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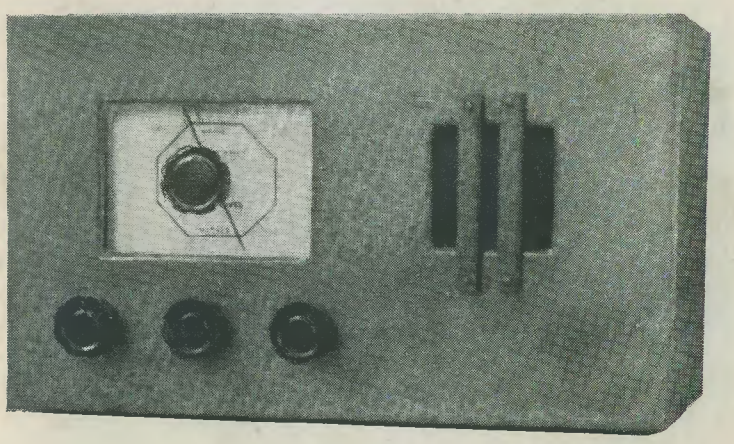
Volume 8
Number 2
SEPTEMBER
1954

The RADIO CONSTRUCTOR

incorporating The Radio Amateur

for the Radio and Television Enthusiast

THE EASI-BUILD



A design for the Beginner

ALSO IN THIS ISSUE

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DESIGN, CONSTRUCTION, CALIBRATION AND USE OF SIGNAL GENERATORS, PT. I

FM TUNER UNIT MODIFICATIONS

REPAIR & MAINTENANCE OF LINE OUTPUT TRANSFORMERS

INEXPENSIVE RECORD PLAYER

KNUPPLE SYSTEM OF RADIO CONTROL

BEGINNERS THREE-VALVE BATTERY RECEIVER · Matching · Using the New Panel-Signs · Query Corner · Radio Miscellany, etc

The
Radio Constructor

INCORPORATING *The Radio Amateur*

VOL. 8 NO. 2

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SEPTEMBER 1954

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CONTENTS FOR SEPTEMBER

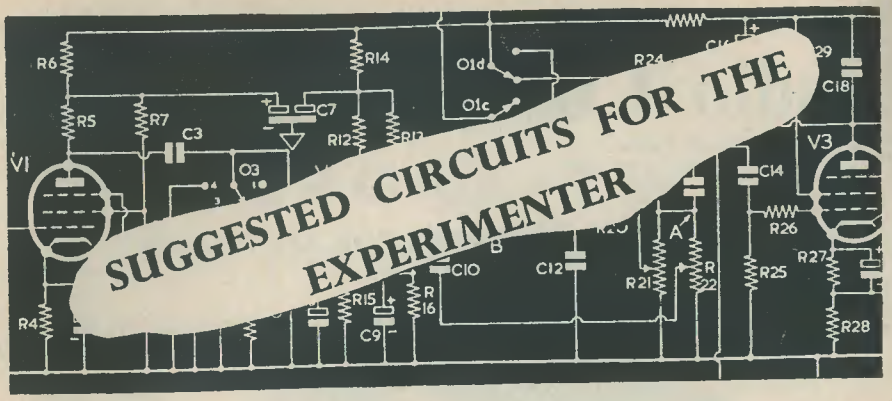
NOTICES

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 produce for review in this section.

ALL CORRESPONDENCE should be addressed to THE RADIO CONSTRUCTOR, 57 Maida Vale, London W.9 *Telephone* CUN. 6518



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. 46. AN INEXPENSIVE RECORD PLAYER

THERE APPEARS TO BE, AT THE PRESENT time, a large number of gramophone record players of various manufacture offered for sale to the public. These players range from the inexpensive popular types to the more costly "quality" models. Several readers have requested details of a simple and reliable record player, stating that, although much space is devoted in the technical press to high-fidelity equipment, little attention is given to the design of cheap and less pretentious gear.

This month's circuit, therefore, illustrates a very simple amplifier which may be used with most modern crystal pick-ups, and which is capable of being built into a compact carrying case together with the attendant gramophone motor and loudspeaker.

The Circuit

As will at once be apparent, the circuit is very simple and straightforward. The amplifier proper employs one valve only, and this may consist of any high-gain output pentode. The crystal pick-up is taken direct to the grid of this valve, via the volume control R1. The anode then feeds into the speaker transformer, and thence to the speaker.

A simple tone control is provided by R3, R4 and C4. This control is of the top-cut variety. (For smooth operation, incidentally, R3 should be logarithmic). The resistor R4 is included to prevent heavy AF current flow through the track and slider of the tone control when it is set to the full-cut position. If this resistor were not fitted it is possible that the heavy AF current would burn the track and cause subsequent sparking when the speaker transformer primary had high AF voltages built up across it.

The power supply arrangement is of interest. This utilises a normal heater transformer to supply the heaters of the valves. The primary has three taps at the conventional voltages (210, 230 and 250); and the rectifier anode is fed from the 250 volt tap to ensure that a reasonably high HT voltage is available whatever the mains supply voltage may be. If the record player is to be built as a "portable," it would be worth-while having a mains adjustment panel fitted in an accessible position.

The half-wave rectifier, V2, is supplied via a 120Ω limiter resistor, and its cathode is connected to a 32μF reservoir condenser, C6. The HT voltage appearing across this condenser is applied to the anode of V1 directly. The screen-grid of V1 is fed from C5, however, the resistor R5 providing additional smoothing. Suitable rectifiers are the 6X4 or EZ41.

The bias resistor, R2, has been chosen for use with the Mullard EL41 output pentode. It may be necessary to alter its value when other output valves are employed.

Performance

The performance to be obtained from this record player will, with most crystal pick-ups, be found to be surprisingly good. The amplifier is, of course, by no means intended to be in the high fidelity class, but its quality of reproduction will be at least as good as that given by the conventional domestic type of receiver.

Although only one stage of amplification is used, volume should be more than adequate for normal purposes. As mentioned above, a crystal pick-up is needed. The voltage of a magnetic pick-up would not be sufficiently high for the limited amplification available. The writer has checked the circuit by building a working model; and he obtained very good results with a modern turn-over crystal cartridge playing both 78 rpm and microgroove records.

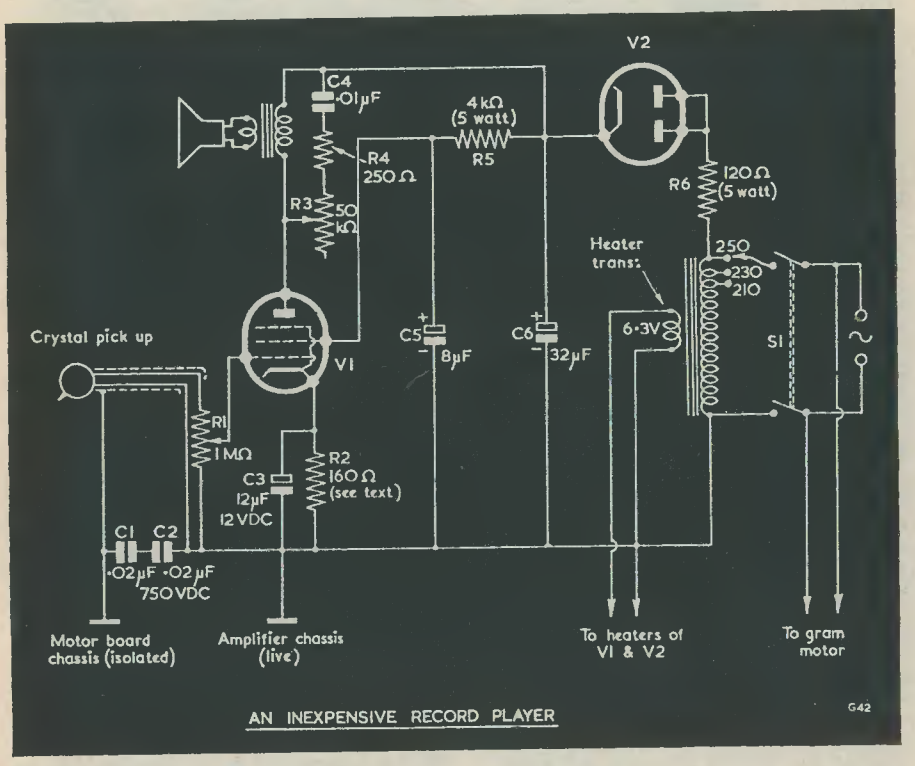
Despite the extremely simple HT arrangements, no trace of hum was discernible in the working model. If a large, high fidelity reproducer were used, however, slight hum might be apparent. Nevertheless, it is doubtful if hum would be at all noticeable with most of the more inexpensive loudspeakers which are at present available.

The Chassis

The record player has two chassis; that of the amplifier, and that of the motor-board and pick-up assembly.

The amplifier chassis is "live," and must be mounted, accordingly, in the body of the record player cabinet where it cannot inadvertently be touched. As the motor-board chassis will most probably consist of a large surface of metal, part of which must inevitably be handled when the player is operated, this is isolated from the mains. Although it is customary to use a single isolating condenser at this part of the circuit, two condensers connected in series (C1 and C2), are shown here. This course is recommended as it lessens the chances of accidental shock due to breakdown or leakage.

[*continued on page 78*



IN YOUR WORKSHOP

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

POTTERING AROUND WITH SURPLUS EQUIPMENT is liable, at times, to bring back many recollections of the war. The other day, for instance, I was rather urgently in need of some temporary test-gear for a special job. I didn't have the time to make up a proper chassis and case for the gear, and so I dug out an old store-soiled R1132 which I had bought some years ago at a knock-down price.

Looking Back

This set had never done anything since I bought it; apart, that is, from collecting dust and yielding the odd resistor or condenser every now and again. It had become, therefore, thoroughly "Christmas-treed," and I decided to strip it down for the chassis.

On examining the receiver more carefully I found that someone in the past had been writing in pencil on the chassis at the side of the RF strip. The legend ran something like the following.

"IF's re-aligned to 180 kc/s bandwidth. V5 replaced. C12 (leaky) replaced. RF Volume pot slightly scratchy, no spares." It carried on like this for a few more lines, then ended with the date: 22/3/44. There was no signature.

In 1944, I was doing my inconspicuous bit to help win the war on an RAF Maintenance Unit near Naples. And in our Radio Workshop we used to have a very keen type repairing R1132's who was in the habit of putting an unofficial report of this nature on the sets he passed through in just this very manner. It was quite a good idea, too.

The repair system working at that time was that all the unserviceable radio gear from the nearby RAF units went into the Maintenance Units' Stores and was issued to the Radio Workshop for repair. The sets were put out, usually in dozens, on Job Cards; and were sent to the Serviceable Stores, for re-issue to units, on the same Job Card number after they had been made serviceable. It was quite a good system since the Job Cards kept a reasonable tally on what went in and what came out, and it didn't give the office staff the excuse to waste too much paper.

However, it suffered from some disadvantages, the worst of these being that it didn't allow for shortages of spare components. If some of the Powers-that-be at that time had had their way, they would have been quite happy to see two receivers sitting side-by-side on the shelf awaiting spares, one with a burnt-out output transformer, the other with a broken tuning condenser. The technical types, who wanted to get the war over and go home, were not too keen on this scheme and so, in practice, one set was often "cannibalised" to repair another.

The result of this was that from a Job Card of a dozen sets there occasionally emerged an output of eleven shining and serviceable receivers and one which, like Jacques' old man, was "sans eyes, sans teeth, sans taste, sans everything!"

Of course, the work was not really carried out quite as irresponsibly as the above may suggest, and it was usually found possible to keep a set which was very bad on receipt

hidden away in the Stores, and use this for spares.

"That Old Junk!"

Another disadvantage with the Job Card idea was that a record of faults and repairs was never attached to the set itself. A set was either "Serviceable" or it was "U/S." Therefore it was never possible to know whether a set had been aligned recently, what components had been replaced in it, and, most important of all, whether it had ever suffered from an intermittent fault.

The airman who was servicing the R1132's at the time I am talking about felt rather keenly about this, and so he started making his own unofficial and unsigned maintenance records on the chassis. It was quite possible, therefore, that the 1132 I was stripping down a few weeks ago was one of those that passed through his hands in 1944. I couldn't help reflecting on the journey it must have undergone: from Italy to England; thence to the MOS dump; to the job-lot buyer; and, finally, to the shop in London where I purchased it.

At about that moment, a young chap who has just completed his National Service marched into my workshop and watched me working away on the dusty old receiver.

"This," I remarked impressively, "is one of the sets which helped to win the war."

"What!" he said scornfully, "that old junk!"

VHF

That young man was quite right, in a way, because the R1132, with its VR65's and VR53's, is definitely somewhat venerable these days. But it was never junk. One has only to examine an 1132 to appreciate the care with which it was designed and, despite the fact that these receivers were built during the war, the workmanship which went into its construction.

The 1132 was the first ground station VHF receiver used in the RAF, and it carried on all the way through the war with hardly a modification at all. It was one of those receivers which one fitted into a rack, switched on, and forgot about until it was due for its next workshop checkover.

So far as I can remember it suffered from one snag only, that being frequency drift. The drift was not excessive, especially after the set had been switched on for several hours, but it was enough to make it worthwhile checking the tuning every thirty minutes or so. Bad cases of drift could usually be cleared by changing the oscillator valve.

Apart from that small trouble the 1132 was a very fine receiver, and was well to the fore-front of contemporary design at the date of its inception. So I think I wasn't so far wrong, either, when I described it as a set "which helped to win the war."

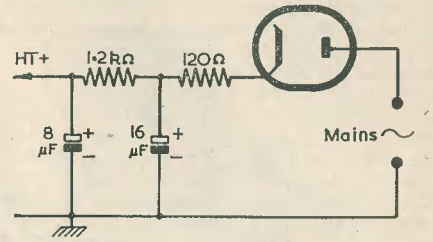


Fig. 1a

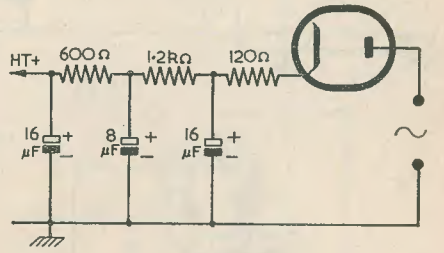


Fig. 1b

E60

Fig. 1. "Before and After" diagrams showing how hum was cleared in a midget receiver when it was connected to a larger loudspeaker. The original circuit is shown at (a); whilst (b) shows how an additional resistor and condenser improved smoothing. The two extra components need take very little space on the chassis.

Improving a Midget

An acquaintance, working on a small broadcast receiver, encountered one or two interesting little points recently which should be of interest to readers.

He had obtained a set in the semi-midget class and had decided to improve its performance. Examining its circuit, he soon realised that it was just a normal four-plus-one in miniature, with most of the trimmings. He considered therefore that his first step should be to try it out with a bigger loudspeaker. His ultimate aim was to keep the little set on the mantelpiece and to have the speaker, in a large cabinet, in a corner of the room.

The set, working into the larger speaker, gave a much improved performance; and was marred only by a slight, but noticeable, hum. He decided, quite rightly, that the hum had been present in the output of the set all the time, and that the miniature speaker used originally simply hadn't been capable of reproducing the lower audio frequencies at their full volume. What was needed was extra smoothing.

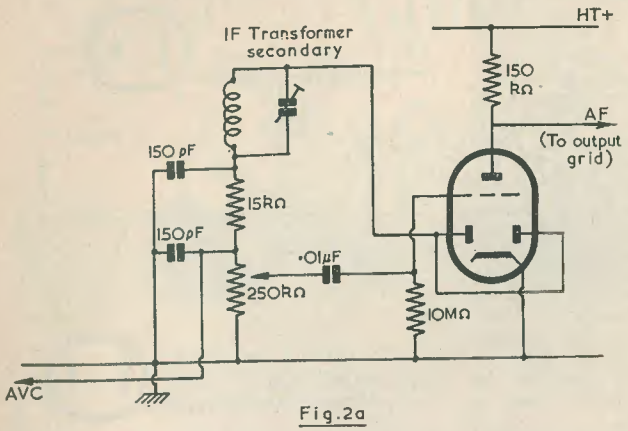


Fig.2a

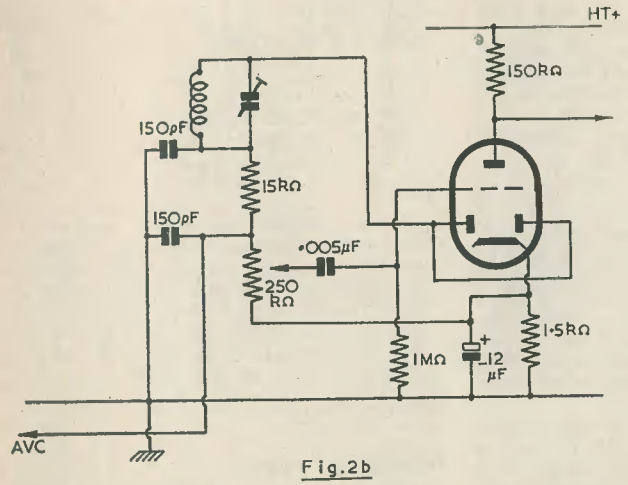


Fig.2b

E61

Fig. 2. Another improvement to the miniature receiver. In (a) an economic circuit, which provides bias for the triode by leaky-grid rectification, is employed. This was changed to that of (b), in which conventional cathode bias is used.

The original HT circuit is shown in Fig. 1 (a). The arrangement used is perfectly conventional, a half-wave rectifier feeding into a 16μF reservoir condenser and being finally smoothed by a 1.2kΩ resistor and an 8μF condenser. My friend considered that this was not adequate when the larger speaker was being used. He would have liked to have fitted a choke instead of the 1.2kΩ resistor but there wasn't sufficient room on the chassis for the component he had in mind. He finally used an additional resistor and condenser, as shown in Fig. 1 (b), and this cleared up the hum completely. The extra condenser, incidentally, was a miniaturised component; a condenser of this type being quite permissible as it had to pass very little ripple current.

My acquaintance was still not quite satisfied with the reproduction, however, and he next attacked the double-diode-triode stage. This, originally, used the arrangement shown in Fig. 2 (a), in which the triode grid is biased by reason of the negative voltage developed across the relatively high value of grid leak. He altered this to the circuit of Fig. 2 (b), in which conventional cathode bias is used. He was careful, as may be seen from this diagram, to return the diode load to the cathode as well, instead of leaving it connected to chassis. As the AVC line now had a standing positive bias equal to the cathode bias at the detector it was necessary to increase the cathode resistors of the frequency-changer and IF amplifier to allow for this. After having completed all these alterations he tried the set once more; and he claims that the altered circuit gave noticeably improved reproduction.

