuned circuits. Before this can be explained, we must once again examine in more detail the nature of the transmitted signal.

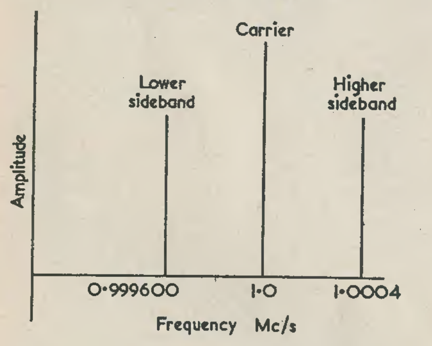


FIG. 1. Sidebands resulting from modulating 1 Mc/s carrier at 400 c/s

G17

Sidebands

It is not immediately obvious from a picture of the modulation envelope what is really transmitted. Actually, around the centre frequency to which the transmitter and receiver are tuned, are grouped a great number of radio frequencies, which are all present at the same time.

These frequencies are known as sidebands, and are related to the modulation – for example, in the simplest case of a 1 Mc/s signal modulated by a pure sine wave of frequency 400 c/s, there are present 1 Mc/s and 1 Mc/s+400 c/s and 1 Mc/s–400 c/s. This is depicted in Fig. 1.

How these sidebands occur is a rather complex business. There are many explanations given for this phenomenon, most of them mathematical. Probably the easiest to understand is with the help of vectors.

Although the subject of vectors have already been mentioned in this series, it is possible that the reader has forgotten what they are. Fig. 2a demonstrates the line AB, called the vector, generating a sine wave. The wave is produced by plotting the distance x against the angle θ as the vector is rotated anticlockwise.

To produce a modulated sine wave, the length of the vector has to vary at a rate determined by the modulating frequency. If we now add to AB another vector, BC, and rotate this at the modulating frequency, keeping AB fixed in one direction, a modulation wave will be produced like that shown in Fig. 2b.

Simultaneously rotating AB at the radio frequency and BC at audio frequency will now produce the required modulation envelope – but for one snag still to be overcome. The dotted vector AC in Fig. 2b is the resultant of the addition of the two vectors AB and BC. Now the angle θ will vary as the vector BC rotates and this angle represents a displacement or phase modulation of the carrier.

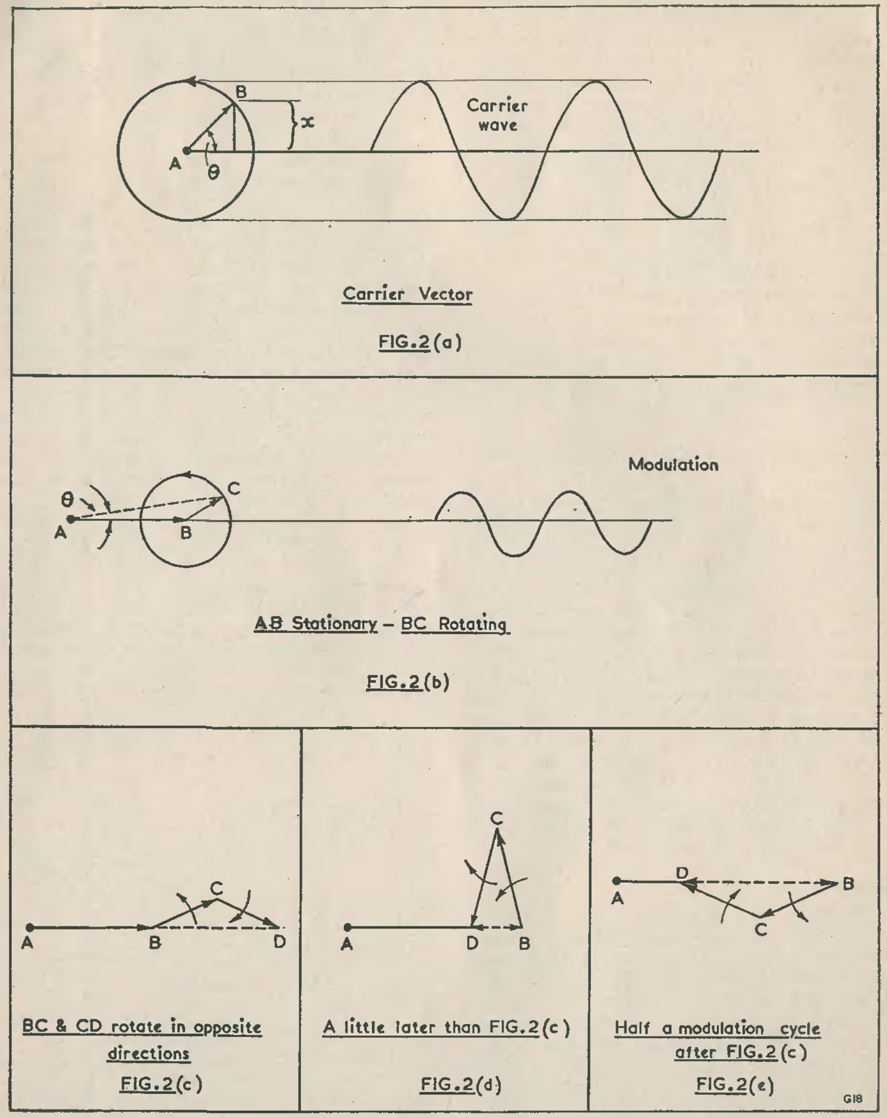
Such an effect is undesirable, as it would lead to further sidebands which are quite unnecessary to the signal.