Speaker Transformers

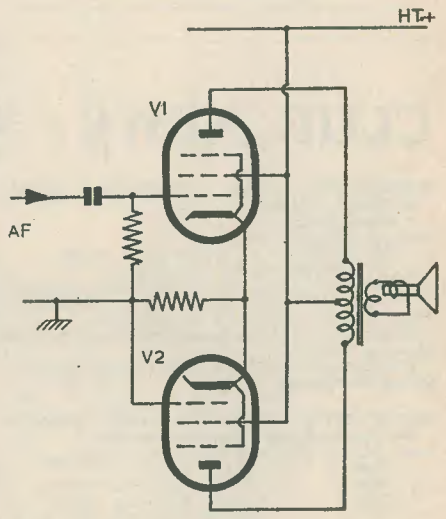
Nevertheless, he felt that he could improve the quality still further, and so he next directed his attentions to the speaker transformer. This component was rather small in physical size. My friend suddenly noticed also that the laminations were not interleaved, but were butt-jointed. That is to say, all the "E's" had been put in together on one side of the bobbin and all the "I's" on the other. (The same would apply, of course, if "U" and "T" shaped laminations had been used).

Breathing curses on the machinations of "tight-fisted manufacturers who wouldn't spend an extra penny on their products if they could get away with it," (his own words!), he then proceeded to remove the transformer from the chassis, strip out the laminations, and refit them carefully interleaved. He connected the transformer to the set and switched on, expecting the reproduction to be as good now as it ever could be. His disappointment was intense when he found that it was worse that it had been in the first place with the miniature loudspeaker! Thinking that he had possibly damaged the transformer, he dropped in to see me in order to borrow a spare component to check the circuit.

This series of events is rather like last month's "glowing fuse" fault, because I am certain that the more experienced reader will know immediately what was wrong. The trouble, of course, was that the output transformer was *intended* to be butt-jointed, and should never have been altered.

The reason for this is that speaker transformers intended for single-ended output stages have to carry the continual standing anode current of the output valve. Thus, if the laminations were interleaved, they would be relatively heavily magnetised due to the completed magnetic circuit. In the case of miniature output transformers the iron could, indeed, be well on the way to complete saturation. To prevent this trouble single-ended speaker transformers are always butt-jointed; the slight gap between the laminations preventing the completion of the magnetic circuit. In better-class transformers this gapping is maintained accurately within close tolerances during manufacture.

On the other hand, push-pull transformers are always interleaved. This is due to the fact, of course, that the opposing standing anode currents in the primary cancel out each other's magnetic field, and there is then no risk of core saturation. It is possible, therefore, for a push-pull speaker transformer to work more efficiently than a single-ended transformer even when both types employ laminations of the same size.



E62

Fig. 3. A "Mystery Circuit," dating from the earlier days of radio. It was claimed that this circuit gave push-pull performance merely by adding V2, as shown.

Whilst on this subject, Fig. 3 shows a "Mystery Circuit" which used to cause a certain amount of heated discussion in the earlier days of radio. With this circuit one converted an ordinary singled-ended output valve (V1) to "push-pull" working simply by omitting its cathode by-pass condenser and adding V2, with a push-pull output transformer, as shown. The results, so it was

claimed, were those of a push-pull output stage.

This is quite untrue, of course, because V2, although driven in anti-phase to V1 via the common cathode resistor, receives only a small proportion of the drive applied to V1. The only "advantage" of the circuit, therefore, is that the two standing anode currents passing through the transformer primary cancel out each other's magnetic field, and slightly improved reproduction with small output transformers is quite feasible. But the circuit is not push-pull.

To revert once more to my friend and his midget receiver, he solved the problem finally by obtaining a larger single-ended (and butt-jointed!) output transformer which could just be squeezed onto his chassis; and he is now quite satisfied with the performance he obtains.

SUGGESTED CIRCUITS

continued from page 73]

Particular attention should be paid to the method of connecting the leads from the pick-up to the amplifier. The two central leads are connected to the volume control, R1, and are consequently at amplifier chassis potential. The *screening*, however, is connected to the motor-board chassis and is isolated, therefore, from the mains.

Switching

It will be noted, finally, that the mains input to the gram motor is taken direct from the mains supply, and not through the amplifier on-off switch, S1. This method of connection is advisable, since the loading on the contacts of S1 is thereby reduced. The gram motor can, of course, be switched on or off by the switch contacts fitted on the motor-board itself.

CLUB NEWS

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

WARRINGTON AND DISTRICT RADIO SOCIETY, G3CKR

Future Events:

Aug. 3 Mystery evening.
,, 15 Shack Visit to G2FCV—G. S. Leigh.
,, 17 Business and any questions.
,, 29 Field Day. Site: "Davyhulme Cottage," Dark Lane, Higher Whitley, Cheshire.
Sept. 7 Radio Control for Model Planes.

Meetings are held in the King's Head Hotel, Winwick Street, at 7.30 p.m.

Hon. Secretary: G. H. Flood, 32 Capesthorne Road, Orford, Warrington.

THE CLIFTON AMATEUR RADIO SOCIETY

The proposed programme for September is:

Sept. 3rd and 17th Constructional evenings.
,, 5th 3rd D.F. Contest.
,, 10th 8th Annual General Meeting.
,, 24th "Radio Receiving Valves and their Manufacture," Mr. G. P. Thwaites (Standard Telephones & Cables Ltd.).

Meetings are held every Friday at 7.30 p.m. at the clubrooms 225, New Cross Road, London, S.E.14.

Secretary: C. H. Bullivant, G3DIC, 25 St. Fillans Road, London, S.E.6.

NORWOOD AND DISTRICT GROUP—RSGB

The next meeting of the above group will be held as usual on the third Saturday in September (i.e. September 18th) at Windermere House, Westow Street, Crystal Palace. The meeting will commence at 7.30 p.m. and all local members and interested persons are invited to attend.

Further particulars may be obtained from W. G. Mott, B.R.S. 18308, of 199 Tilson House, Tilson Gardens, S.W.2.

SOUTH MANCHESTER RADIO CLUB, G3FVA

Our future programme of lectures will be as follows:

Sept. 10 Design of Mains Transformers and Chokes, N. Ashton, G3DQU.
Sept. 24 Power Pack Design, M. Barnsley G3HZM.

Oct. 8 ANNUAL GENERAL MEETING.

Our scheme of simple lectures for beginners has been a great success and new members are continually coming along to join us. Anyone who desires to come along and see what we have to offer in the way of membership of our club can do so without any obligation.

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

SLADE RADIO SOCIETY

Headquarters: The Church House, High Street, Erdington, Birmingham 23.

FUTURE PROGRAMME—THIRD QUARTER, 1954.

1954
Sept. 3 "The Balancing of Rotors," by Mr. A. B. Cape, M.B.E.
,, 17 "The Possibilities of Inter-Planetary Travel," by Mr. W. E. Merrill (Member).

D. F. Events
Sept. 12 R.S.G.B. National D.F. Contest Final.
,, 26 Double Midnight D.F. Test.

Aug. 25—
Sept. 4 NATIONAL RADIO SHOW.
Oct. 23 ANNUAL DINNER.

Visitors to the Society's meetings, which commence at 7.45 p.m. prompt, are cordially welcome.

Full particulars of the Society and its activities may be obtained from the Honorary Secretary: Mr. C. N. Smart, 110 Woolmore Road, Erdington, Birmingham 23.

The Society's clubroom at the Church House is now available, and is open every day of the week for the use of members.

Transmitting and receiving equipment is being installed, constructional facilities are available, and Morse and theory classes are being arranged.

REPAIR and MAINTENANCE of Line Output Transformers

Part 1. *By* **S. WELBURN**

AS MANY PROFESSIONAL RADIO ENGINEERS will agree, one of the most troublesome and difficult-to-service components in the modern television receiver is the line output transformer. This is due mainly to the fact that this component has to perform several functions simultaneously whilst handling comparatively high power, and because it needs considerable care in its manufacture. The amateur who constructs his own television set is rather fortunate in this respect because, if he chooses a branded transformer of reliable manufacture, he can avoid many of the line output snags which are relatively common in the competitively priced commercial televisor.

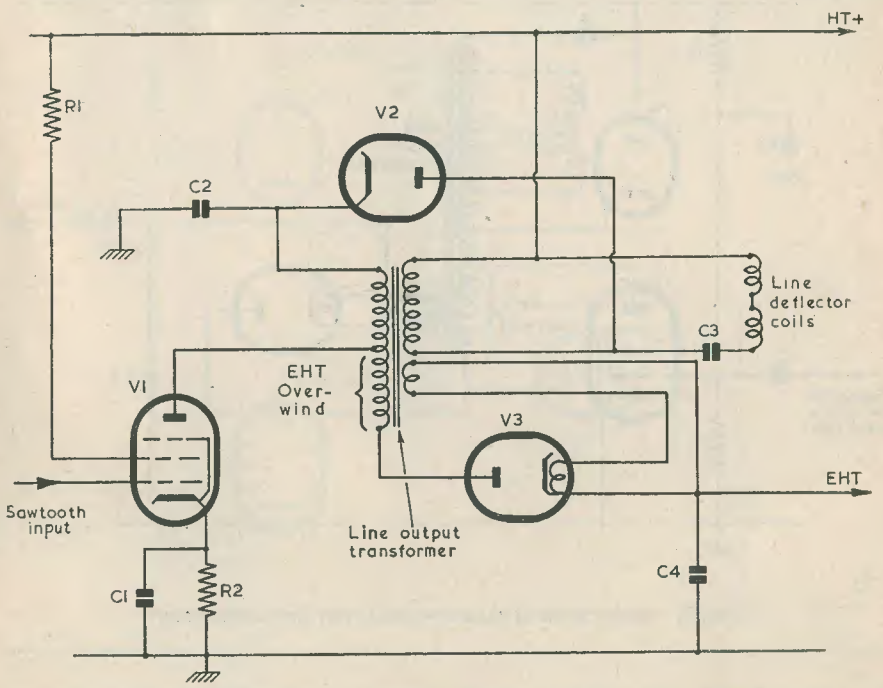


Fig. 1. *A typical line output stage using a transformer with a separate secondary winding*

Basic Theory

Modern line output transformers and their associated circuits can nowadays be said to

fall into three roughly standardised groups.

Fig. 1 shows an example of the circuit employed with a line output transformer of the type having a separate secondary winding for the scanning coils. In this diagram a booster diode, V2, is connected effectively across the secondary winding and serves to charge the condenser, C2, during the second half-cycle of the flyback period. It also tends to damp out any ringing voltages which may be formed. It will be noticed that C2 is charged in such a manner that the rectified AC voltage applied to it is added to that of the HT supply, offering therefore a boosted voltage for the anode of the line output valve itself. The flyback EHT voltage is rectified by V3.

During the scanning period of the sawtooth cycle, the anode of the line output valve is drawing a continually increasing current. The anode may, therefore, be considered as becoming progressively more negative. When the anode is passing its peak current, at the end of the scanning period, the arrival of the line sync pulse at the associated timebase results in the grid of the valve being cut off; whereupon the anode suddenly ceases to draw current.

The magnetic field in the line output transformer immediately collapses, with the result that the transformer swings through one half-cycle at its characteristic frequency. The bottom part of the winding, previously going negative, now goes violently positive;

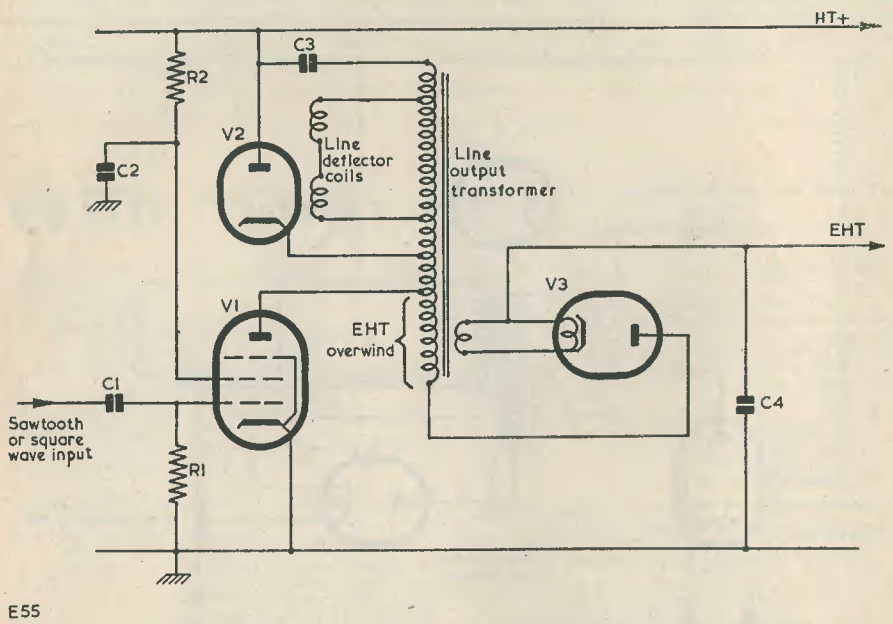


Fig. 2. Basic circuit of the auto-transformer line output stage

A more modern type of line output transformer employs the auto-transformer circuit shown, in skeleton form, in Fig. 2. The use of the auto-transformer arrangement confers a particular advantage, since it allows very tight coupling to be obtained between the line output anode and the scanning coils. As may be seen, part of the winding is common to both these circuits.

The functioning of the flyback and booster components is very easy to follow when the circuit of Fig. 2 is examined.

causing a high positive voltage to appear at the anode, and an even higher voltage (stepped up by the turns ratio between the EHT over-wind and the main winding of the transformer) at the EHT terminal. This high voltage serves to charge the EHT reservoir condenser, C4, via the EHT rectifier, V3.

The transformer then swings back to its former polarity, in which circumstance its bottom end is once more negative, and its top end positive. This causes the booster

diode to conduct, charging the booster condenser, C3, such that its right-hand plate becomes positive with respect to its left-hand plate. The charge on C3 adds an additional (boosted) voltage to that of the HT line. This boosted voltage may be tapped off C3, if desired, for use by the time-base circuits. It is applied also, via the transformer winding, to the line output anode itself.

During the first few sawtooth cycles which occur after switching on the receiver and before C3 has charged up to the boost voltage, it is helpful to consider the "earthy point" of the auto-transformer as being at the cathode of the booster diode. After C3 has charged up, the top terminal of the

and is cut off sharply by a negative pulse during the flyback period. The result of this procedure is that the line output valve functions as a switch (with its own internal resistance) and the line output transformer anode winding, together with the reflected inductance of the line deflector coils, functions as the inductance of an inductive time-base.

A third type of line output transformer circuit is shown in basic form in Fig. 3. This circuit illustrates the direct-drive arrangement, and its operation, when analysed fundamentally, is somewhat complex. It functions by employing high impedance deflector coils whose inductance is much higher than that of the transformer primary.

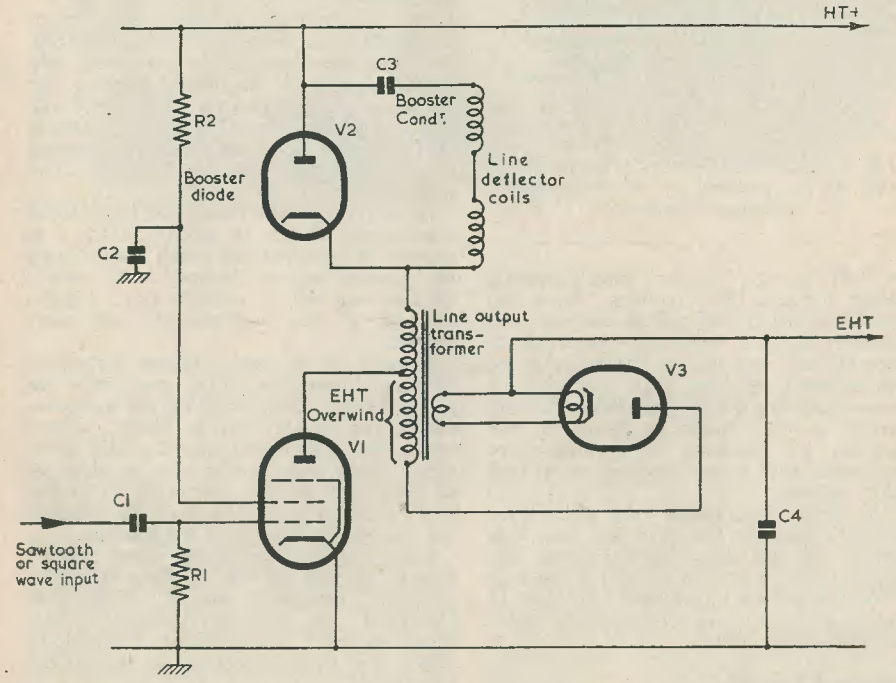


Fig. 3. A skeleton circuit showing the basic essentials of the direct-drive arrangement

winding, connecting to this condenser, may be considered as being "earthy."

It is modern practice to feed the grid of the line output valve with a square wave, rather than with a sawtooth. By this, it is meant that the grid is given little, or zero bias, during the scanning part of the cycle;

Thus, during the scanning stroke of the sawtooth cycle, most of the deflecting voltage is built up across the deflector coils themselves. However, sufficient voltage appears across the line output transformer primary to produce an appreciable magnetic field. This field collapses on the initiation of the

flyback, with the result that the bottom terminal (see Fig. 3) of the EHT over-wind swings violently positive and provides an EHT charging pulse.

It is usually conceded that the main purpose of the line transformer in the direct-drive arrangement is merely that of providing the EHT voltage, together with a heating voltage for the EHT rectifier. Since the power handled by the transformer is comparatively light it need only be small in physical size, and it can consequently be manufactured at low cost. Whereas a conventional line output transformer usually requires a closed magnetic circuit of core material, the windings of a direct-drive transformer need be mounted only on a small rod or cylinder.

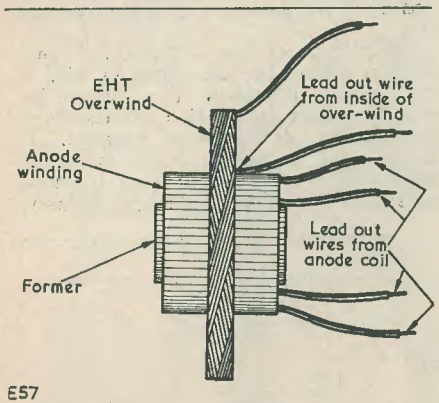


Fig. 4. Side view, showing the construction of the windings of a conventional line output transformer

The great disadvantage with direct-drive circuits is given by the fact that very high flyback voltages now appear across the deflector coils, instead of across the windings of the line output transformer. In cases of breakdown, they are consequently more difficult to deal with.

Width and Linearity

No width and linearity controls have been shown in the circuits of Figs. 1, 2 and 3. They have been omitted because the types of control most commonly used, and their position in the line output circuit, vary considerably for different manufacturers and designers. It is fairly safe to say, however, that when inductive width controls are used they are usually connected either across part of the anode winding of the output transformer or, suitably damped, in series with the deflector coils. In the first case they then offer a variable load across the transformer winding; whilst in the second case, they give a variable impedance between the scanning coils and the transformer. Linearity controls may appear almost anywhere in the line output circuit. They are sometimes omitted in commercial designs.

Construction

The construction of most line output transformers is nowadays fairly standard. So far as the windings are concerned, they consist usually of the anode winding, on top of which is wound the EHT over-wind. The general arrangement is shown in Fig. 4. (This diagram does not show the "corona ring" fitted around the outside of the over-wind).

A very important feature of line output transformer design is given by the low number of turns-per-volt which occur during the flyback period. Indeed, it is usually the other way round – volts-per-turn! Figures as high as ten volts-per-turn are quite feasible.

Because of the high voltages appearing between consecutive turns, great care has to be taken in design and during manufacture. The anode coil is almost always interleaved with paper; and the EHT over-wind, which uses thinner wire, is given its characteristic narrow dimension to ensure that too high a potential cannot exist between any two adjacent turns in the winding.

Line output transformer cores consist mainly of one of the specially-developed magnetic materials; notably Ferroxcube (Mullard) and Caslam (Plessey). These materials have now ousted laminations, which are rarely encountered in modern televisors.

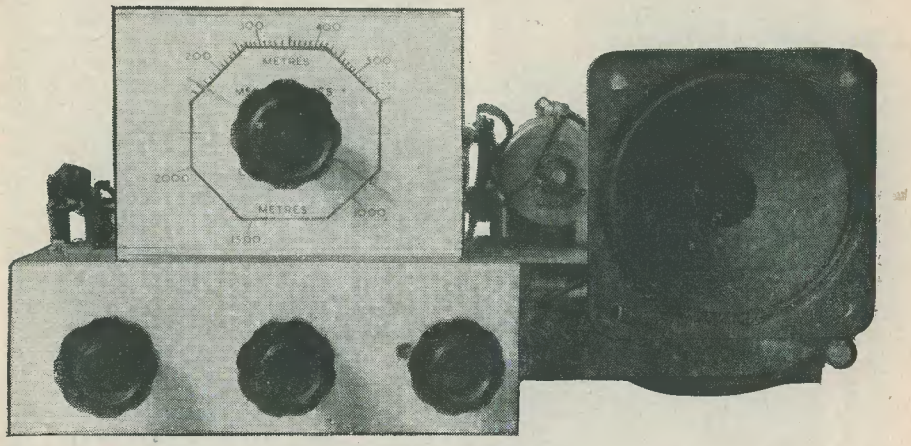
(To be continued)

INDEXES FOR VOLUME SEVEN

● Readers desiring a copy should forward a stamped self-addressed envelope (preferably 9in. × 6in.) marked RC INDEX in top left-hand corner to

The Radio Constructor · 57 Maida Vale · London W9

THE EASI-BUILD RECEIVER



Part 1. *By* **M. HARVEY**

Introducing a simple local station receiver designed especially for the beginner and for those with limited workshop facilities

ALTHOUGH THE "RADIO CONSTRUCTOR" has been a pioneer in the field of television for the amateur, and has published many constructional articles on advanced equipment and test gear, a considerable number of letters arriving at the Editorial offices still ask that such material be balanced by articles intended for the beginner. These letters convey most forcefully the fact that there is a strong demand for a simple receiver which may be constructed by the tyro who has little experience and few facilities.

It is for this reason that we now introduce the Easi-Build, a receiver in which everything, including the chassis-work and the wiring itself, has been designed to make construction as simple as it possibly can be without detracting from the final performance obtained. The set has no trimmers and, apart from the adjustable iron-dust cores, which are used only to finally make the dial calibration correspond to the frequencies received, the set is ready for use as soon as it has been completed. Indeed, the iron cores themselves need not be adjusted at all if this is not desired; as their setting at the factory is sufficiently accurate to enable dial readings to be reasonably correct for normal purposes. No loss of sensitivity is incurred if the cores are left un-adjusted.

The Easi-Build is a mains-operated medium and long wave receiver capable of working from any aerial longer than four feet. It will adequately load any normal loudspeaker, and its quality of reproduction compares very well with any normal domestic broadcast set. It is, however, intended strictly as a local-station receiver. Whilst its sensitivity is sufficient to bring in almost as many Continental and remote Home stations as the average superhet, the simple tuning arrangements employed are obviously not in the class needed to separate weak stations in the present crowded broadcast bands. In many districts it will, admittedly, be capable of selecting a large number of stations with excellent selectivity, but such a

performance cannot be guaranteed for every locality. In one or two instances where the receiver is used in the close proximity of a powerful station it may be necessary to employ a rejector wave-trap in the aerial circuit; but this course will probably only be necessary in isolated cases.

The Circuit

The circuit of the receiver is shown in Fig. 1, and it will be seen at once that this is very simple and straightforward.

Starting at the power supply, it will be noted that the mains input is applied directly to the primary of the heater transformer, and to chassis and a metal rectifier for the HT supply. The rectified HT is smoothed by the two condensers, C14 and C15, and the resistor, R9. The smoothed HT supply is then directly available for the screen-grid and anode supplies of the output valve, V2. A tone-correction condenser, C12, is connected across the primary of the output transformer, and one side of the speaker voice coil is connected to the speaker chassis to prevent static discharge.

The AF input to the grid of V2 is taken via the volume control, R7. The volume control is fitted at this point rather than in an earlier part of the circuit in order to simplify wiring and to obviate the necessity of using screened cable. It has the further advantage that it is completely isolated from the reaction circuits and that there is consequently no possibility of interaction between the two controls. During tests on the prototype, very heavy signals were fed to the receiver, but there was no evidence of overloading of V1 (b), despite the fact that this valve receives the full AF output of V1 (a).

COMPONENT LIST

Resistors

R1 1MΩ, ½W.
R2 50kΩ, ½W.
R3 22kΩ, ½W.
R4 220kΩ, ½W.
R5 100kΩ, ½W.
R6 2.2kΩ, ½W.
R7 250kΩ, volume control, with DP switch, Dubilier.
R8 470Ω, ½W.
R9 2.7kΩ, 5W.
R10 120Ω, 1W.

Condensers

C1 0.0025μF, 600VDC, type 648, TCC.
C2 800pF, 350 VDC, type 601 SMP, TCC.
C3 0.0025μF, 600 VDC, type 648, TCC.
C4 300pF Variable, reaction, Jackson Bros.
C5 500pF Variable, tuning, Jackson Bros.
C6 50pF, 350 VDC, type 101 SMP, TCC.
C7 4μF, 350 VDC, type CE88LE, TCC.
C8 400pF, 350 VDC, type 501 SMP, TCC.
C9 0.02μF, 350 VDC, type 346, TCC.
C10 25μF, 25 VDC, type CE77C, TCC.
C11 0.02μF, 350 VDC, type 346, TCC.
C12 0.005μF, 400 VDC, type 545, TCC.
C13 25μF, 25 VDC, type CE77C, TCC.
C14 8μF, 350 VDC, type CE99LE, TCC.
C15 16μF, 350 VDC, type CE91LE, TCC.
C16 0.005μF, 600 VDC, type 648, TCC.

Inductors

L1, L2, L3 Medium Wave Coil, type DM/2 Teletron.
L4, L5, L6 Long Wave Coil, type DM/1 Teletron.
L7 Reaction Choke, type SP/1 Teletron.

Rectifier

MR1 Metal rectifier; 250V, 60mA; DRM1B Brimar.

Valves

V1 ECC40 Mullard.
V2 EL42 Mullard.

Valveholders

BM8/E McMurdo.
XM8/EC1 McMurdo.
8/85 (Screening Can) McMurdo.

Transformers

Output transformer, type OP1320, Allen Components, Ltd.
Heater transformer, type MT1209, Allen Components, Ltd.

Loudspeaker

3½", 3Ω coil, Whiteley Electrical type S.3.57.

Epicyclic Drive

¼" spindle, Jackson Bros.

Switches

S1, S2, S3, S4 Miniature 4-pole, 2-way, H. L. Smith & Co.

Tag Strips

5-way, centre earthed, 5 required.

Grommets

⅜" inside diameter, 5 required.

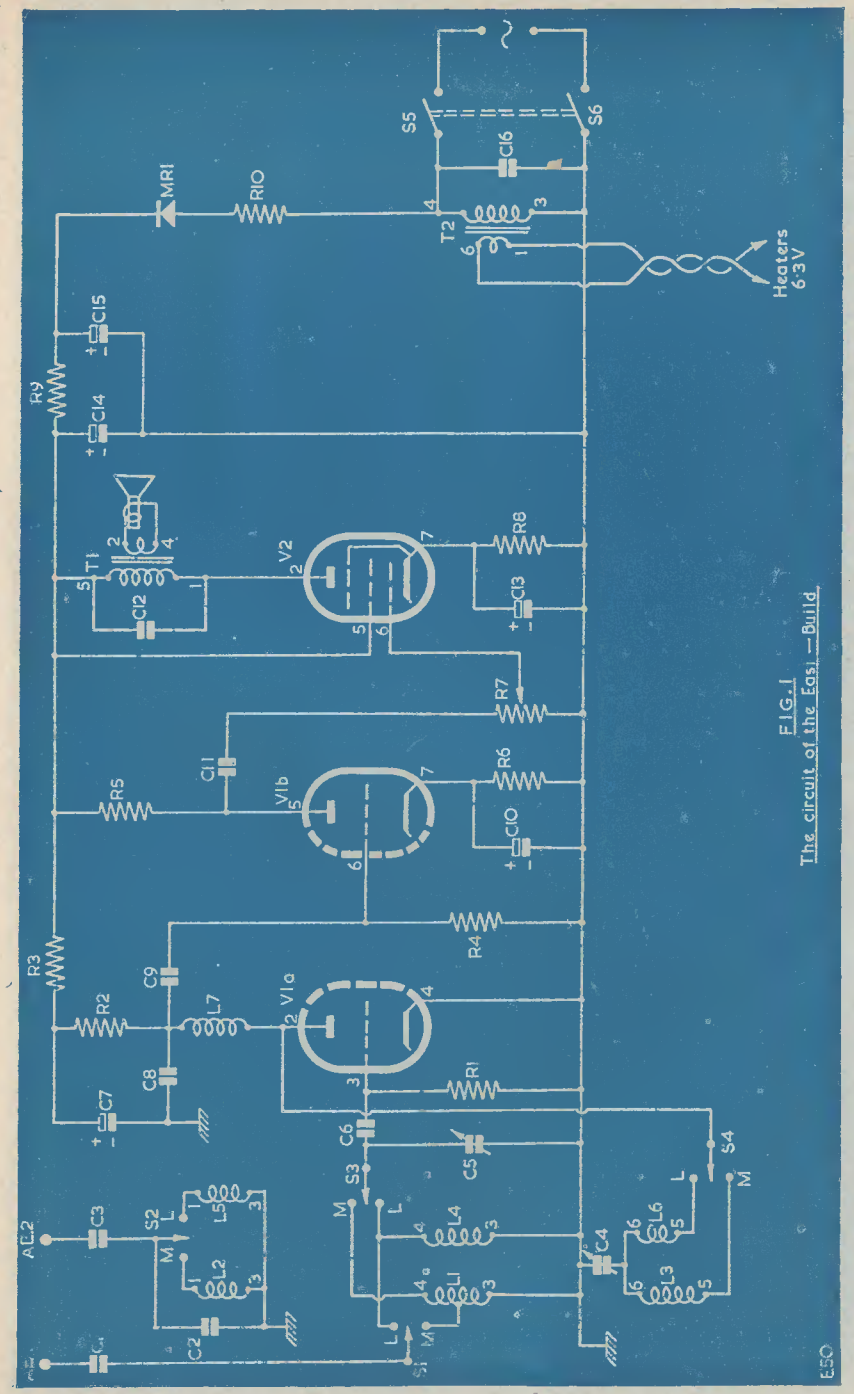
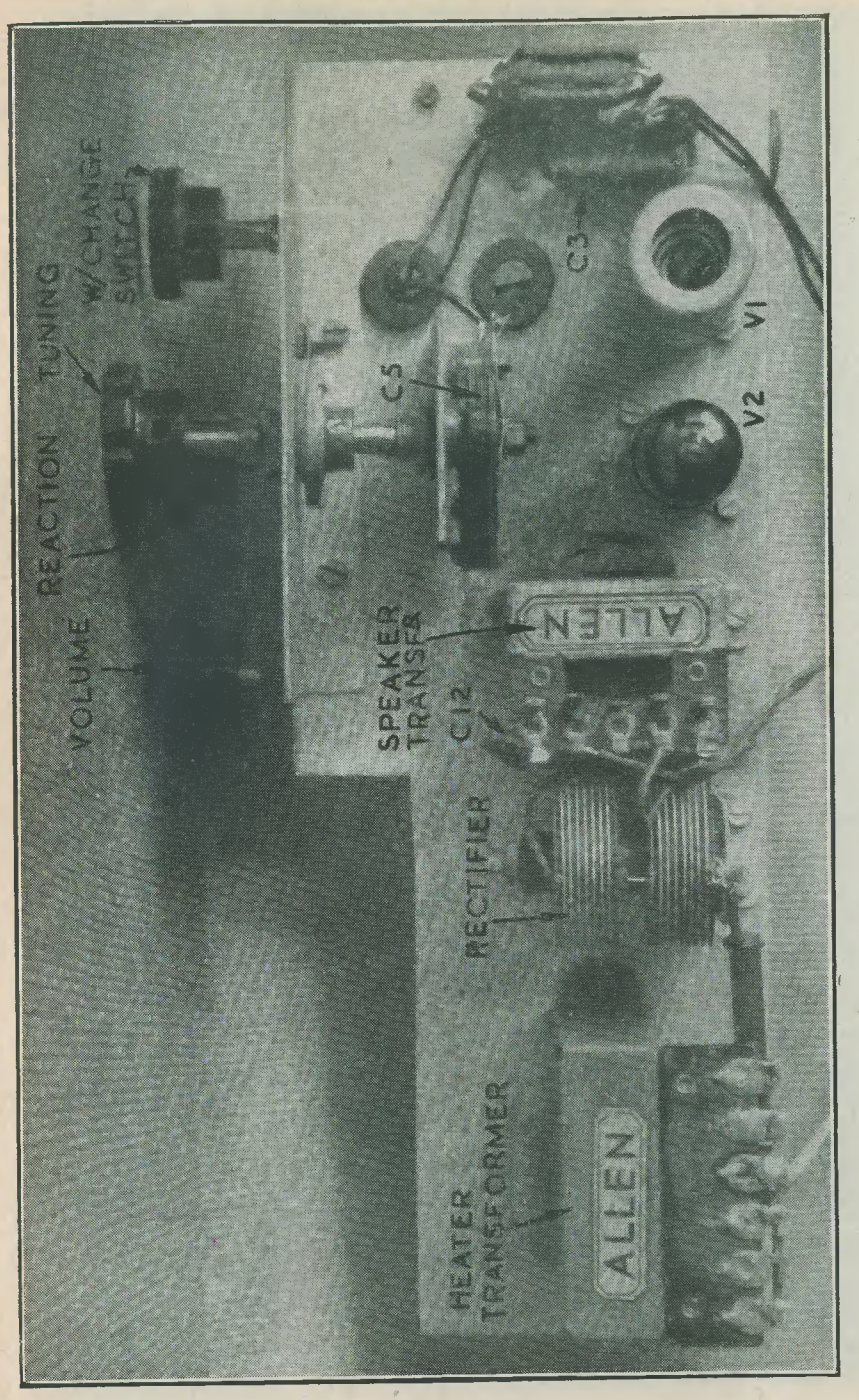
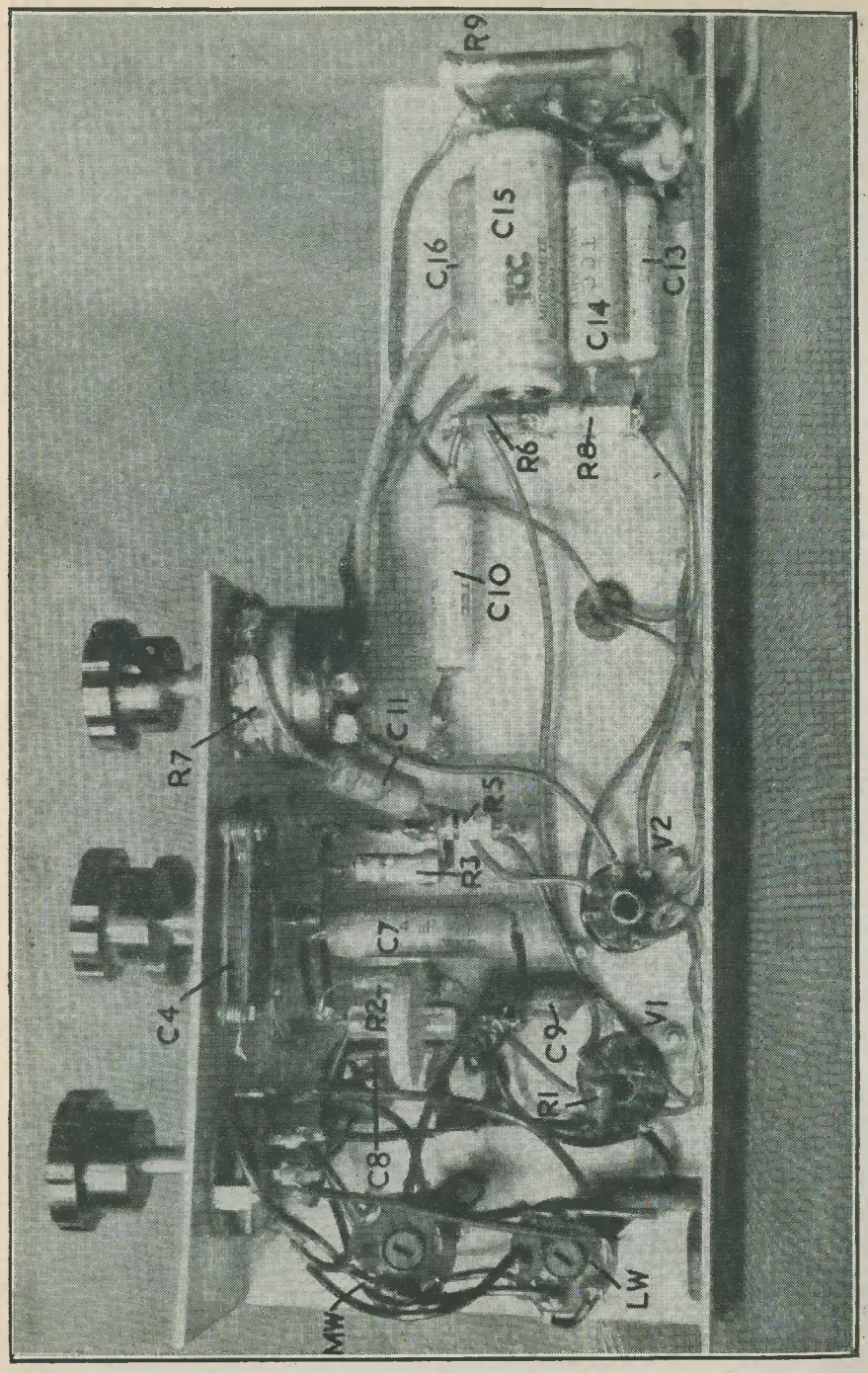


FIG. 1
The circuit of the Easi-Build

Note. In the above circuit one side of the heater wiring should be connected to chassis. The tap on L1 is brought out to tag No. 2 on the coil former.