Fig. 2c shows a further vector CD added to BC, but so placed, relative to BC, that the resultant BD (dotted in 2c) is always in phase with the carrier. You will notice that both BC and CD are of equal length and are rotating in opposite directions. BD is the resultant of BC and CD and as they rotate its *length* will vary, but not its angle, relative to AB. These two vectors, BC and CD, represent the two sidebands present in the signal. To get the complete modulation envelope, AB rotates at the radio frequency and BC and CD rotate in opposite directions at the audio modulating frequency.

All this may seem a little divorced from the practice of transmission, but it does actually occur in practical modulated carriers. The vectors may represent the voltages or currents associated with the tank tuning circuit of the transmitter, or even the signal currents in the RF stages of a receiver.

Figs. 2d and 2e are added to complete the picture of one modulating cycle. Note that in these cases the resultant BD of the modulation vectors is pointing to the left. This represents a shortening of the carrier vector. If BC and CD are half as long as the carrier vector, AB, the time will come when BC and CD both point toward A, and AB will be completely cancelled. This is the condition for 100% modulation. Varying the depth of modulation merely entails shortening BC and CD.

This rather lengthy explanation has been included to stress the fact that sidebands really do exist. Many find it difficult to believe that periodically changing the amplitude of a carrier wave produces other frequencies.



Carrier Vector FIG. 2 (a)

AB Stationary – BC Rotating FIG. 2 (b)

BC & CD rotate in opposite directions FIG. 2 (c)

A little later than FIG. 2 (c) FIG. 2 (d)

Half a modulation cycle after FIG. 2 (c) FIG. 2 (e)

G18

As we shall see later, the way we deal with the sidebands has a considerable effect upon the quality of reproduction.

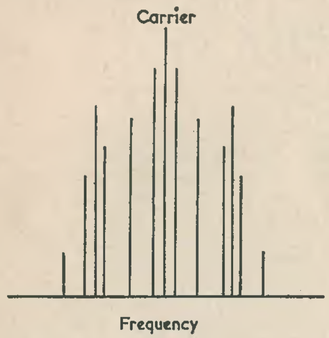


FIG.3. Group of sidebands produced by a complex sound G19

The complex nature of the waveforms which occur in speech and music produce many frequencies. The transmitter will, therefore, be modulated with these frequencies, and a number of sidebands will occur. If the highest frequency involved at any one instant is 6 kc/s, then sidebands will occur spaced 6 kc/s either side of the centre frequency. There will, of course, also be present other sidebands of lower frequencies if they exist in the sound being transmitted at the time. A group of sidebands, produced by a complex sound, is shown in Fig. 3. All sidebands vary in strength, relative to one another, as the various frequencies produced by the sound vary in strength in the sound itself.

Response

Methods for ensuring high frequency response in AF circuits have been mentioned in these articles and exhaustively discussed elsewhere. However, the key to the effect of RF circuits on AF response lay in the last article in this series, in which selectivity and the quality of coils was discussed.

If there are frequencies extending either side of the centre frequency, it is important that all these should be equally amplified before reaching the detector. However, we have seen that, in a high-Q tuned circuit, frequencies away from the centre frequency are attenuated. But, you will say, I pointed out that this was necessary in order to reject unwanted signals. Which, of course, is quite true, but like most things you can't have it all ways. The ideal arrangement would be a circuit which accepted the wanted signal and sidebands and completely rejected any unwanted signals and their sidebands. A response which would achieve this is shown in Fig. 4. Superimposed upon this ideal shape is the response curve or resonance curve of a tuned circuit. Adding more tuned stages, each tuned to the same centre frequency, unfortunately does not help in attaining the perfect response.

The resultant Q of a system involving two tuned circuits, tuned to the same frequency, and separated by a valve, is the Q of each multiplied together. In practical terms, a tuned-grid/tuned-anode RF stage with circuits of Q value 100 has an overall Q of 100^2 or 10,000. We have previously concluded that the bandwidth is equal to the centre frequency divided by Q. In this case, if the centre frequency were 1 Mc/s and the Q 10,000, the bandwidth would be 100c/s at the half-power points. This means that sidebands of 100 c/s will only be 0.7 the value of a frequency very close to the centre frequency, e.g. a sideband of 10 c/s. Sidebands of higher values than 100 c/s would be of even smaller amplitude, the amplitude decreasing as the frequency is raised. To increase the number of tuned stages would be to make the situation worse.