The Easi-Build—above chassis layout



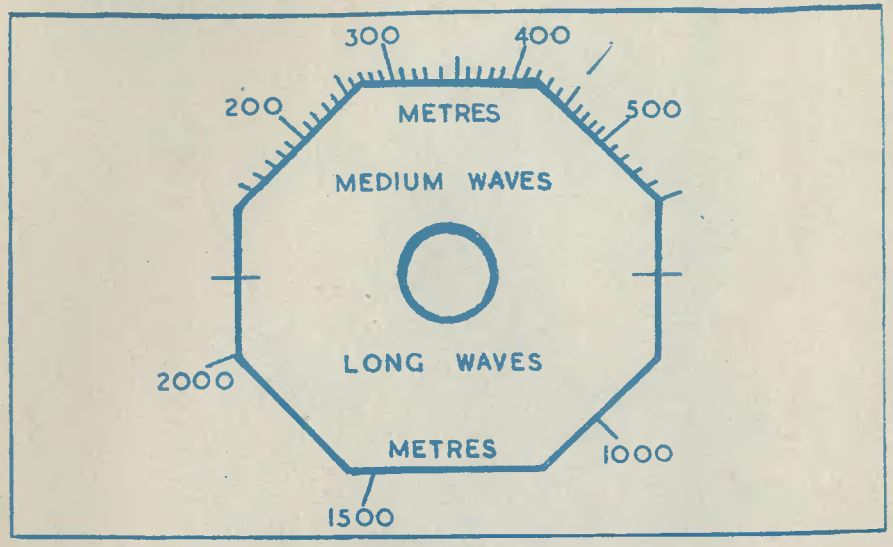
The Easi-Build—layout underneath

The volume control is fed from the anode of V1 (b), this being half of the double-triode, V1. V1 (b) acts solely as an AF amplifier, AF input to its grid being applied via C9. V1 (a) is a leaky-grid detector, and has the additional refinement of being fitted with a reaction circuit. Whilst reaction is not usually needed with the receiver when listening to local stations, its availability has the considerable advantage of improving selectivity when it is desired to pull out a weak signal from an interfering background. A simple RF decoupling circuit consisting of the RF choke, L7, and the condenser, C8, assists in providing smooth reaction and in preventing RF from being passed to later stages in the set. A simple AF decoupling circuit (C7, R3), is also provided.

A conventional leaky-grid arrangement is provided at the grid of V1 (a), the values of C6 and R1 being specially chosen to ensure smooth reaction.

Two aerial input circuits are provided, one being a tight coupling which connects to the grid winding itself of each coil, the other being a loose coupling which is taken to a separate aerial coupling winding. The tight coupling connects to the point marked "Ae 1" in the diagram and is intended for use with very short aerials. Using this connection, an aeria of four or five feet will give full loudspeaker volume in most localities from the local medium-wave Home station and from the Light programme on 1,500 metres. This facility is particularly attractive since it allows the receiver to be treated as a portable. The looser coupling (Ae2), is intended for a larger and more conventional type of aerial. In many cases, excellent results will be given with this terminal using an aerial of the "bed-springs" variety. No earth connection is needed, and none should be used unless conditions of heavy interference necessitate it. This point is dealt with later on in these articles.

It will be noted that a relatively large value of capacity, C2, is connected across the aerial coupling coils. This condenser is fitted to ensure that the resonant point of the coupling coils lies well outside the band to which the receiver is switched. The coupling achieved is then almost entirely aperiodic. The fitting of this condenser has the further advantage of lowering the effective input aerial impedance of the receiver, with the result that highly differing aerials result in hardly any variation in reaction or tuning adjustments.



This dial should be cut out and pasted on thin card which may then be fastened on to the Metal Backing Plate

Live Chassis

It will be appreciated from Fig. 1 that the chassis of the Easi-Build is "live" to one side of the mains. Although live chassis are not at all new to the home-constructor, emphasis is placed once more upon the fact that the appropriate precautions should always be observed when the chassis is handled. The only safe method of ensuring that the chassis is disconnected from the mains when it is desired to work upon it is to remove the mains plug from its socket. Professional engineers observe this precaution, and it is a very wise measure.

Components List

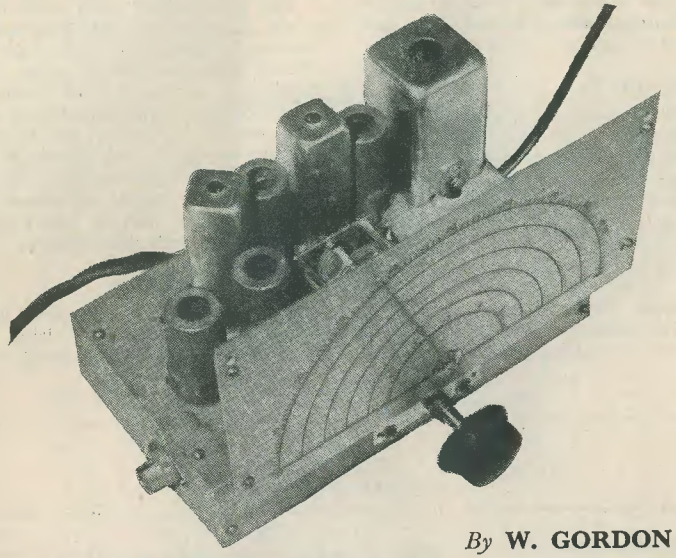
This month's article is intended to serve as an introduction to the Easi-Build. It also includes a list of the components needed for building the receiver. All the more important components are specified by the manufacturer's name and reference number; these being the types which will fit into the chassis layout to be described in the succeeding article. The resistors have not been specified under manufacturer's names as, so long as the wattage ratings recommended are followed, standard components will fit comfortably into the chassis. If they are difficult to obtain, however, the two eighth-watt resistors, R1 and R4, may be replaced by quarter-watt components; although this will make their mounting slightly more difficult. The condenser C2 has rather an "awkward" value, and it may be replaced, if desired, by two 400pF condensers in parallel.

The loudspeaker used with the receiver is not mounted on the chassis, although a cut-away is provided for it. The type finally chosen depends mainly upon the cabinet employed; an easily built cabinet will be described later. The impedance of the voice coil should, however, be 3 ohms. The speaker used with the prototype and illustrated in the photographs is the W.B. Stentorian 3½" model, reference S3.57, and this component may be relied upon to give good results with this receiver.

Next Month's Article

The next article in this series will describe the chassis-work and wiring procedure needed for building this simple receiver.

FREQUENCY MODULATION TUNER UNIT MODIFICATIONS



By **W. GORDON**

MANY READERS HAVE BUILT THE FM TUNER Unit described in the July issue of this magazine, with good results. Since then, various improvements have been effected which will be discussed in this article.

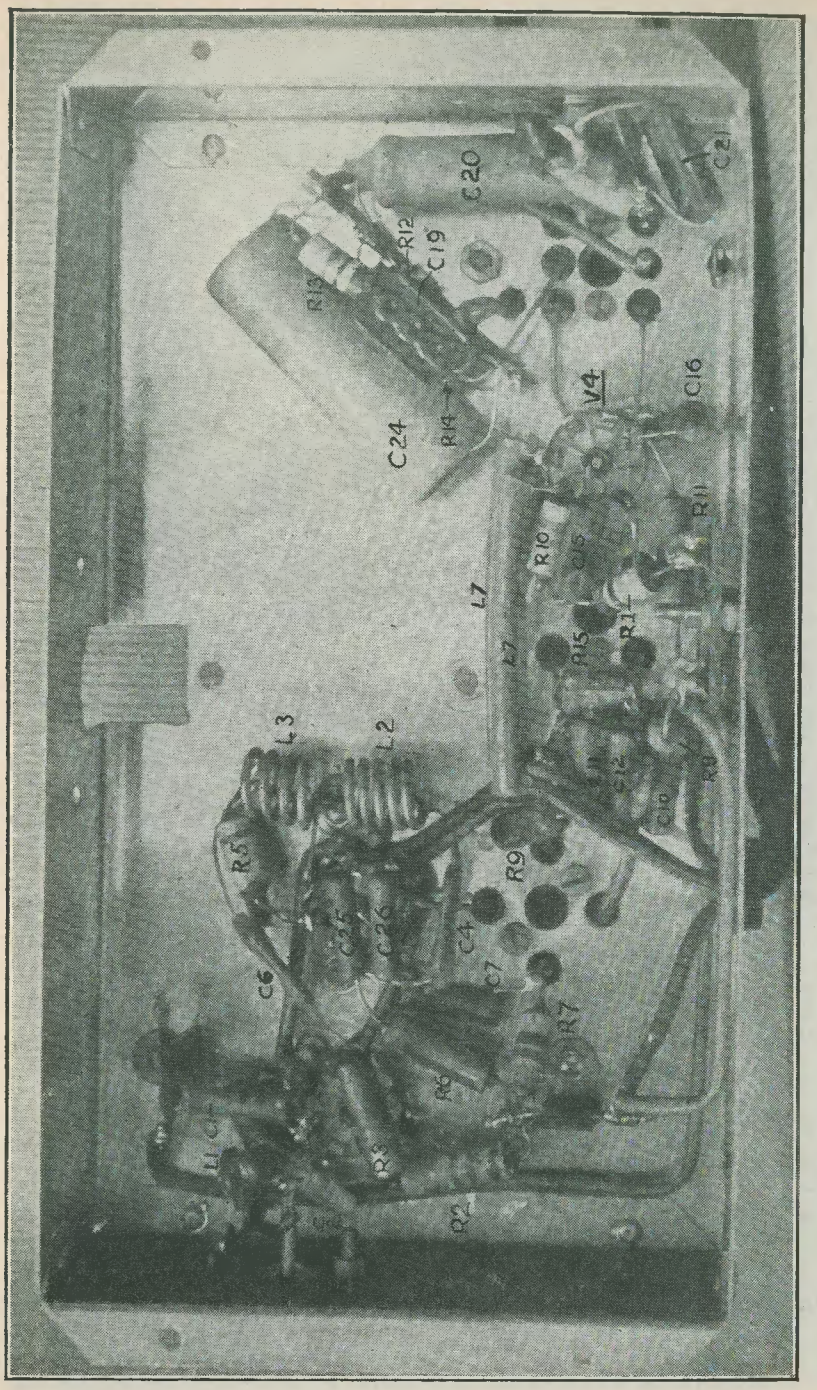
The Frequency Changer circuit has been altered because it was found that, in the old circuit, some valves were prone to spurious harmonic oscillation. The new circuit, given here, is easier to align and is very stable. It is, in effect, a tuned-anode tuned-grid oscillator, and therefore no critical coupling is required between L2 and L3, and these windings should be spaced $\frac{1}{4}$" apart. L3 has now only 4 turns instead of the original 5, and this coil is tuned by parting the turns to give a maximum limiter grid voltage reading. L2 is the main frequency controlling circuit and, as this has no grid capacity connected across it, the oscillator is inherently very stable.

When measuring the limiter grid voltage, a 100kΩ resistor should be soldered to the junction of C15 and R10. If a long lead is connected to this point, the tuning of L5 secondary is altered. The 100kΩ isolation resistor prevents this. It has also been found that a 47kΩ $\frac{1}{4}$W resistor across the anode circuit of L5 improves the balance of the response curve in most cases.

If the audio output is low, check carefully that C24 is connected the right way round. The positive of the condenser should be connected to the red end of the crystal. Low output may also be caused by poor crystals. Some cheap crystals of a well-known make have been found quite effective. Others provide a heavy damping on the ratio detector coil, and spoil the linearity. G.E.C. crystals type GEX34 are very suitable, or alternatively make sure that the crystal has been tested for this application before purchasing.

A diode in the ratio detector is not recommended because IF harmonic feedback occurs along the heater line. This becomes more prevalent when a floating heater supply is used. For the same reason, when using a floating heater supply, chokes are required between V3 and V4. The specification of the chokes is as follows: Using $\frac{1}{8}$" diam. former, wind on as many turns as possible of 26 swg enamelled to make a coil length of $1\frac{7}{8}$". This harmonic trouble can easily be recognised by the fact that dead spots occur at harmonics of the IF – 85.6, 96.3 and 107 Mc/s.

Without the aerial connected, there should



New layout when using floating heater supply—compare with photograph in July issue, page 717

be a quiet rushing noise which does not change as the tuning is altered. Whistles may be heard; these will be caused by the old cathode tap oscillator, and the employment of the new circuit will overcome this.

From the photograph it may be seen that the layout has been altered to leave room for the heater chokes L7 between V3 and V4.

If one side of the heater is earthed, as in the original circuit, then no heater chokes are necessary and only one condenser, C25, is required, connected from the heater of V2 to chassis.

There was also one circuit error in the ratio detector. The bypass condensers C22 and C23 are no longer connected to chassis. As previously drawn, a very slight loss of top response may have been experienced.

The aerial coil slug is of the same type as used in the other coils, but may need cutting shorter. The diameter of the slug is $\frac{5}{16}$", and it has a 2-BA thread moulded on it. The length should be cut to $\frac{1}{4}$", and the wire wound in the thread.

RADIO AMATEURS EXAMINATION COURSE

Dear Sir,

I am pleased to inform you that once again we have made arrangements with the Islington L.C.C. Mens' Evening Institutes for an official course of instruction for the RADIO AMATEURS EXAMINATION to be held at the Grafton School, Eburne Road, Holloway, N.7 (one minute from the "Nags Head") during the coming winter months in conjunction with the society.

Classes, with Morse instruction to the required speed, will be held on Monday evenings at 7.0 p.m. – 10 p.m., commencing Monday, September 27th (enrolment week Sept. 20/24th) – instructor: Mr. A. Perry (G3DKX) – fee 10/–.

Application, in the first instance, should be made to the GRAFTON RADIO SOCIETY Hon. Secretary – Mr. A. W. H. Wennell (G2CJN), 145 Uxendon Hill, Wembley Park, Middlesex.

Component List

Resistors

R1	100kΩ
R2	4.7kΩ ½W
R3	6.8kΩ ½W
R4	150Ω
R5	470kΩ
R6	47kΩ ½W
R7	4.7kΩ
R8	4.7kΩ ½W
R9	150Ω
R10	47kΩ
R11	47kΩ ½W
R12	100kΩ
R13	10kΩ
R14	10kΩ
R15	47kΩ

Resistors all ¼W unless otherwise stated.

Condensers

C1	5,000pF ceramic
C2	1,000pF ceramic
C3	5,000pF ceramic
C4	33pF silver mica
C5	33pF silver mica
C6	47pF silver mica
C7	5,000pF ceramic
C8	15pF silver mica
C9	15pF silver mica
C10	5,000pF ceramic
C11	5,000pF ceramic
C12	5,000pF ceramic
C13	15pF silver mica
C14	15pF silver mica
C15	47pF silver mica
C16	5,000pF ceramic
C17	15pF silver mica
C18	47pF silver mica
C19	300pF mica or ceramic
C20	0.05μF paper
C21	500pF mica or ceramic
C22	300pF mica or ceramic
C23	300pF mica or ceramic
C24	8μF 150V electrolytic
C25	2,000pF ceramic
C26	2,000pF ceramic
VC1-2	Split stator 25pF+25pF, Jackson Bros. type U101.

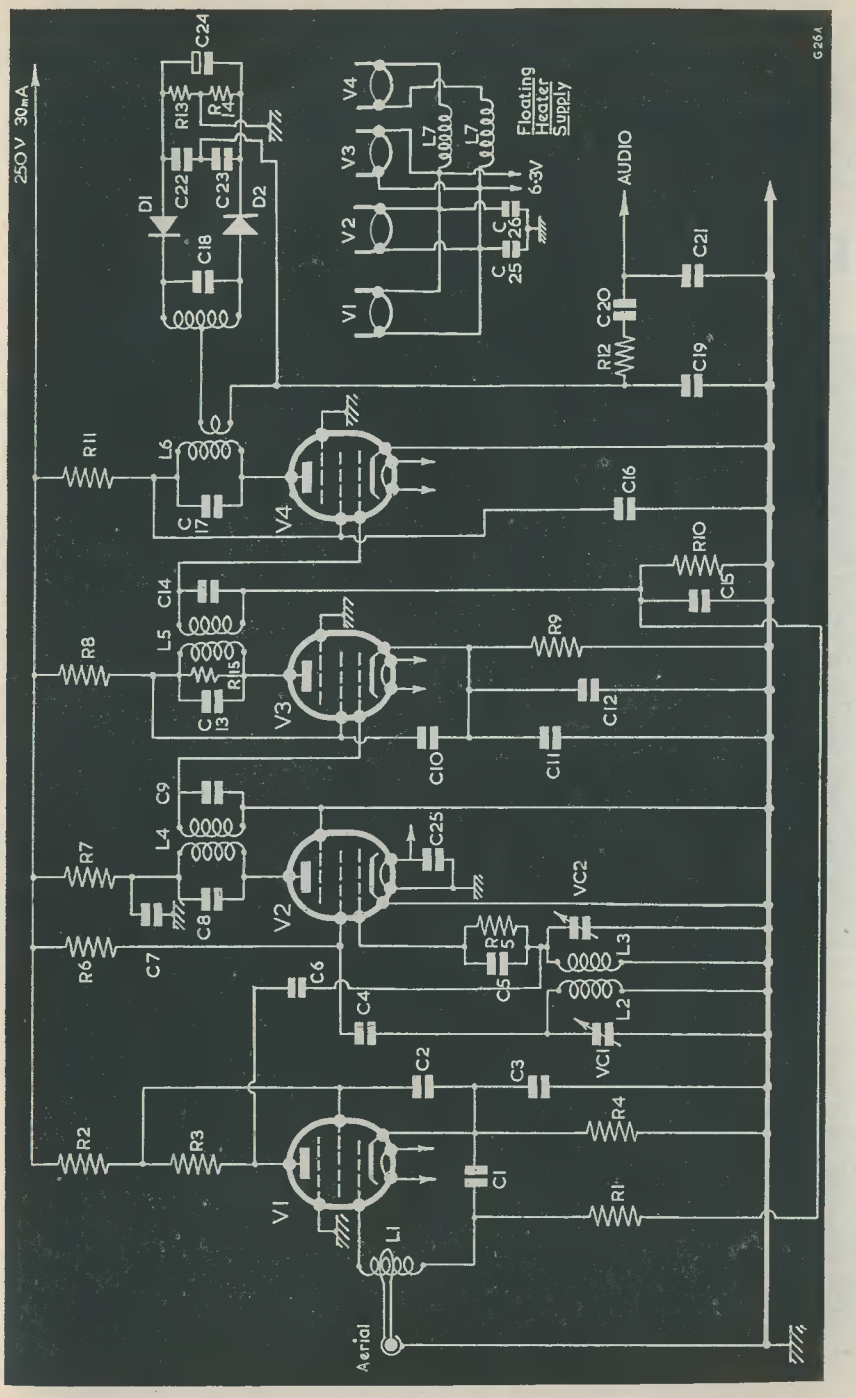
Miscellaneous

Tag Strips

Dial Jackson Bros., full vision drive type 2154 fitted with scale type 4838

Valves V1, Osram Z77
V2, Osram Z77
V3, Osram Z77
V4, Osram Z77
V5, G.E.C. GEX34 germanium diodes.