One method of overcoming this is to 'stagger' the tuned circuits. Each circuit is tuned to a slightly different frequency until a response as shown in Fig. 5 is obtained. This, at any rate, approximates to the ideal

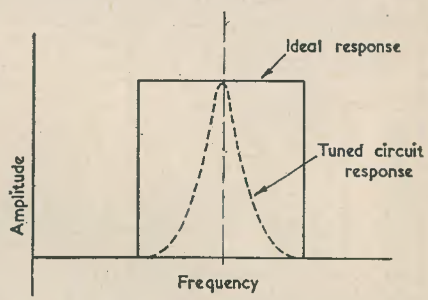


FIG.4. G20

and is used most effectively in the IF stages of many commercial receivers. To produce such an effect in continuously tuned RF stages would, of course, be practically impossible, because the width of the response curve would vary as the tuning capacitor were operated.

Frequency Effects

There are two simple ways by which the effect of too great a selectivity and the effect of sidebands may be demonstrated. If an ordinary domestic receiver, particularly the superhet type, is detuned slightly from a signal, it would be noticed that the reproduction becomes very harsh and the bass disappears almost completely. This is

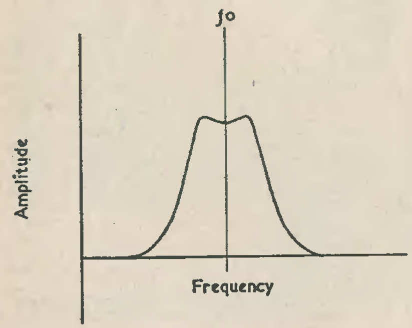


FIG.5. Stagger tuned circuits G21

because the receiver is not tuned to the upper sidebands and, as far as the receiver is concerned, it is accepting a signal containing high frequencies only. The effect is also noticeable at times when an interfering signal produces high harsh noises, and is usually known as 'sideband splash'. Once again, this is because upper sidebands of the unwanted signal are being accepted by the tuned circuits, whilst the lowest sidebands of the unwanted signal are being severely attenuated.

Too great a selectivity is most noticeable in high grade communications receivers. Such receivers are designed to have a very narrow bandwidth, i.e. a high selectivity, and it will be found that high frequencies in music are almost completely lost. This is an effect called 'sideband cutting'.

The conditions for very high selectivity and very high quality cannot be met simultaneously. When designing your chosen receiver, you must decide upon the purpose to which it will be put. At the price of some complexity, it is possible to switch the circuit in a receiver to fulfill either condition, so that the receiver may be as versatile as possible. This is usually done by varying the selectivity of the IF stages.

IF Stages

Staggering the tuned circuits is not the only way to produce the response shown in Fig. 5. The coupling between IF stages normally consists of two tuned circuits magnetically coupled to form a transformer. The degree of coupling between the windings has a considerable effect upon the shape of the response curve. Generally speaking, a loose coupling produces a sharp response curve of the type shown dotted in Fig. 4. As the coupling is increased, the curve becomes less and less sharp, until a point is reached where two distinct humps appear. As the coupling is further increased, the humps move wider apart in frequency, and the 'trough' between them deepens. Such a curve is shown in Fig. 6.

If severely overcoupled circuits were used in a receiver IF stage, the sidebands nearest to the centre frequency, i.e. the bass notes, would be attenuated, the amount of attenuation depending upon the depth of the trough. These sidebands occurring at or around the peaks, would receive what may be termed preferential treatment, but those of higher frequencies would suffer attenuation.

Slight overcoupling may be an advantage as it tends to give the 'squared off' response required. The majority of modern IF transformers are, in fact, designed to be slightly overcoupled.

As the degree of coupling in an IF transformer depends upon the position of the

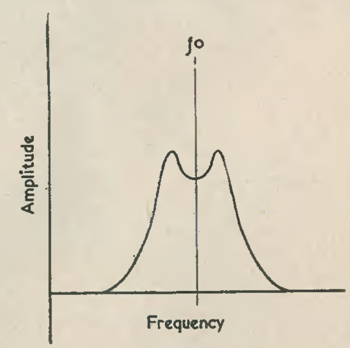


FIG.6. Overcoupled circuits G22

two windings relative to one another, clearly the simplest method of varying the selectivity is to mechanically move the coils apart. Such a system has been used, not only to vary selectivity, but also to provide a measure of tone control.

There is, however, a limit to the extent to which this principle may be applied. As we have already seen, if the coils are too close together, overcoupling results and a considerable trough appears in the response. The coils cannot be placed much closer together than the distance required for critical coupling. Critical coupling is the point where a compromise is reached between a double hump response and a very sharp response. It is also the point for maximum power transfer from primary to secondary of the transformer.

At the other end of the scale, to narrow the response, the coils must be moved farther apart, but in so doing the voltage induced into the secondary will diminish. A point will be reached where the voltage in the secondary becomes so small that the overall gain of the receiver will be insufficient to deal with the signal. Only a limited degree of bandwidth variation, therefore, is possible by this method.

A great number of systems have been developed with the object of providing variable selectivity. They include the use of quartz crystals as very-high-Q tuned circuits, extra windings on the IF transformers, and complex networks – far too many, in fact, to deal with here.

Carrier Power

An interesting fact that results from a consideration of sidebands is that when a carrier is modulated 100%, one third of the total radiated power is in the sidebands.

For the sake of economy, high power commercial communication transmitters often have one sideband and the carrier suppressed. All the power is concentrated in the remaining sideband. The carrier is reintroduced at the receiving end and the signal reconstituted to a form very much like the double sideband type that we know. Without this reconstitution the signal could not be used for conveying intelligible information.

RADIO CONTROL STEERING UNIT

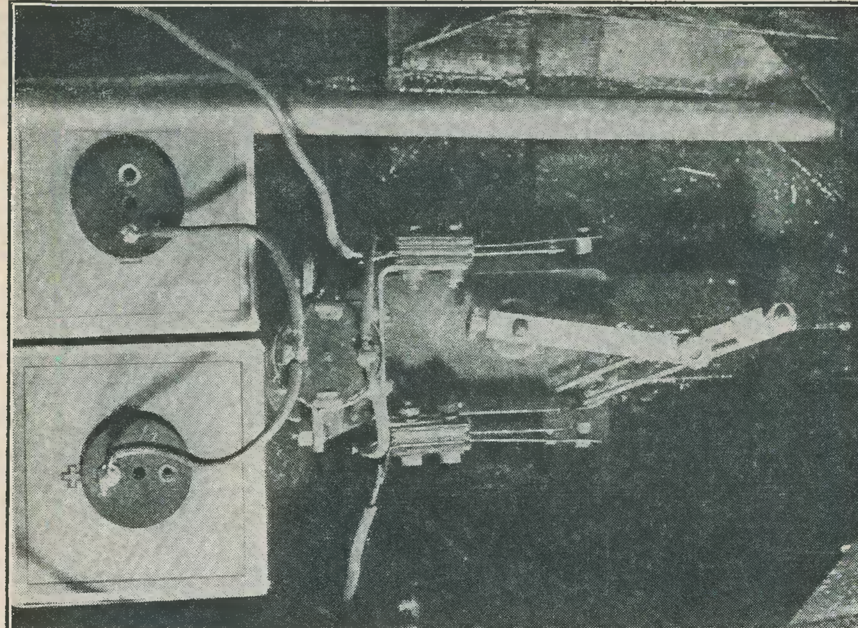
By **DR. A. C. GEE,** G2UK

FOLLOWERS OF THE RECENT SERIES OF articles in this magazine on radio controlled mechanisms will be interested in the unit described herewith, which the writer has just completed for use in a radio controlled model yacht.

The unit will provide proportional rudder control when used with a suitable radio system, that in the model under construction being of the tuned reed type.

Steering units of this type are expensive to buy, but can be quite easily built with the normal tools available in the average home tool chest. As can be seen from the photographs, a train of gears from an old Gauge O clockwork toy locomotive is used to give the required reduction from a miniature electric motor. By this means, the high speed of the motor is geared down to give a movement of the rudder actuating bar taking about two seconds to traverse from full port to full starboard, or vice versa. Interrupting the current to the motor at any instant between these two positions will give any desired intermediate position. Two limiting switches are fitted as shown to prevent the unit over-running.

Most of the details of construction are well shown in the illustrations, little further written comment being necessary. One need not slavishly follow the design shown. Generally speaking, the procedure is to take the clockwork mechanism to pieces by carefully bending back the metal tags on the chassis which hold the mechanism together. Care must be done in doing this that they are not broken off. Remove the spring from the main driving shaft and immobilise the ratchet mechanism, either by soldering together the pawl plate and the



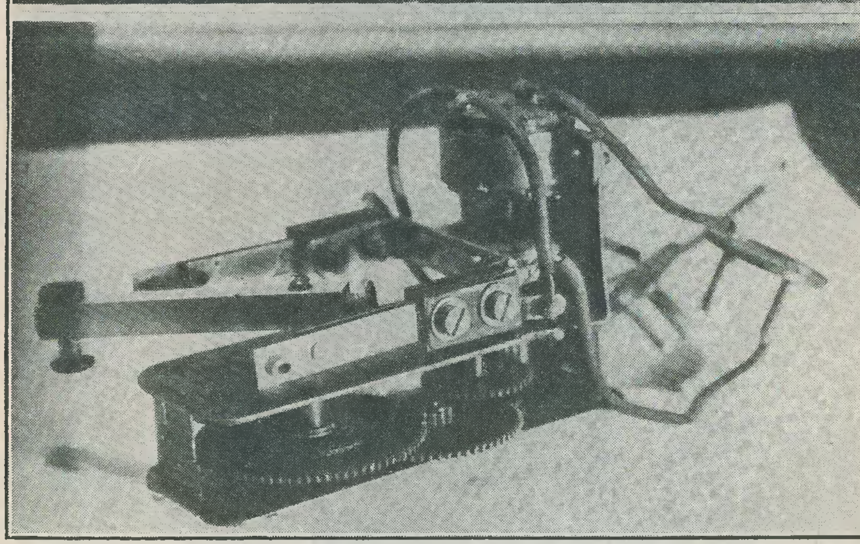


Fig. 1 (Top) *Shows general arrangement of the unit in the stern of model launch. Method of controlling the rudder is well shown, as is also the connections to batteries*
Fig. 2 (Bottom) *General arrangement of the unit*