Chassis; Coils, complete with condensers. G. Blundell, 7 Sunnyside House, Child's Hill, London, N.W.2.



Modified circuit of the FM tuner unit

THE DESIGN, CONSTRUCTION CALIBRATION and use of SIGNAL GENERATORS

Part 1. *By* **R. J. STEPHENSON**

IN THE HOME CONSTRUCTOR'S WORKSHOP, one of the most important items of test equipment is usually noticeable by its absence.

I refer to a good signal generator. A good commercially made signal generator is an expensive item. Most enthusiasts who build one are usually disappointed with the performance, but it is hoped to show that a good signal generator can be made and calibrated in the home workshop, once the basic principles have been understood.

In the course of these articles, a circuit that the author has used satisfactorily for some time will be given, the purpose being to give the average reader some ideas on which to base his own individual design.

First, let us examine the requirements of a signal generator. These are:—

(1) Freedom from Frequency drift of the RF oscillator.

(2) An AF oscillator capable of modulating the RF oscillator up to about 30%.

(3) The AF oscillator should operate on about 400 c/s and be of good waveform.

(4) The frequency of the RF oscillator should be unaffected by the audio modulation.

(5) The complete instrument must be carefully screened to prevent unwanted direct radiation.

(6) The range of frequencies must cover all the usual ones (including TV), but not necessarily on fundamentals.

(7) If mains operated, the hum must be negligible.

(8) The output need only be of the order of a few volts, but an attenuator should be fitted.

(9) For convenience, a switch should select the type of output required, i.e., RF, Modulated RF, or AF.

Many single-valve signal generators have been described in the past, but a glance at the requirements will show that it is rather a lot to expect one valve to do. It is my experience that such circuits usually fail in requirements 2, 3 and 4.

The most important requirement for the RF oscillator is its frequency stability (i.e., its freedom from drift). The following points must be observed:—

(1) The internally generated heat must be kept down to a minimum.

(2) The components forming the tuned circuit must be of a high "Q".

(3) The Ra of the oscillator must be high.

(4) The loading of the tuned circuit must be light.

(5) Some oscillators are more prone to frequency drift than are others.

Let us examine these points in more detail.

(1) *Internally Generated Heat.* If the tuned circuit is subjected to changes of temperature, its resonant frequency will change. A change in temperature will cause both the coil and condenser to expand or to contract, thus altering their values. Whilst compensating condensers with a negative temperature co-efficient can be used, it is better to reduce the heat to a minimum by placing resistors and valves (e.g., rectifiers) as far away as possible from the tuned circuit. I prefer to use a separate power pack, kept well away from the signal generator proper.

(2) *The "Q" of the Tuned Circuit.* Without going too deeply into mathematics, the expression for the resonant frequency of a tuned circuit is usually given as

$$f = \frac{1}{2\pi\sqrt{LC}}$$

This formula is only approximate, since it takes no account of the resistance of the coil or the condenser leakage resistance, or the Ra of the valve (if used as an oscillator). The full equation contains an expression taking these resistances into consideration.

From this it can be shown (a favourite phrase with mathematicians!) that the higher the "Q" of the components in the tuned circuit, the better the frequency stability. It is beyond the scope of the modest workshop to wind coils to exact specifications, especially the lower (RF) frequency ones, but several manufacturers produce suitable inductors. (The Teletron Co. will supply coils to individual specifications – Ed.). The tuning condenser should be of the best type available, preferably with ceramic insulation.

(5) *The Oscillator Valve Circuit.* The type of circuit used must be given careful thought. Some of the more common types of oscillator are listed below, with a few notes on their characteristics.

Tuned Grid. This circuit is easy to build and works well, it is reliable in operation, and suitable coils are readily available – but it is difficult to load. It can be series- or parallel-fed.

Tuned Anode. Very similar to tuned grid.

Meissner Oscillator. Very stable, but

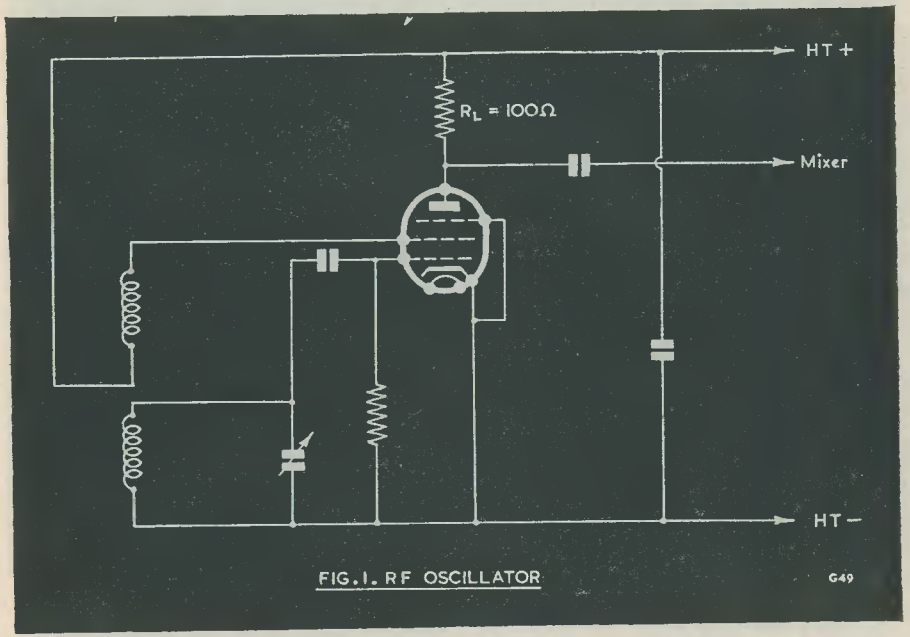


FIG. 1. RF OSCILLATOR

(3) *The Ra of the Valve.* The Ra of the oscillator valve also has some effect upon the frequency stability. Briefly, the higher the Ra of the oscillator valve the better the stability will be. For this reason, a pentode with an anode resistance of about 1MΩ is preferred to, say, a triode whose anode resistance is much lower.

(4) *The Loading of the Tuned Circuit.* If the output of the signal generator is taken from the oscillatory circuit, either via a separate winding on the coil former or a tapping on the grid coil, the load will effectively lower the "Q" of the tuned circuit – which is what we are trying to avoid (see section (2)). The loading must be taken from some point other than the tuned circuit. difficult to load. Suitable coils are not readily available commercially.

Hartley Oscillator. The performance of this circuit is good, but it is not easily loaded. Commercial coils are not readily available with a suitable tapping point (see note re The Teletron Co. above – Ed), and there is the practical difficulty that neither the rotors nor the stators of the tuning condenser can be earthed. It can be series or parallel-fed, or can have a cathode tap.

Colpitts Oscillator. This is very stable in operation, but again is not easily loaded. Furthermore, the tuning condenser consists of two units in series, which reduces the tuning range unless high value condensers are used. The output is practically free

from harmonics, which is a decided disadvantage from our point of view.

Tuned Anode Tuned Grid (TPTG) Oscillator. This circuit is not suitable for continuous tuning.

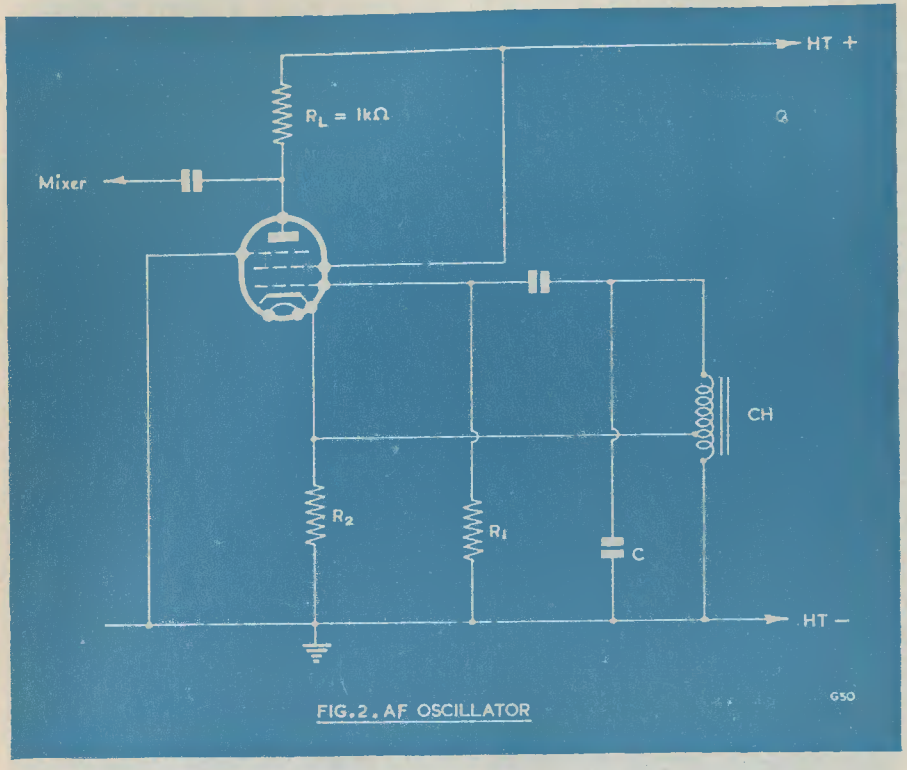


FIG.2. AF OSCILLATOR

Common Anode Oscillator. As the TPTG.

Common Grid Oscillator. As the TPTG.

Franklin Constant Frequency Oscillator. As its name implies, this circuit is very stable in operation, but it is not easily loaded and the value of the coupling condensers is rather critical for any particular frequency. This last makes it difficult to achieve satisfactory operation with continuous tuning.

Electron Coupled Oscillator (ECO). This is a very stable oscillator, and if the load is taken from the anode it has little or no effect upon the oscillatory circuit. Its second and third harmonics are strong – indeed its fourth and fifth harmonics are of useable strength – and the ECO is capable of being continuously tuned.

The Screen Coupled Oscillator. Although no personal originality is claimed for this circuit by the writer, he has not seen it described before. It has been used for some time now in a signal generator, with excellent results. Using coils which can be readily obtained, it is stable in operation, and the load, if taken from the anode, has no appreciable effect upon the tuned circuit, since it is screened from this by the suppressor grid. Also, the load resistor of a pentode has very little effect upon the anode current (a pentode can be used as a constant current device – hence its high Ra).

The circuit is given in Fig. 1. It will be noticed that the anode load is unusually low, but if a larger output is required the value of the resistor may be increased. The reason for the low value of 100Ω will be explained later.

Let us now consider one or two points about the audio oscillator for the modulation of the RF voltage. First, and most important, it must approach as nearly as possible a pure sinusoidal waveform, i.e., it must be substantially free from any harmonic content. An audio oscillator of poor waveform working on, say, 400 c/s can have harmonics as high as 200 kc/s. If this were used to modulate the RF it would produce "whiskers" extending to 200 kc/s on either side of the carrier frequency. This is most undesirable, hence the need for a pure modulating waveform. The actual frequency (fundamental) of the oscillator is usually between 100 c/s and 1 kc/s, but it is in no way critical. A value of about 400 c/s is usually employed, since this is a standard test frequency (ω=2,500) and also a pleasant note to which to listen.

Also, the output must be capable of being adjusted to give the necessary modulation depth. The circuit given in Fig. 2 is most useful. Thecondenser C is of such a value (found by trial and error) as to cause the tapped choke (Ch) to resonate at about 400 c/s. A variable resistor of low value (say 5kΩ) is connected in place of R2, and reduced in value until the circuit just oscillates, when the waveform will be very nearly sinusoidal. The variable resistor is then removed, its resistance measured, and replaced by a single fixed resistor of like value (or combination of resistors to this value). Incidentally, it is interesting to observe the output on an oscilloscope as R2 is varied.

The load resistor R1 is chosen to give the required output; in the instrument to be described it was 1kΩ, as will be later explained. The tapped choke Ch can very well be an intervalve transformer connected as in Fig. 3.

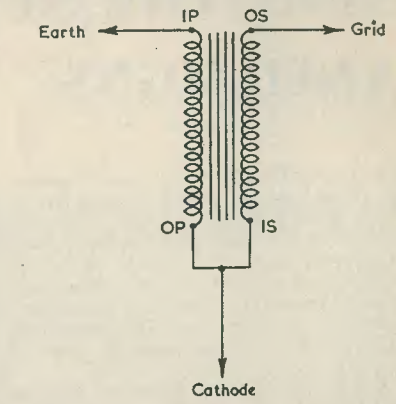


FIG.3. AF TRANSFORMER CONNECTIONS

GS1

Many other types of audio oscillator can be used, but this one – it is an ECO – is very flexible.

(To be continued)

COURSES OF INSTRUCTION

EAST LONDON R.S.G.B. GROUP

THE FOLLOWING CLASSES ORGANISED BY THE EAST LONDON R.S.G.B. GROUP in conjunction with the Essex County Council are available for all those interested in Amateur Radio irrespective of whether they are members of any Society or of the general public.

1. RADIO AMATEUR EXAMINATION COURSE

Wednesday, 7.30 p.m. to 9.30 p.m.

Eight months course for those intending to take the examination.

2. MORSE AND CODES OF PRACTICE

Monday, 7.30 p.m. to 9.30 p.m.

Six months course for those who wish to learn Morse up to the G.P.O. requirements for an Amateur Licence. Arrangements have been made with the G.P.O. for those who, in the opinion of the Masters, have reached the required speed, to be tested at the College by a representative of the Post Office.

The venue for the above classes is the Ilford Literary Institute (High School for Girls) Cranbrook Road, Ilford, Essex. It is adjacent to Gants Hill Station on the Central London Tube, and buses pass the door. The fee for any one course for those living in the Essex County Council area will be 10/–. For those attempting both courses, the fee will be 17/6. Students from other parts of London will be admitted as out-County Students provided the local authority is notified.

ENROLMENT NIGHTS

September 6th, 7th and 8th.

CLASSES COMMENCE

September 20th.

These classes have now been running for seven years, during which period over 100 students have passed the R.A.E. examination. Those interested should drop a line to C. H. Edwards, G8TL, 10 Chepstow Crescent, Ilford, for reservations.

USING THE NEW PANEL-SIGNS

With the introduction of "Panel-Signs," designers and constructors of home-built equipment may now purchase cheaply, for a few shillings only, panel fixtures which previously would have cost considerably more. Moreover, these may easily be adapted to the particular purchaser's requirements and are not, in themselves, difficult to affix to any panel or piece of equipment.

It is not the writer's intention here to present a list of the packet contents, or indeed to state the method of mounting; details are given in the advertisement on page 113 of this issue, and in the case of panel fixing, instructions are clearly given, on the reverse of every package, for water-slide or varnish fixing, whichever is preferred. Within the scope of this article, it is the many uses and methods of adaptation which will be discussed in order to give readers some ideas on how best to utilise these transfers – which are, in themselves, a new departure for the home constructor.

Receivers and Amplifiers – Set No. 1

First to note here is the large full vision dial, measuring some 6 inches across and 4 inches deep. This has a provision for five ranges, and each range is clearly numbered along the bottom. Once having been affixed correctly to the panel, it may be calibrated with a signal generator; a note being taken of the outer scale reading (which is accurately marked with 100 divisions), this considerably assisting with the accurate calibration of the receiver. The dial itself may either be marked in "Block" form, i.e., the various broadcast bands being filled in solid line, or it may be marked in kc/s and/or Mc/s and/or metres – your choice entirely and not that of the manufacturer, as is the case with most commercial scales. Whether the coils are home-wound or commercial items does not matter one iota – the difficulty of matching frequency coverage of the former type of coil with a standard commercial scale does not now apply.

Dial marking is simple – and this applies to the whole range of these transfers – it merely requires a little patience and a supply of ordinary indian ink together with a mapping pen.

The transfer, once in position, should first be allowed to dry thoroughly. This having been done, calibration and dial marking may be safely commenced. The tuning condenser knob, or spindle, should have affixed to it a length of thin perspex sheet some 2¾ inches in length (measuring from the spindle centre), and this should be scored along the centre, afterwards filling in with indian ink. The outer scale readings may now be read against known signal generator readings, or those of a frequency sub-standard. Having noted these readings, it is a simple matter to mark the dial on the chosen scale line, e.g., band 4, with the correct frequency. The whole full vision dial may be easily and accurately calibrated in this manner within a very short period of time. Note that it is not essential to use direct drive; reduction gearing or a cord drive may be employed – the only proviso is that the condenser spindle should project through the panel.

Should the dial prove to be too large physically for any particular panel, it may, of course, be cut to a smaller size, within reason, with a sharp pair of scissors prior to mounting on the panel. The decorative top portion and some of the lower part may be omitted in this manner if so desired.

It should also not be overlooked by the user that various colours of indian ink, say one colour for each band, or perhaps red for broadcast and blue for amateur bands, etc., may be utilised. The possibilities and variety of markings are many and varied indeed.

The control panels, i.e., those used with potentiometers, switches and condensers, are self explanatory, but a few words on their possible uses will not come amiss here – especially for those who are beginners in radio construction.

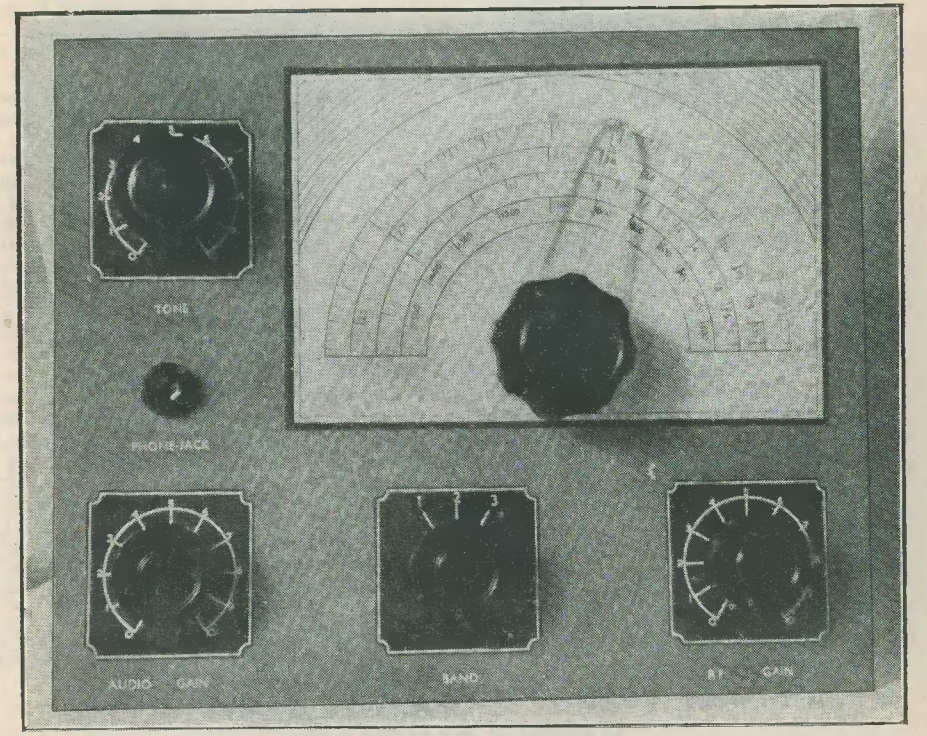
Those with 180° rotation are for use with small variable condensers such as, in a TRF, *Reaction*, *RF Trim*, *Aerial Coupler*, or even *Bandset*; in a superhet – in addition to the aforementioned, *BFO*, *Crystal Phasing*, *Oscillator Shift*, etc. For potentiometers, in a TRF – *Reaction* (where screen HT is varied), *Tone*, *AF Gain*, *RF Gain*, *Audio Filter*, etc. For Superhet, apart from those previously mentioned, *IF Gain*, *Noise Limiter*, *Variable Selectivity*, etc.