main driving gear or by the use of suitably placed nuts and bolts. The next step is to extend the shaft of the gear which will give the greatest gear reduction, so that the drive from the electric motor can be connected to it. In most of the clockwork mechanisms the writer has seen, a governor mechanism is fitted which naturally rotates at a high speed. The construction of this is such that it is not too difficult a matter to extend its shaft so that connection can be made to the electric motor shaft. If this mechanism is not fitted, it may be possible to get a sufficiently high gear reduction by driving the wheel shaft. In this case, no difficulty will be encountered in having to carry out extensions of the shafts, as it is then just a matter of removing the wheels and using the remaining shaft to connect up to the motor.

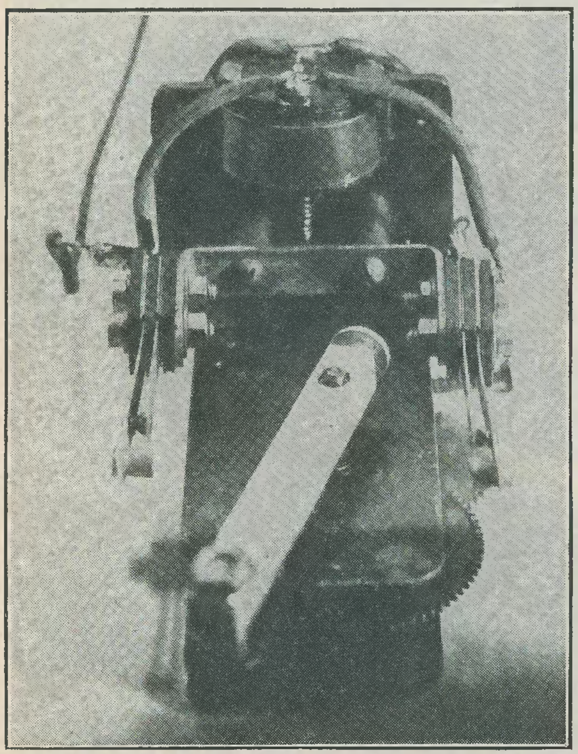


Fig. 3. Shows the arrangement of the limiting switches, the method of connecting motor to extended governor shaft, and the mounting of the motor

In extending the governor spindle, first of all remove the parts comprising the governor. It will be found that apart from the small spigot which forms the bearing for this spindle, the main part of it is fairly thick. With care, file off the spigot leaving the end of the spindle square, and centre punch carefully dead in the centre. Then drill down into the shaft with a suitably small drill. If you have a steady hand you can do this with a hand drill, but it needs care. Finally drive in a short length of suitably sized rod – an old piece of clock gear spindle will do. Drill out the bearing hole on the chassis and re-assemble the mechanism.

Fix the electric motor in a suitable position by making up a bracket for it from sheet brass. Connection of its shaft to the extended governor spindle can be made by twisting up a short length of spring coil wire into a suitably sized connecting spring.

The limiting switches are made up from old relay contacts. Their construction and arrangement is self-evident from the photographs.

In order to provide for reversing the motor, two batteries are necessary, wired up as shown in the accompanying circuit diagram.

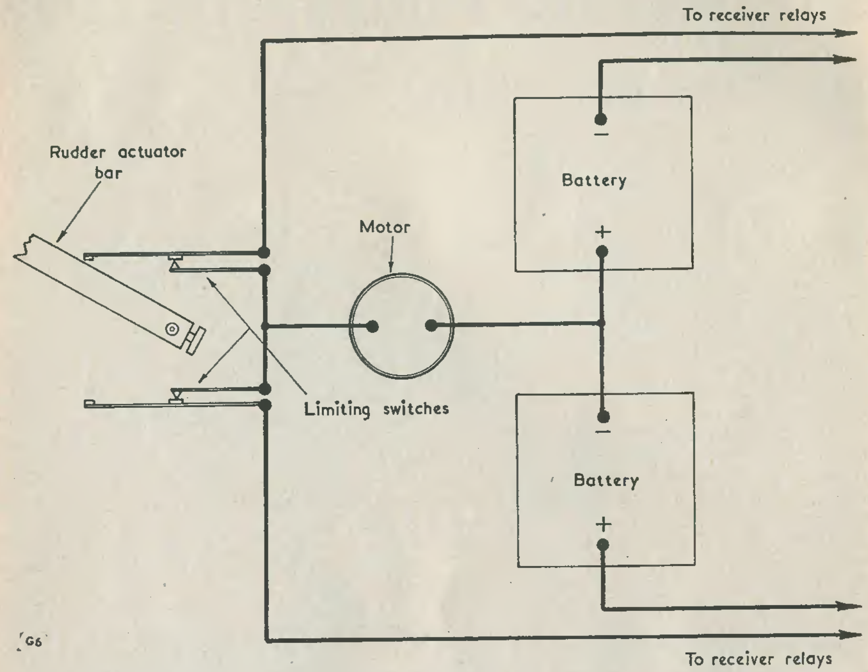


Fig. 4. Circuit wiring diagram for limiting switches, motor and batteries

EIGHTH ANNUAL R.S.G.B. AMATEUR RADIO EXHIBITION

The Council of the Radio Society of Great Britain have approved the plans for the **8th R.S.G.B., Amateur Radio Exhibition** to be held on **November 24th to 27th** at the **Royal Hotel, Woburn Place, London.**

P. A. Thorogood, M.A.S.E.E., G4KD, General Manager of the Electrical Engineers (ASEE) Exhibition has agreed to be Exhibition Manager for the 8th R.S.G.B. Amateur Radio Exhibition. Mr. Thorogood is a Past Member of R.S.G.B. Council, also a Member of the Council of the Association of Supervising Electrical Engineers, Member of Council and Fellow of the Radar Association, Chairman of London U.H.F. Group and President of Edgware and District Radio Society. He is also an active amateur on 145 Mc/s and 70 cm.

VHF AERIAL INPUT CIRCUITS

FOR THE BEGINNER

By **H. E. SMITH** G6UH

IT IS OFTEN STATED THAT THE efficiency of a VHF converter can be no better than the efficiency of the first stage. One can go further, and say that the efficiency of the first stage depends almost entirely on the manner by which the feeder is connected to it (provided, of course, that due attention has been paid to the circuit layout within the converter).

The beginner on the VHF bands must always remember that the amount of signal arriving on the aerial, except from local stations, is microscopic, and must be conveyed to the grid (or cathode) of the first valve with as little loss as possible. Incorrect matching from aerial to feeder is a common cause of inferior results on 145 Mc/s, and this should be the very first consideration. The listener can do no better than to follow carefully a design in one of the Handbooks, and to use the specified feeder for any given type of aerial.

The transmitter can measure the S/W Ratio by feeding RF to the aerial. For the purposes of these notes, we will assume that the aerial and feeder are correctly matched. (Remember that if the matching is bad the aerial will not only have a poor signal-to-noise ratio, but there will be a considerable loss of signal due to the high standing wave ratio). Unless one is reasonably certain that a good match exists from aerial to feeder, there is little point in attempting to match correctly at the input end, as no improvement will result.

Converters with RF Pentodes

The input impedance of the first stage depends on the type of valve used. The EF54 or Z77 types produce a fairly high impedance at 145 Mc/s, anything from 800 to 1,500Ω. This makes it difficult to match a feeder impedance of, say, 50Ω.

The reason for this is that the input capacitance of the valve is too high to allow a large inductance to be used. With the EF54, for instance, the input coil will consist of only 4 turns, ⅜" diameter. The transformation ratio necessary for direct connection of a 50Ω feeder is 16:1, which means that the inner will need to be connected *one quarter turn* up from the earth end of the coil.

As there is no certainty, in many cases, of what the input impedance of any given valve might be at these frequencies, this is a "hit or miss" arrangement, and one might easily be in error by as much as 50%. There are at least two better methods than the tapped coil arrangement. Fig. 1 shows a "top-coupling" method which will provide a reasonable match into any pentode from a feeder of 50 to 75Ω.

Fig. 2 shows an even better method. Although this latter one introduces some reactive effect, it is not in the least detrimental, and when adjusted on a signal will provide an almost accurate match. (Note: It is always advisable to adjust any aerial trimmer on actual signals, or from a signal generator. Never trim for maximum noise. A high noise level peak may indicate regeneration, and the signal level may be lower at this point).

Grounded Grid Inputs

The 6J4 type of grounded grid amplifier has a much lower input impedance than the pentode and is, in some respects, far less critical in its matching requirements. However, there is one problem which may confront those who wish to use 300Ω ribbon feeder. As the input impedance of the average GG stage is only about 100/150Ω, there will need to be *step down* from feeder to cathode. Additional to this is the problem of feeding an unbalanced circuit with a balanced feeder. Fig. 3 shows methods of connecting 50 to 80Ω co-axial feeder to a GG amplifier.

Fig. 4 is the most efficient method of feeding a GG stage from 300Ω feeder. All values given are for use with a 6J4 or EC91. An interesting and efficient circuit using a Push-Pull GG stage and 300Ω feeder is given in Fig. 5. It will be seen that no tuned circuit is necessary. In this case the aerial itself becomes the input tuned circuit.