Appropriate transfers for Yaxley type switches are also included, and these may be marked in accordance with the constructor's wishes from the wording included. Mentioning only a few uses to which these may be put, there are *Bandswitch* (marked with the selected frequency coverage from the figures provided), a switched *Tone Control*, *AVC or BFO On/Off* control, switched *Selectivity*, etc. As before, these may be cut into any desired size, within certain limits, by means of scissors. Any particular white markings not required may be omitted by the simple expedient of blacking them out with indian ink – a most useful point to remember. The name of the control may be placed either above, at the side of, or below the panel, whichever is the more convenient or best suits the panel layout.

Finally, as a point worth noting, it should be borne in mind that these "Panel-Signs" may be used with any existing transfer wording which the constructor may have on hand.

Test Instruments – Set No. 2

This set contains, in addition to the wording, lettering and figuring commonly used on test equipment, a useful set of electronic symbols such as μ, Ω, +, –, %, and various other markings. Potentiometer, Yaxley type switch and variable condenser control panels are included. The uses to which these may be applied are almost too numerous to mention here. Almost every unit of test equipment contains a varied selection of these controls. As in Set No. 1, these transfers may be altered either by blacking out with indian ink, should erasures be required, or by the addition of wording and/or symbols should these be considered necessary.



Panel for an all-wave receiver, showing the workmanlike and professional appearance obtainable with "Panel-Signs"

Two dials are included in this set, and these measure 4 inches long by 2¾ inches deep. They are both marked from 0 to 100 and provision is made to accommodate four separate ranges.

Whilst "Panel-Signs" are self-fixing as supplied, the use of fixing varnish is recommended for best results on crackle and other rough surfaces.

These dials are of the full vision type, and an interesting feature here is that two may be "married" to form a complete circular dial calibrated to a total of 200 divisions, i.e., 100 to the left and 100 to the right. This is especially useful for those about to construct a bridge and no doubt other uses will suggest themselves to readers.

General

The new "Panel-Signs" are, of course, permanent paint transfers, and it is a good point to remember that added protection may be imparted by treating these, when once dry, with a coat of varnish (Panel-Signs Transfer Fixing Varnish is recommended), which may be obtained from your local radio supplier. The use of clear nail varnish is not recommended, as this soon becomes brittle and easily chips.

Set No. 1, previously referred to, is also equally applicable to amplifiers, suitable wording and control panels being provided. "Panel-Signs" are an indispensable aid to the home constructor; nothing like them have ever before, to the best of the writer's knowledge, been offered to enthusiasts in this country. They most certainly fill a long-awaited need, and, regarded in the same manner as most constructors view their components, they are very good value for money indeed. When one considers the cost of dials and other panel fixtures of the type to be found currently on the market, these new components, for that is what they are, represent a great saving. And as for adaptablity – if they prove to be too large for the scheme of things, then cut them down; calibrate and mark them as you will; erase such markings as are not required; add the chosen wording or the figures, juggle with the symbols and even choose your own pet colour scheme for the tuning dials – what more could the discerning radio enthusiast desire of any component?

HAMFEST IN HOLLAND

The V.R.Z.A., the Radio Society of Transmitting Amateurs in Holland, will celebrate its annual hamfest this year in a beautiful camp site in Voorthuizen, half-way between Apeldoorn and Amersfoort, on the week-end of the 25th and 26th of September.

Accommodation will be in bungalows, and all licensed amateurs, S.W.L.'s and their families will be very welcome.

There is an extensive programme of entertainment with dances, films and cabaret, together with all kinds of radio lectures, a D.F. competition, an exhibition of modern equipment, and demonstrations.

The cost for the whole week-end, including all meals and sleeping accommodation, is only 10 guilders, or one pound.

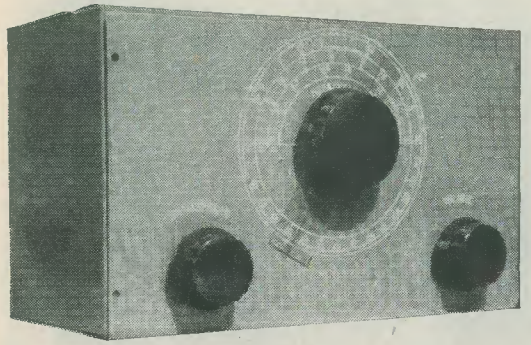
Further information will be gladly given by

PAOXE, Claes de Vrieselaan 153 a Rotterdam, Holland,

who will also be pleased to accept bookings.

This is an ideal occasion to see the other end of your contact, and as an extra attraction we may add that besides door prizes to every 25th visitor, the visitor who came farthest will get an extra prize.

BUILDING THE RCS BATTERY RECEIVER*



Part 3

A THREE-VALVER

By **JAMES SINCLAIR**

IN THIS ARTICLE IS DESCRIBED HOW TO add the third and last valve, together with the associated components required, to make this little set into a three-valve receiver. As such, it is capable of a very good performance indeed. Being a battery set, the background noise is very small, almost unnoticeable in fact, and this means that many stations are audible which might otherwise go unnoticed.

With a set of this nature, it is advisable for the beginner to spend some time getting thoroughly used to the receiver and to develop some skill at operating, particularly on the Short Waves. Here, with the world at one's fingertips, many happy hours may be spent listening to the various transmissions put out by the many powerful international broadcasting stations. For the guidance of those interested, Table 1 should be consulted. (*World Radio Handbook*, obtainable from us, gives a complete list of these stations, together with times of transmission, call signs, interval signals, station addresses etc., – Ed.). The Amateur Bands should also be "watched" for interesting transmissions between Amateurs (See Table 2).

The simple and comparatively cheap receiver described places within the reach of every beginner the delight and thrills of these bands, i.e., the Amateur and Broadcast Short Wave frequencies. These, together with the Medium Waves, provide most of the broadcasts likely to be of interest.

Wiring Instructions

STEP No. 1. Disconnect one end of R2 which goes to Yellow on phone socket, and solder a length of Green flex to this end of R2, and then push Green flex through rubber grommet on rear of chassis.

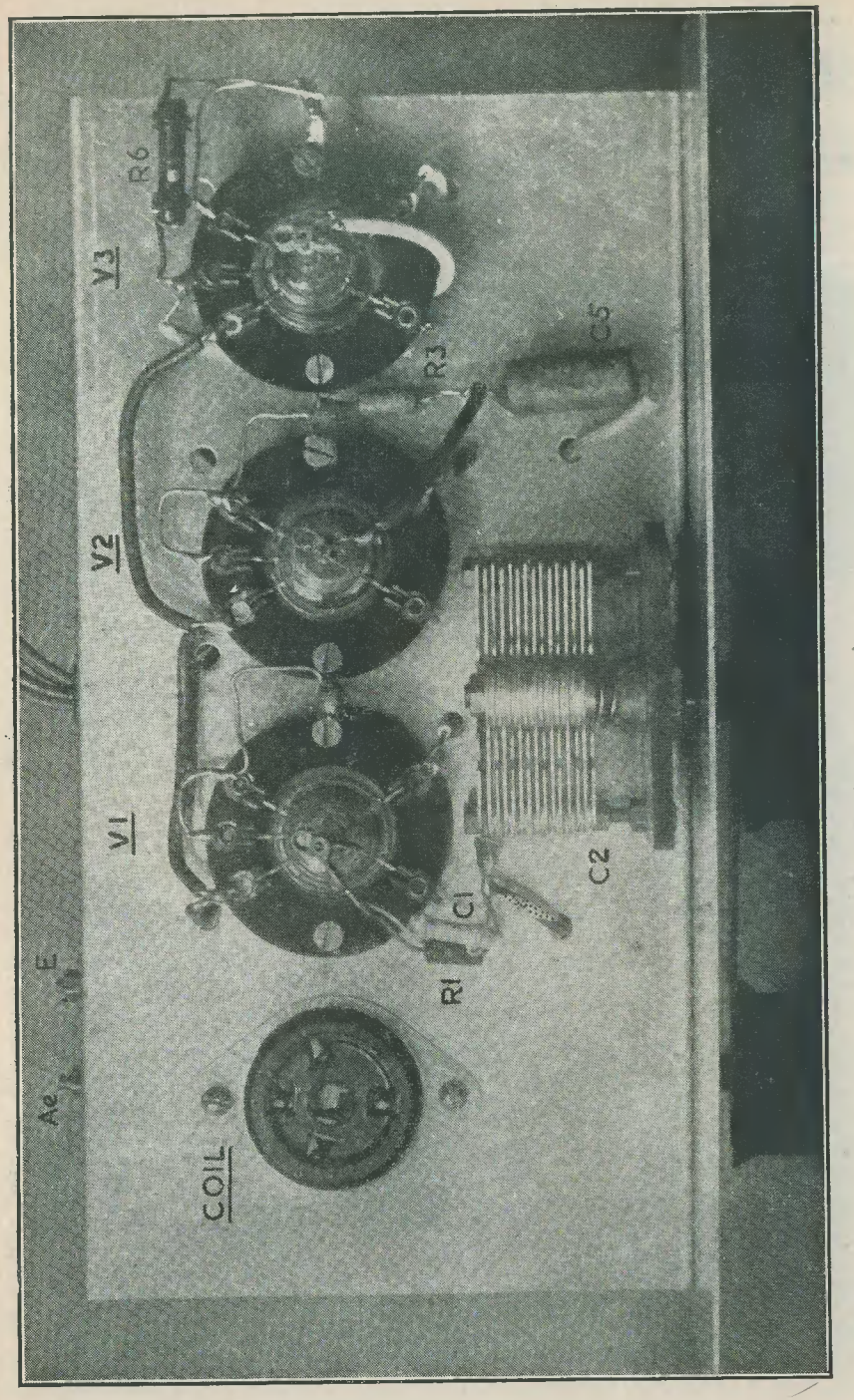
,, No. 2. Disconnect wire that goes to Red on phone socket, and then connect this wire to one end of C6 and one end of R5.

,, No. 3. The other end of R5 goes to Yellow on phone socket.

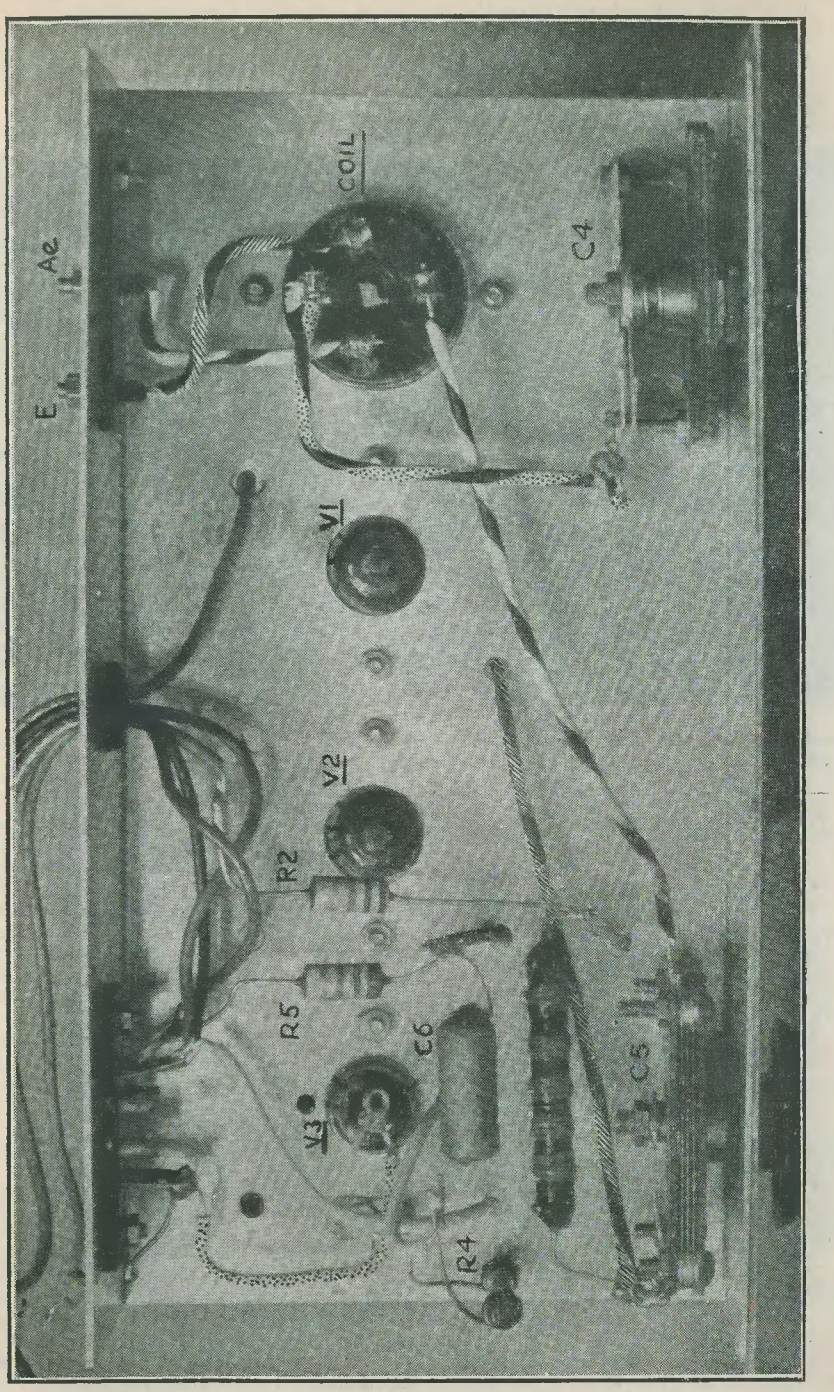
,, No. 4. The other end of C6 goes to one end of R4. The other end of R4 is soldered to earthing tag fitted under nut which holds valveholder No. 3 in place.

,, No. 5. To the junction of C6 and R4, fit a short length of wire and push through chassis. At the other end of this wire solder one of the valve clips provided and fasten this to the

* *See advertisement on page 123.*



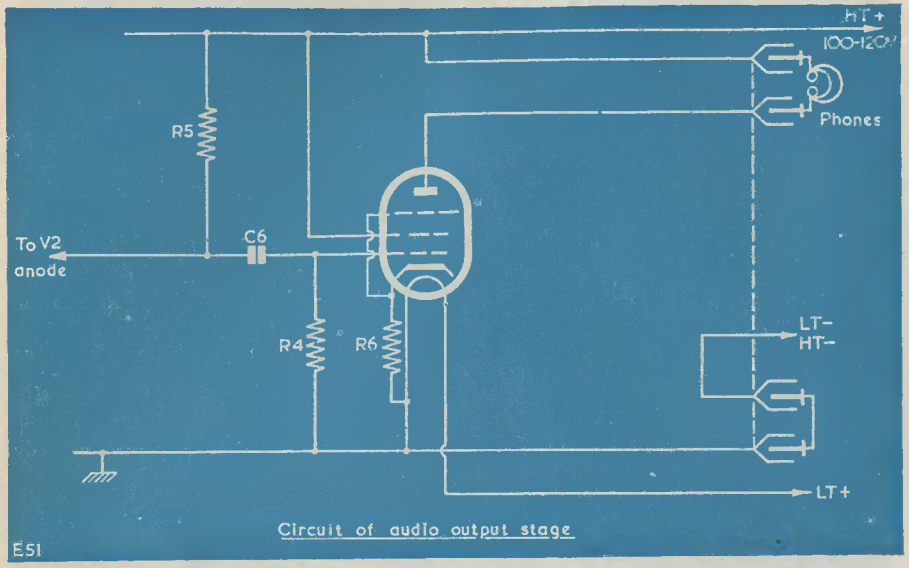
Above chassis view of the RCS three-valver



Below chassis. Identification of components

STEP No. 5. *cont.* grid connection which protrudes from the valve. (This is opposite to the Red end of the valve).

STEP No. 8. Solder one end of R6 to Red on valveholder No. 3 and other end to earthing tag fitted on valveholder.



Circuit of audio output stage

NOTE: *In the August issue there was an error in the circuit of the AF stage—R2 should have been connected to the other side of the phone sockets. The text and photographs were correct*

STEP No. 6. Join White on valveholder No. 2 to White on valveholder No. 3.

„ No. 7. With a short length of flex, join Gold and Red on valveholder No. 3.

TABLE 1
SW BROADCAST BANDS

Metre Band		*Metres*
49	6,000 kc/s to 6,500 kc/s	50 to 45.88
41	7,000 kc/s to 7,500 kc/s	49.85 to 40
31	9,370 kc/s to 10,000 kc/s	32.01 to 30
25	11,560 kc/s to 11,996 kc/s	25.92 to 25.01
19	15,000 kc/s to 15,640 kc/s	20.00 to 19.18
16	17,677 kc/s to 18,025 kc/s	16.97 to 16.64
13	21,460 kc/s to 21,750 kc/s	13.98 to 13.79

NOTE: Most of the short wave stations are to be found within these frequency limits. Many stations, however, work on lower frequencies, the most notable being the South American stations below 6,000 kc/s. These extend right down to as low as 2,340 kc/s or 128.2 metres.

TABLE 2
LF AMATEUR BANDS

Metre Band		
160	1,800 kc/s to 2,000 kc/s	"Top Band"
80	3,500 kc/s to 3,800 kc/s	"80 Metres"
40	7,000 kc/s to 7,300 kc/s	"40 Metres"
20	14,000 kc/s to 14,350 kc/s	"20 Metres"
15	21,000 kc/s to 21,450 kc/s	"15 Metres"
10	28,000 kc/s to 30,000 kc/s	"10 Metres"

STEP No. 9. Join Blue on valveholder to same earthing tag as R6.

„ No. 10. Solder length of flex to Yellow on phone socket and push through hole in chassis. Connect other end of this flex to Yellow on valveholder.

„ No. 11. To Red on phone socket, solder short length of flex at the other end of which is fitted the other valve clip provided. Secure this clip to anode connection which protrudes from valve (End of valve coloured Red).

This completes the actual construction of the three-valve receiver, but a change in the voltage supply is now required in order to get the best performance out of this set. The LT, of course, remains the same, but the HT+ should be increased and connected as follows:—Black to HT–, Green to HT+ 30-50 volts and Red to HT+ 100-120 volts. For the small outlay both in cash and time, this little set is the ideal medium for the budding radio enthusiast to gain both experience and some knowledge.

Query Corner

A *Radio Constructor* Service for Readers

Earthed Ion Traps

I have noticed that in a number of the more modern television receivers the ion trap magnet assembly is earthed to the receiver chassis by a short length of wire. What is the purpose of this connection?

F. Hamer, Cardiff

The use of higher EHT voltages for the picture tubes in television receivers is now standard practice, with most receiver manufacturers. Potentials in the region of 14-16kV are quite common, and are used to provide pictures of the best possible brightness and definition. The use of these high voltages introduce added complications to the receiver – one of these complications, although small but nevertheless significant, is that isolated parts in the vicinity of the tube can collect an appreciable electrostatic charge. This may in time build up to the point where it can flash over to some nearby component causing a burst of interference on the picture. The ion trap magnet assembly can collect such a charge either because of stray fields from points of high potential, or because of a small amount of leakage along the glass walls of the tube. This charge can be most unpleasant if the magnet is touched; and it may cause the operator to remove his hand very quickly, introducing the possibility of damage to a component. It is to prevent an occurrence such as this that many set manufacturers now earth the ion trap assembly, a procedure which can be recommended to the constructor.

Anti-Static Polish

There are a number of anti-static polishes at present on the market. Do you recommend the use of these on the screens of CR tubes to prevent the collection of dust on the glass?

E. Browne, Ilford

In order that it may be effective in preventing the formation of static charges, this type of polish must be a semi-conductor of electricity. By this means it prevents the building up of isolated electrostatic charges. It is particularly suitable for treating gramophone records and the plastic masks through which many television tubes are viewed. In preventing the formation of these electric charges, the polish also reduces the tendency for dust to be attracted to the treated object, which therefore requires much less frequent cleaning.

It is not, however, advisable to use an anti-static polish on the screens of television tubes because, whilst it may prevent the collection of dust, it will lead to a tendency for screen blocking. This effect is noticeable on many tubes when the receiver

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 matters will be accepted, though it will not be possible to provide complete circuit diagrams for the more complex receivers, transmitters and the like. Queries relating to ex-W.D. surplus or commercial equipment cannot be accepted.

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

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

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

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

is first switched on, the raster often appearing very distorted and not completely filling the whole screen area. The distortion

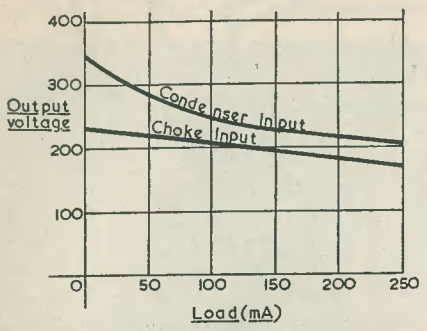


Fig.1
Comparative graphs for a 250V AC input to rectifier

E58

disappears after a minute or so, its disappearance being hastened if the picture brightness is turned up. This form of screen blocking is attributed to the formation of isolated charges on the screen phosphor, a trouble which may be aggravated if the outer glass of the tube is covered by a semi-conducting layer of polish.

If any readers have tubes which are giving trouble with screen blocking, the cure lies in wiping the screen and the clear glass around the sides of the screen with a cloth damped with methylated spirits. Care should be taken not to wipe over the cone of the tube if it is coated with graphite as this coating can easily be washed off.

Choke Input Filter

I have a power pack in an amplifier which is giving an output voltage too high for the valves in the output stage. Is it permissible to reduce the voltage by the use of a choke input filter in the HT smoothing circuit to avoid the use of large dropping resistors?

H. Lennox, Brighton

The choke input HT smoothing filter is indeed capable of providing a lower output voltage than the condenser input filter. To many designers this point may be a disadvantage; so to present the case fairly, the other properties of this type of filter must be considered. The choke input system has two main advantages. First, the inductance restricts the condenser charging current so that the peak current drawn from the rectifier is substantially reduced; this results in a much improved rectifier life. Secondly, the regulation of the power supply is very much better, a feature which is of particular importance if the power pack is required to supply a fluctuating load current. The regulation characteristics of the two types of filter are shown in Fig. 1, whilst in Fig. 2 the circuits of the three main variations of smoothing filters are shown. However, as with all circuits, optimum performance can only be obtained if the correct values of inductance and capacitance are chosen for the filter components.

The function of the choke is to raise the ratio of average to peak current, and in so

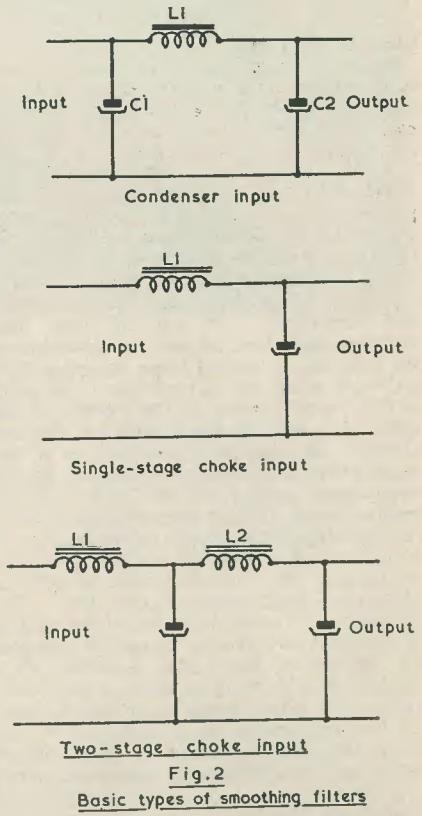


Fig.2
Basic types of smoothing filters

E59

doing it prevents the DC output voltage rising above the average value of the AC voltage fed to the rectifier. The choke can only perform this function properly if its value equals or exceeds the critical inductance which is given approximately by the formula:

$$L\,(\text{Crit}) = \frac{\text{Load Res. (ohms)}}{830}$$

assuming a full-wave rectifier circuit operating on a 50 c/s supply. The optimum value of inductance is twice the critical value, and represents the point at which further increase in inductance gives a disproportionately small improvement in operating characteristics. The load resistance is calculated from Ohms law by knowing the HT voltage and load current. The above formula clearly indicates that the optimum filter inductance varies with the load resistance, the inductance being highest under conditions of light load. Now the inductance of a choke tends to fall as the current through it increases, so it is possible to design a choke having a "swinging" characteristic. A swinging choke is designed to have the critical inductance at very low loads and optimum inductance at full load. By fulfilling these requirements, optimum performance is achieved with a choke of minimum size.

The value of capacitor is chosen to give the required degree of smoothing. The degree of ripple is given for a single section choke input filter by the approximate formula:

$$\%\ \text{ripple} = \frac{70}{LC}$$

If a ripple better than 5% is required, it is usually most economical to employ a two stage filter. In this case the ripple is given by:

$$\%\ \text{ripple} = \frac{380}{L_1 L_2 (C_1+C_2)^2}$$

The above formula applies to a full-wave circuit operating from a 50 c/s supply.

It is most important to avoid resonance in the first stage of the filter. Resonance will occur when the product of the choke inductance in henrys and the condenser capacitance in microfarads equals 2.53. The product should equal at least twice this figure to guard against resonance effects.

Finally, the output voltage of a correctly designed power pack using a choke input filter is given very closely by the formula:

$$\text{Vout} = 0.9\,\text{VE} - \frac{\text{I}\,(\text{Rc}+\text{Rr})}{1{,}000}$$

where VE=RMS voltage applied to one anode of the rectifier,

I=Load current (mA)

Rc=Resistance of choke(s)

Rr=Resistance of rectifier valve between anode and cathode. (About 100Ω for a high vacuum valve).

[END

Can Anyone Help?

DEAR SIR,– Can any of your readers help me in converting a 1/50th horsepower 50V 50c/s 3-phase induction motor to 230V single phase operation? – *G. Truscott, 2 Granville Street, Monton, Eccles, Manchester.*

DEAR SIR,– I wonder if any of your readers would lend, sell or give me the circuit and details of the Eddystone 358X receiver. The makers cannot now supply me with the required information.– *K. Gray, 60 Braithwell Street, Denaby Main, Nr. Doncaster.*

DEAR SIRS,– I would like to take advantage of your offer under *Can Anyone Help* to ask for circuit diagram and conversion data for 144 Mc/s of the R1137A.– *A. R. A. Love, 18 Coy. R.A.S.C. (W.T.), H.M. Gun Wharf, Sheerness, Kent.*

DEAR SIR,– I would be glad of any books, circuit diagrams, etc., on all-purpose superselective IF amplifiers, better IF selectivity, and double-conversion 35 kc/s, 50 kc/s, 85 kc/s or 100 kc/s second IF's. All literature, etc., will be returned if required.– *B. N. Gregory, G3DNT, "Sayesbury," Jackson Tor Road, Matlock, Derbyshire.*

SIRS,– I am constructing a double superhet, some details of which appeared in the Jan. '53 issue of *The Radio Amateur*. The author, C. R. Greenland, G4HD, gives the second IF's as Ferrocart 110 kc/s with variable mica coupling condensers between the windings. I understand these IF transformers are no longer obtainable; perhaps one of your readers has three in his "junk-box" which he will supply to me.– *A. Nash, 3 Swiss Cottage, Tadworth, Surrey.*

SIR,– Can anyone furnish me with details, such as crystal frequencies, valve line-up, HT line voltage, and where a circuit diagram could be obtained, of the R.A.F. Transmitter A.M. type T1043, Ref. 10/D 3330.– *H. G. Chieseman, "Malvalla," 265 Cliffe Road, Strood, Nr. Rochester, Kent.*

DEAR SIR,– May I be allowed to crave a space to appeal for help in getting a home-built 6H6 ratio discriminator for FM to work – signal going in but no audio output.– *J. A. Cusdin, 99 Cavalry Crescent, Eastbourne, Sussex.*

DEAR SIR,– Can anyone possibly sell, lend or otherwise supply me with any information on the 358X communications receiver? – *R. O. Streek, Cawood Road, Wistow, Selby, Yorks.*

Radio Miscellany

Portable

A CORRESPONDENT, REFERRING TO MY recent comments on telephone gadgets etc., writes to say that perhaps the G.P.O. are not so unenterprising after all. He tells me that at an Acton Hospital there is a roving telephone, fitted on a trolley which is wheeled around the Wards. The trolley is complete with Directories – and coin box! It is designed to enable bed-ridden patients to call up relatives and friends, and occasionally join in the old English pastime of getting wrong numbers.

No, there is no VHF link or anything like that. Simply a plug-in socket beside each bed.

Of Mice and Men

The latest edition of TV's Inventors' Club contained one item which interested me greatly. As usual the programme was spoiled by its breakneck speed. It is impossible to treat fourteen or fifteen ideas adequately in what is left of thirty minutes after the introduction, announcements, lists, and farewells are deducted. True, such ideas as new coathangers, or an indicator to stick on a reel to show where the cotton ends, can be demonstrated in half-a-minute, but mechanical devices need more than just showing. Most people I have discussed this with agree with me that they are not content to merely see that the inventions submitted DO work; they want to see HOW they work.

Many TV programmes, especially the documentaries, are padded out with lots of tedious detail about the obvious or the unnecessary. This makes the high pressure speed of Inventors' Club doubly exasperating. I can only imagine the BBC fix programme times by the clock instead of allowing each item to run its natural length. To the admin. staff the time-table has always been more important than the broadcast itself. Perhaps that is why the plays are usually successful. The time has to be made to fit the play, not the play to fit the time.

However, the invention which so excited my especial interest was a "contour accommodating vice" which, in contrast to the rigid jawed type, shapes itself so as to securely hold irregularly-shaped objects.

Hot-Point

Don't ask me how it works. Either the commentators didn't know or weren't telling. They did, however, vouchsafe that it was the most beautiful model submitted. A vague reference was made to some little stops in the jaws and we were shown how a piston engine con-rod could be held in it.

Even if this invention had not been so useful and of obvious interest to radio-men, it would have captured my attention as it was quite a coincidence that a vice should be in the programme. Earlier in the evening I had been at a friend's workshop and seen an idea I intended to mention in Miscellany. Many will have already heard of, or practised, the idea of using a spring-clip clothes peg for holding wires and small objects when soldering. They don't absorb the heat and, more to the point, they obviate scorching one's fingers. The friend I visited had gone one better. He uses a break-back mouse trap, screwed to the bench, for soldering jobs of this nature. It not only gives a firmer grip than clothes pegs, but being screwed to the bench there is no danger of it moving just as you take the iron away.

TV Marches on

Recently when washing down my ancient roadster I had an interviewer call from the BBC Audience Research. I dutifully answered all the questions – even the politely worded nosey ones about my age group, occupation etc.

Perhaps I wasn't a lot of help. I neither listened or looked-in the previous evening or on the Sunday, the nights in which he seemed most interested. Experience teaches us to be cautious of the results of such "surveys" even when it is possible for a decisive answer to be given. Frequently "polls" are several-per-cent out on clear cut issues. With questions to which it is impossible to give an unqualified answer the results are often widely wrong. It is indisputable that two separate interviewers will get quite different answers simply on account of differences in the way in which the questions are phrased. How simple it will be when we have an alternative programme. All one will have to answer will be, which programme one's family preferred to watch last night and the night before.

CENTRE TAP *talks about* G.P.O. — B.B.C. Programmes Inventor's Club — B.B.C. Polls

I am still convinced there are too many hours of both sound radio and TV. Less hours and better programmes is still the slogan for discriminating audiences, and in "off-peak" hours there could well be a number of specialised programmes for miniority groups. While there are many programmes of the entertainment or amusement type the BBC do well – really well – serious programmes can rarely be included under this heading. Why must it always be assumed that listeners have never given time or thought to any subject of a serious nature? Many a programme which, on paper, has promised well has turned out like something specially edited for semi-literates.

Since my interview, the April/June Audience Research figures have come to hand. Once again it seems that TV expansion is gaining ground by stealing the customers from "sound" radio. Does this mean that the regular viewing public is chiefly made up of people who don't know what else to do with their spare time?

All in a Row

I suppose most readers solved last month's problem without difficulty but, as promised, here is the answer. The following ten resistors will enable any value to the nearest ohm between 1 and 1,023 to be selected at will.

1	2	4	8
16	32	64	128
256	512		

By simply adding another five resistors to the collection one could get any value up to well over thirty thousand ohms and it wouldn't require many more to go over the million mark. Yet quite why anyone should want a 469,999 ohm resistor instead of the conventional 470,000 would be a still harder problem to solve.

WALTON AMATEUR RADIO EXHIBITION

Organised by the QRP Society

On Saturday, October 30th, 1954, there will be staged for the first time in Walton-on-Thames an exhibition covering all aspects of Amateur Radio.

The purpose of the Exhibition is: (a) to convey to the visitor a comprehensive idea of the varied and often valuable work which Radio amateurs are carrying out, (b) to lay special emphasis on the efficiency of low power for amateur transmissions, particularly as regards local communications, and (c) to provide a review of contemporary equipment, both amateur built and commercially manufactured, in all branches of radio and allied spheres.

The Exhibition, to be held in the St. Mary's Parish Church Hall, will be opened by a well-known public personality at 2.30 p.m. Admittance will be by ticket, price 1/– (children half), obtainable at the entrance. Blocks of six or more tickets at 8d. each are obtainable from the Secretary of the QRP Society not later than 23rd October.

Refreshments will be available, and there will be approved parking facilities for motorists.

All proceeds will be given to the Chorister's Parents Guild of St. Mary's, whose funds are devoted to the requirements of the Parish choir.

Among the exhibits there will be displays of amateur equipment, commercial sound and vision receivers and components; demonstrations of radio-controlled models, high fidelity reproduction, amateur television and "walkie-talkie" communication. There will be an amateur station "on the air" from the exhibition hall, exhibits from the popular National radio journals and a stand devoted to the sale of surplus equipment.

It is hoped that many of the amateurs from the Home Counties will visit the Exhibition and to aid those who have no knowledge of the district, there has been prepared a guide leaflet obtainable from the Secretary, QRP Society, "The Retreat," Rydens Avenue, Walton-on-Thames, Surrey.

KNUPPLE SYSTEM OF RADIO CONTROL

By **A. C. GEE** G2UK

THE WRITER RECENTLY DESCRIBED, in this journal, a steering unit for use in radio controlled models, which would give proportional control, i.e. it could be 'inched' up, back and forth, so that a fine degree of control can be obtained.

The conventional type of circuitry needed for this mechanism requires two channels, which are usually provided by a receiver using the tuned reed system.

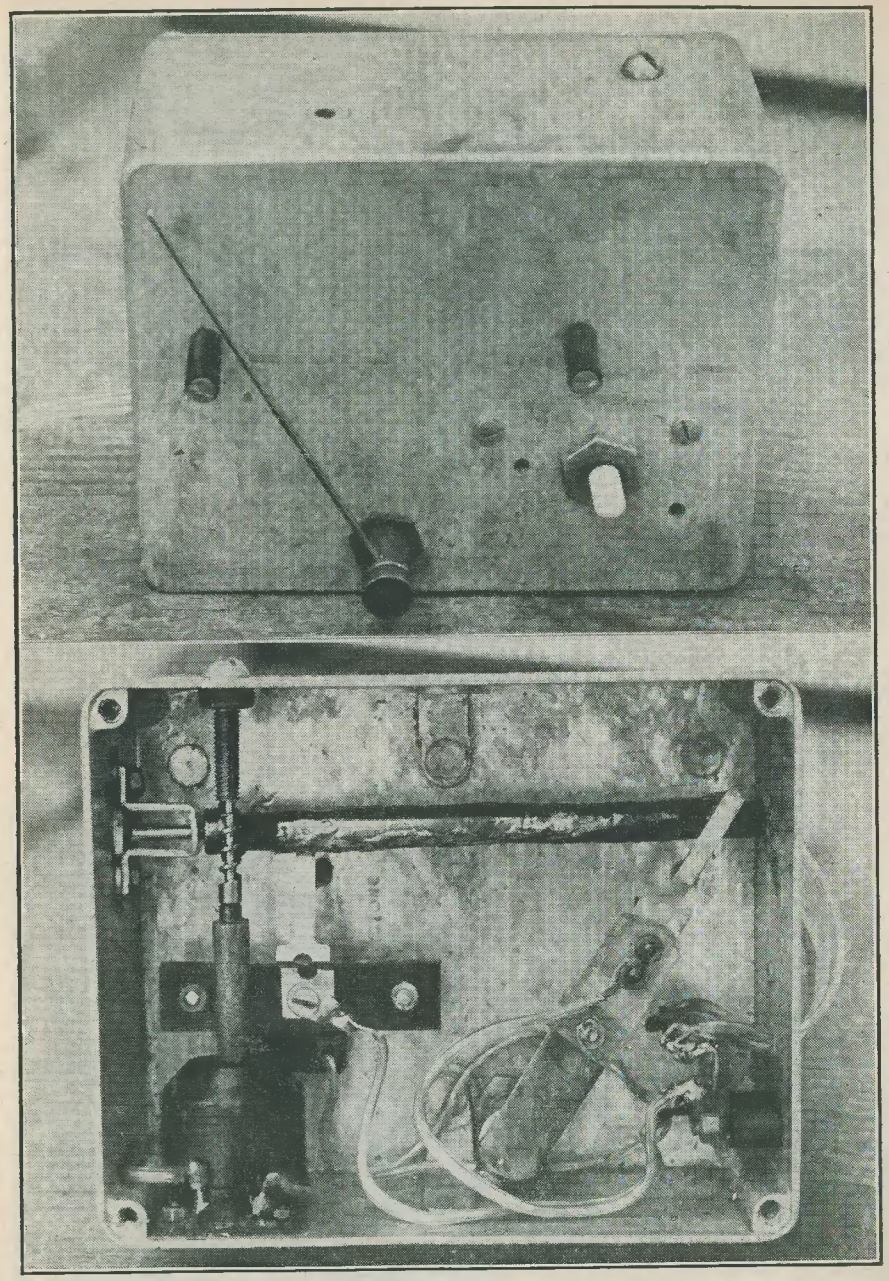
There is a method available, however, which will permit this proportional control mechanism to be used with a single channel receiver and transmitter. It is known as the 'Knupple' system, after that used in the German glide bombs of wartime fame. It consists essentially of a space-marker pulse system, the position of the proportional control depending on the ratio between the signal beats and the spaces between them.