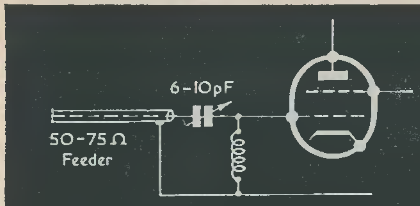
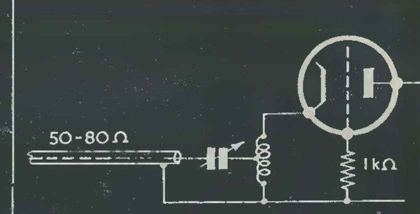


FIG. 1. Direct coupling of low impedance feeder to high impedance circuit



Centre tap method

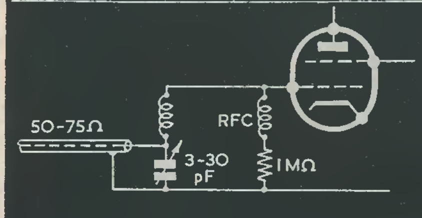


FIG. 2. "Reactive" coupling - low to high impedance

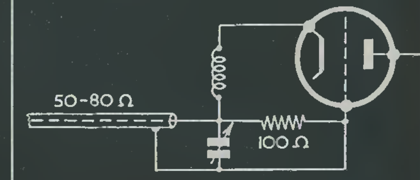


FIG. 3. Two efficient methods of coupling low impedance feeder to a G G stage

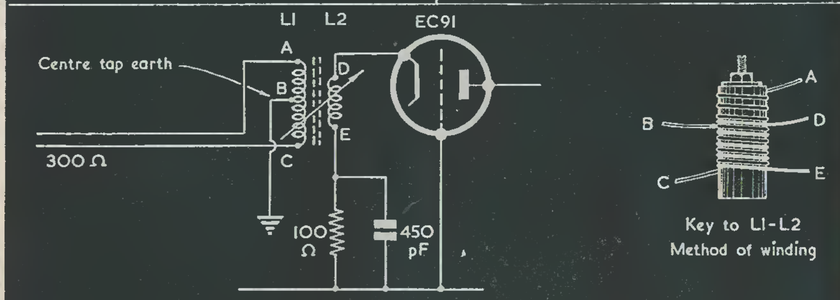


FIG. 4. Coupling 300Ω feeder to a GG stage. L1 = 7 turns 18 swg enam: L2 = 4 turns 18 swg enam: Turns spaced 1/16". ⅜" former. Dust iron trimmed

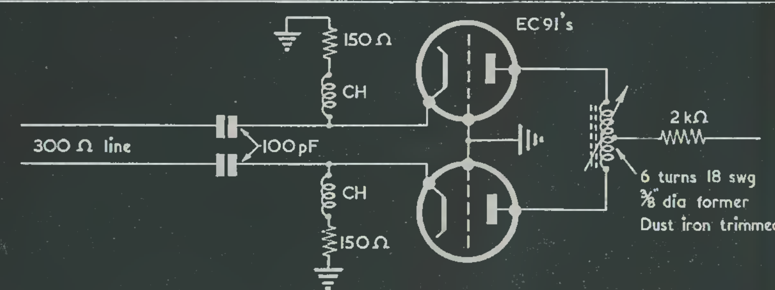


FIG. 5. Coupling 300Ω line to Push Pull GG stage. No input tuned circuit necessary. CH = 20 turns 30 swg wound on a 1 MΩ ceramic resistor

G16

COLOUR TELEVISION

COLOUR TELEVISION, as transmitted at present in the United States, was the subject of a paper read by Commander C. G. Mayer, U.S.N.R., O.B.E., M.I.E.E., before the Royal Society of Arts on the 5th May. Sir Noel Ashbridge presided.

The Commander introduced his subject by pointing out the necessity of radio spectrum conservation; and mentioned the consequent decision of the Federal Communications Commission, some time ago, that colour television transmissions, as well as being "compatible," must also occupy only the 6 Mc/s bandwidth allocated to existing monochrome transmissions. This necessitated considerable work by RCA and others, one of the major problems being the compression of the colour information required into this relatively narrow bandwidth.

To appreciate the working of the system finally adopted it is necessary to examine the problem in two parts. These are, firstly, the characteristics of sight in relation to colour, and secondly, the electrical techniques needed to transmit the additional colour information.

Colour, as perceived by the eye, consists of three attributes. These are brightness, (a measure of light intensity or luminance); hue, which represents the actual wavelength of the colour; and saturation. Saturation describes the vividness of colours of the same hue, and may be thought of as "purity."

Whilst colour in large areas can be reproduced by blending three primary colours (red, green and blue), colour in small areas needs the blending of two primaries only; these being orange-red and a greenish-blue (called cyan). For very fine detail the eye responds to colour hardly at all, although it is fully responsive to brightness. Thus, fine detail, which requires the greatest bandwidth, need carry little or no colour information. These three complementary methods of presenting a colour picture require individual bandwidths of $\frac{1}{2}$, $1\frac{1}{2}$ and 4 Mc/s respectively, (American 525 line standards). The last of these, brightness, corresponds to the bandwidth of the monochrome signal it largely resembles.

In colour television, the different channels of information are transmitted simultaneously by multiplexing. Two of these channels, saturation and hue, are sent on two carriers of the same frequency, displaced in phase by 90 degrees. This results in two sidebands and a suppressed carrier (the chrominance sub-carrier), which has to be re-introduced at the receiver by a local oscillator. The latter is locked to the transmitter by sending about 9 cycles of the sub-carrier during the line blanking period.

This sub-carrier, with its sidebands, is now added to the main, 4 Mc/s wide, brightness carrier by siting it such that the main information of one carrier (bunched at points corresponding to whole harmonics of the line frequency), lies between the bunches of information, at whole line harmonics, of the other carrier. The effect is something like the interleaving of the teeth of two similar combs.

This system is compatible because a monochrome receiver responds, in the main, to the brightness carrier only. The monochrome receiver is liable to reproduce a dot pattern, however, due to interference caused by the chrominance sub-carrier. This pattern should be invisible at normal viewing distances. Similarly, only the brightness circuits of a colour receiver respond to a monochrome transmission.

Colour cameras and picture tubes were also described.

A demonstration film was then shown. This had been taken from three separate picture tubes, each handling a different primary, and not from a single-colour tube. The size of the projected film was reduced to that corresponding to a 12-inch screen at normal viewing distances.

The colour rendering in this film was most impressive. A fair description would be that the detail and apparent truth of colour were equivalent to a colour reproduction in, say, *Picture Post*. If compared with Technicolor, it could be said that the shades were softer and did not have the strident brightness that Technicolor has. A single colour across the whole screen area retained its hue, and such things as check "tweed" cloth were reproduced with great accuracy. No evidences of dot pattern interference, (one of the greatest snags of colour television), were seen in the film.

However, the most arresting thing about the colour film reproductions were their vivacity and *life*. After viewing colour scenes of the quality shown in the demonstration film, no television owner could ever be fully satisfied again with his old, monochrome, receiver.

J.R.D.

CURRENT TOPICS

We regret to announce the very sudden death, on April 26 at 5 p.m., of Mr. P. Moseley, Managing Director of Osmor Radio Products Ltd., 418 Brighton Road, South Croydon, Surrey, at the age of 32.

He was a keen radio enthusiast and had controlled this business of the manufacture of Coil and Coil Assemblies, Radio Components etc., since 1947.

A COMPLETE RANGE OF MULLARD VALVES FOR FM/AM RECEIVERS

Mullard Ltd. now have available a complete range of noval-based valves for use in combined FM and AM broadcast receivers. The design of such receivers, which make possible the choice of FM or AM broadcasts at the turn of a switch, has been facilitated by including in the range some versatile dual-purpose valves. FM/AM receivers using five Mullard valves and a rectifier – only one more valve than conventional broadcast receivers – will make the reception of FM broadcasts in Band II (87.5–100 Mc/s) an economic possibility. Care has been taken in the design of these valves to ensure that full advantage can be taken of the potentially high quality of FM broadcasts. An improved output pentode provides 6 watts of audio frequency power, and a new VHF double triode for use in the early FM stages minimises receiver noise and local oscillator radiation.

The range of valves comprises the new high-slope double triode ECC85 for use as FM RF amplifier and frequency changer; the triode-heptode ECH81 (with separate electrode structure for triode and heptode) which is used as an FM IF amplifier or AM frequency changer; the high-slope variable-mu RF pentode EF85 for AM or FM IF stages; the triple-diode-triode EABC80 (FM detector, AM detector, AGC detector and AF amplifier); the new output pentode EL84; and the power rectifier EZ80.

NEW TYPE EMITRON CAMERA FOR BBC TELEVISION STUDIOS

The BBC has placed an order with Emitron Television Ltd., for 17 latest type Emitron television cameras and associated vision channels.

This equipment will replace some of the older camera channels now in use and provide for further expansion of the BBC Television Service.

The cameras incorporate the new Emitron camera tube type 5957 – the latest development in the range of Emitron tubes. The original Emitron – produced in the same laboratories of E.M.I. – was the first electronic television camera to be used in this country and helped to launch the BBC Television Service in 1936.

The 5957 tube is a considerable advance on previous types: its features include improved definition and contrast range, complete stability under all operating conditions, and absence of picture distortion. It also features the traditional freedom of the Emitron from dark haloes around bright objects.

Overall picture quality provided by these new channels is comparable with the highest photographic standards.

Modifications have also been made to the mechanical design of the cameras to ensure greater ease of operation and handling in use.

They have turrets incorporating 4 lenses, remote controlled light density filters and improved picture monitors to simplify operation. The control units also feature improved picture monitors.

HONOUR FOR PIONEER OF ELECTRONIC TELEVISION

The high award of the Faraday Medal of the Institution of Electrical Engineers was recently presented to Mr. Isaac Shoenberg.

This award has been made to Mr. Shoenberg for his outstanding contributions to the development of television in this country.

The great success of the television Coronation programme last year was to a considerable extent the result of his pioneering work and it was with this in mind that the Council of the Institution decided that it would be appropriate while thoughts of the Coronation were still fresh to award him the Faraday Medal of the Institution.

Mr. Shoenberg led the team of scientists at E.M.I. Hayes, who developed the television system and ancillary equipment adopted by the BBC in 1936.

His development of the electronic picture tube known as the Emitron contributed perhaps more than any other single item to the success of the new system.

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