A normal single channel, unmodulated transmitter is keyed in such a way that it will send either a continuous signal, or no signal at all, and all stages of interrupted signals between these two extremes. That is, if the control is set halfway, a signal consisting of equal spaces and impulses is sent; if it is set a quarter way, the spaces are a quarter of the impulses and so on. This signal is picked up on a normal single channel radio control receiver and it will be found, of course, that the relay arm follows the time-space ratio of the transmitted signal. When a continuous note is sent, the relay stays over on one stop. When no signal is being transmitted, it stays over on the other stop; and when intermediate pulses are sent, the arm oscillates between the two stops at a time-ratio in keeping with that of the transmitted signal.

If the relay is connected up as shown in Fig. 1, the motor of the proportional control unit will 'oscillate' in keeping with the relay. It will turn a few revolutions in one direction, and then back again a few turns in the other direction. At the midway point of the transmitter control, the back and forth revolutions will cancel out and the proportional control unit arm will remain stationary or almost stationary, depending on the amount of backlash in the gearing. When a continuous note is sent, the motor will rotate continuously in one direction until the limiting switches cut it out. When no signal is sent, it will turn in the opposite direction, until again the other limiting switch will cut it out. Similarly, intermediate stages of the transmitter control will produce corresponding positions in the proportional control unit.

The unit described herewith consists of the transmitter control unit by means of which the space-marker pulses can be produced. It can be used either with the proportional control unit described previously – as it was in the writer's case – or, of course, with similar home constructed or commercial units. The variation in space-marker ratio is provided by a rotating roller of insulating material on which is fixed a long V-shaped piece of copper foil. A contact arm slides over this V-shaped piece of foil, the arm being actuated by the control rod on the outside of the box. The roller is turned rapidly by a small miniature electric motor mounted as shown in the illustrations. The gearing mechanism shown in the writer's model came from the dial mechanism of a disused telephone, and gives a reduction of about twenty to one. If similar gears cannot be obtained, little ingenuity is needed to devise a satisfactory gear train from the gears usually to be found in the junk box of most radio control enthusiasts.

The roller is made from $\frac{1}{4}$" dowel rod and the foil is stuck on with Bostik Adhesive. Little further comment is necessary as the construction is self-evident from the photographs. The unit is built into one of Eddystone's $4\frac{1}{2}" \times 3\frac{1}{2}" \times 2"$ die-cast boxes. The wiper arm carrying the contact which slides over the foil is attached to a short length of rod which passes through a bush to the outside of the box, a short length of rod



Inside and outside views of Knupple type radio control transmitter control unit

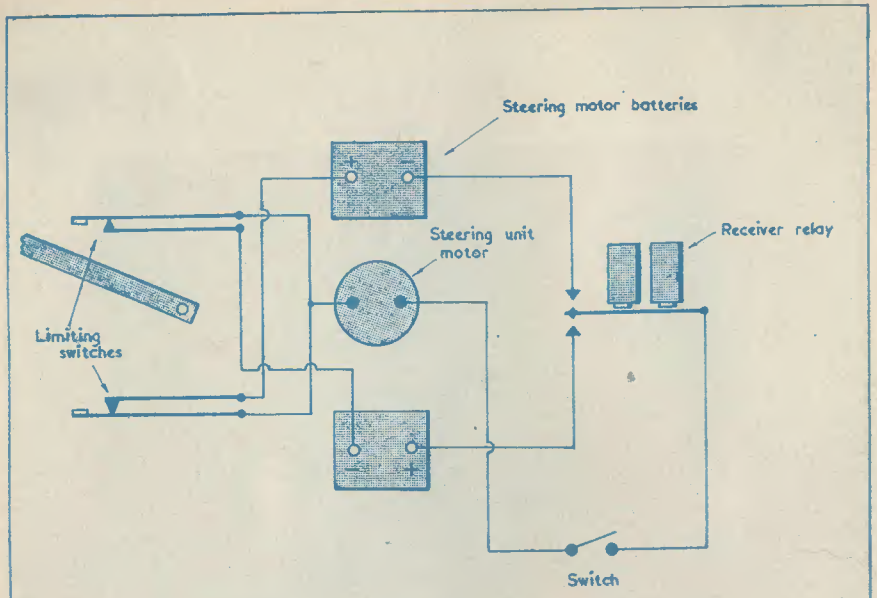


FIG. 1.

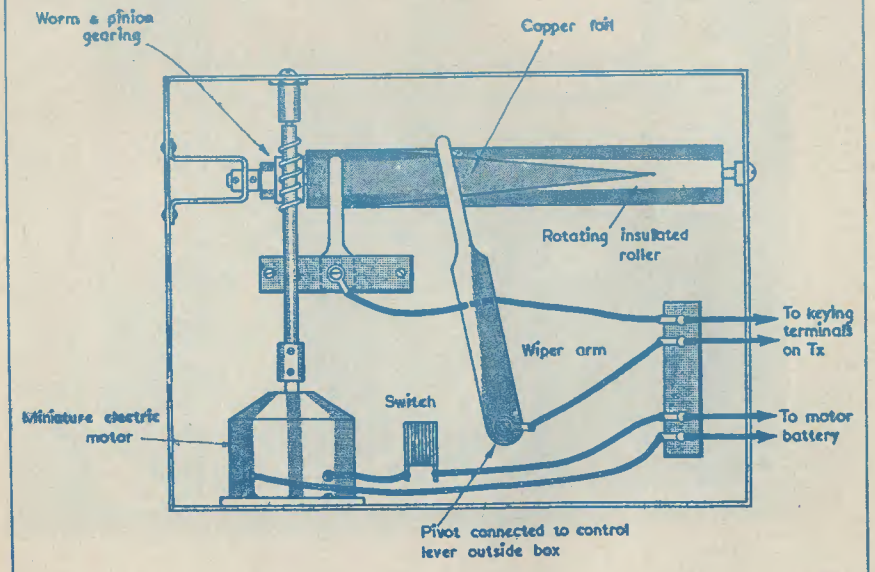


FIG. 2.

being fixed to it as shown to form the control lever. Two stops are fitted as shown to limit the travel of the arm. A small switch should also be fitted to switch off the motor when required. A second wiping contact is needed to make the second contact with the foil. This contact has to be insulated from the box. Two leads are needed from the box; one to carry the current for the motor and the other to connect the rotating foil etc. to the keying terminals of the transmitter.

Once completed, it can be tested out without the radio circuit in the first place, by connecting up to a relay and battery; the contacts of the relay being wired up to the proportional control unit as shown in Fig. 1. In this way final adjustments can be made to ensure that the roller runs smoothly and proper contact between the foil and the wiper arm is taking place. Once everything is going nicely, the radio circuit can be set up and the unit used to key the transmitter in place of the normal transmitter keying arrangements.

The only alteration which is needed to the receiver is that, whereas in the 'sequence' type of operation only one of the contacts on the receiver relay is used, in this circuit both contacts are needed. In most radio control receivers however, the relay is provided with two contacts, so that all that is needed is for a second lead to be soldered to the relay. Some adjustment of the relay itself may be needed to ensure that it travels equally between both stops, but normally little adjustment should be necessary.

Let's Get Started

14: MATCHING

By **A. BLACKBURN**

IT MAY SEEM A BIG JUMP FROM SHORT waves – the subject of last month's article – to audio frequencies, but these apparently diverse topics have one problem in common, regardless of frequency.

Matching the power generator to the load, so that the maximum amount of generated power is efficiently used, can be a headache for any radio engineer until the snags involved have been cleared up.

Unfortunately, despite the fact that this basic requirement has to be met at all frequencies, the conditions may vary considerably from one frequency to another.

Internal Resistance

The simplest type of circuit, for the purpose of illustrating the meaning of the process known as matching, is the battery and resistor.

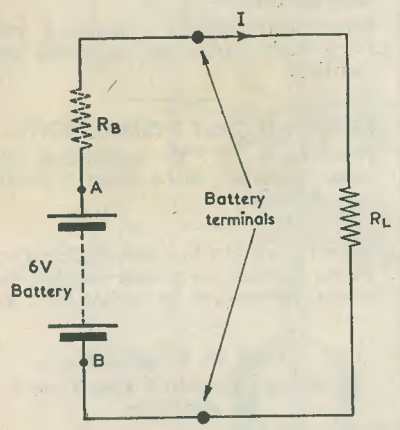


FIG.1. G43

Fig. 1 shows a 6V battery connected to a load resistor, R_L. The other resistor, R_B, is the internal resistance of the battery, and is another of those invisible components which are always cropping up. We can show, however, that it does exist.

Say a short circuit is connected across the battery. For good measure we will make it a 12″×12″ bar of silver, just to show it really is a short circuit. If the resistance of this bar were 0.0001 ohms, and the battery were 6 volts, the current in the circuit should be 6/0.0001=60,000 amps!

But it is most likely that, on measuring this current, we should find it far less than the expected figure. The reason can only be that an additional resistance has found its way into the circuit and limited the current. Suppose the value we find is 100 amps, then the total resistance in circuit is 6/100=0.06 ohms. We know that our short circuit is 0.0001 ohms resistance, which is negligible compared to 0.06 ohms; so the internal resistance of the battery is 0.06 ohms.

One further obstacle must be overcome before going on to power considerations. We cannot get at points A and B in Fig. 1 to measure the battery voltage, because R_B is 'in the box'. If our voltmeter has a very large resistance compared to R_B, then only a tiny current will be drawn from the battery, and the voltage drop across R_B will be negligible.

This voltage is called the 'open circuit voltage' of the battery.

Maximum Power

Now suppose that R_L in Fig. 1 were a heating coil and we wished to get a maximum amount of heat from it with the 6V battery, of internal resistance 0.06 ohms. By application of Ohm's Law:

$$I=\frac{E}{R_B+R_L} \text{ amps,}$$

where E is the open circuit voltage of the battery.

The power in R_L is I^2R_L; by substituting the value of I in the former expression for I in the latter, we get:

$$\text{Power } P=\left(\frac{E}{R_B+R_L}\right)^2 R_L \text{ watts.}$$

A graph should help us here. In the expression for power that we have just derived, we can substitute values for R_L, and plot the power in R_L against R_L.

The graph Fig. 2 shows clearly that the power reaches a maximum at R_L=0.06 ohms, which is the internal resistance of the battery. We can conclude, then, that to achieve a maximum transfer of power from a source to a load, the load resistance must equal the internal resistance of the source.

However, since our problems are primarily concerned with AC applications, the obvious query now arises – what happens at AC? The first step is to replace the battery by an AC generator. Instead of heating a wire, we will use the power of the generator to drive air about, via a loudspeaker.

Even so, it is not plain sailing yet. The first snag we come up against is the resistance of the loudspeaker. We have no say in this at all. Its resistance has been determined by the manufacturer, as has the internal impedance of the generator. But we know that if the two are very different, we shall not get maximum power into the speaker coil.

The solution to this difficulty is to be found in the transformer. There is no need to go so far as to prove the mechanics of matching with a transformer, but the expression

$$\text{Ratio } n=\sqrt{\frac{R_B}{R_L}}$$

is important to remember. Some figures will illustrate its use.

A common value for R_L is 2 ohms, and R_B may be 50 ohms. The transformer ratio will then be

$$n=\sqrt{\frac{50}{2}}=5:1.$$

With an AC generator, therefore, the source and load resistors need not be equal, providing that a transformer is used to match them. In this way, a maximum power transfer is obtained. Of course, some losses occur in the transformer, but these need not be large and we needn't worry about them.

The Equivalent Circuit

Fig 3 is worth closer inspection from one standpoint a little removed from matching. Obviously, the loudspeaker has no way of knowing what the source of the driving voltage is. It may be an AC rotary generator, or a valve. It would be reasonable to assume, therefore, that as far as load is concerned, a valve may be represented by a generator.

However, every generator has an internal resistance. So when a valve is represented by a generator, how are we to find its internal resistance? The answer lies in one of the basic parameters of valves. When a signal is applied at the grid of the valve, the anode voltage, as we already know, fluctuates with the grid signal.

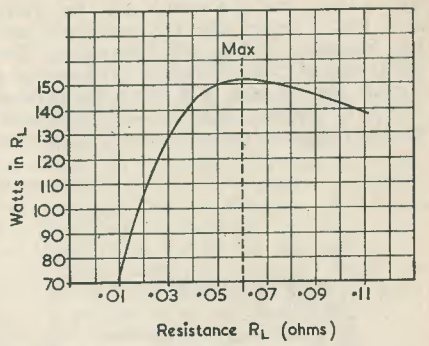


FIG.2. G44

To any load that may be connected between anode and cathode, this has the effect of likening the behaviour of the valve to a generator. The anode resistance,

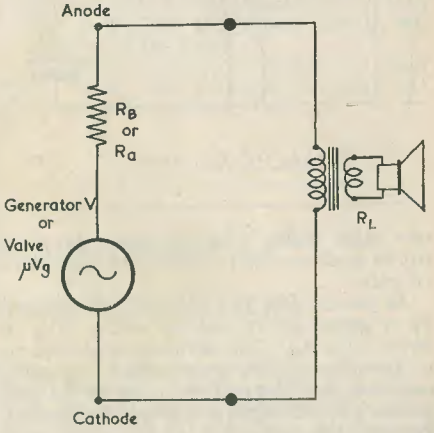


FIG.3. ILLUSTRATING EQUIVALENCE BETWEEN VALVE & GENERATOR G45

R_a, of the valve appears to be in series with this generator – virtually, inside the valve. The value of the alternating anode voltage is expressed as 'the amplification factor μ of the valve times the grid signal voltage'.

We have already defined μ as the change in anode voltage for a given change in grid voltage, when the anode current is held constant. R_a is the change in anode voltage for a given change in anode current when the grid potential is held constant.

In the case of a loudspeaker being driven by a valve, then, the circuit may be drawn as in Fig. 3, except that V becomes μV_g and R_B becomes the R_a of the valve. The advantage of this method of showing valve circuits can be seen if a more complicated circuit is studied. Fig. 4a shows the well-known resistance capacity coupling between

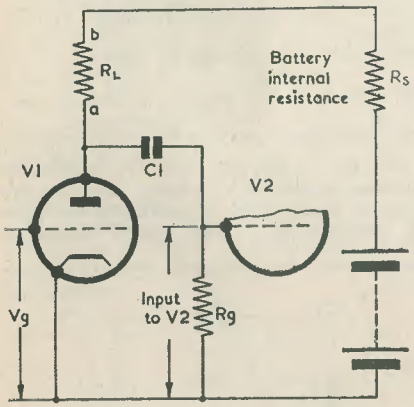


FIG.4A. RC COUPLING G46

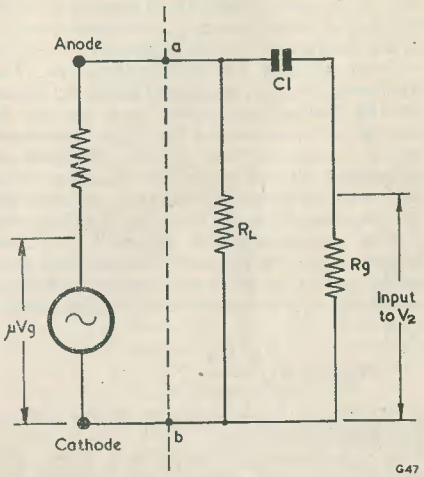


FIG.4B. EQUIVALENT CIRCUIT OF FIG.4A

two valve stages. Fig. 4b shows the same circuit re-drawn, and is called the equivalent circuit.

As you can see, the valve has been replaced by a generator, of output voltage μV_g in series with R_a. The network connected to it consists of the anode load, coupling capacitor, and the grid resistance of the next valve. The DC supplies may now be ignored, because the equivalent circuit deals with *signal voltages only*.

The idea is useful to demonstrate why the DC supplies do not appear. In Fig. 4a the HT supply is a battery of internal resistance R_s, and the current flows around the circuit as shown by the arrows. The battery has no resistance because we have taken it out of the battery box and represented it by R_s. This resistance is therefore added to the anode load R_L. Normally, however, R_L is of the order of many thousands of ohms, and R_s is probably not greater than 10 ohms. We can safely ignore R_s in relation to R_L, because the signal voltages developed across it will also be negligible compared to those developed across R_L. If R_s is ignored, the HT may be regarded as connected to earth so far as the signal current is affected. Which is just what has been done in Fig. 4b. The point marked *b* in 4a is connected to earth in 4b.

Other Cases

The valve amplifier is not the only circuit that can be represented by an equivalent. An interesting case is that of the oscillator.

An oscillator is often required to provide power to a load. The most obvious case is that of the audio oscillator which operates a loudspeaker. The equivalent circuit may be drawn in exactly the same way as in Fig. 3. The oscillator and all its constituent parts are collectively contained in the generator. As we have seen, however, every source of power must have an internal impedance which, once again, is represented by R_B.

The same thing applies with an RF oscillator feeding an aerial. The impedances of both aerial and oscillator must be known and a suitable transformer used to achieve a match. Admittedly, these two factors are difficult to estimate and the match is effected by trial and error. The importance of this

circuit representation is that it enables one to see more clearly how the circuit works, and therefore helps toward a better understanding of the underlying principles.

The equivalent circuit may be used in any case where a source of voltage or power is feeding a network – however complex.

So much for equivalent circuits which, although not strictly relevant to the subject of matching, will later prove a useful reference.

Currents and Voltages

Changing from high to low impedance or vice versa requires a change in the voltages and currents involved, and this is necessary if we wish to have the same power available on either side of the matching circuit as, for example, when using a transformer.

Suppose we wish to transform 1 watt from a 10kΩ source to a 10Ω load. The voltage on the 10kΩ side will be 100V and the current 10mA. On the 10Ω side they will be 3.2V and 320mA. The transformer ratio will be approximately 32 to 1.

The essential thing to notice is that the current increases in the stepped down secondary. So low impedances imply high current and low voltages, and high impedances high voltages and low currents. This is important to remember when wiring a low impedance loudspeaker extension from one room to another. If the gauge of wire used is too small, there will be a voltage drop along the line, and a loss of volume will result.

It is interesting to note that the electrical supply grid is designed to take advantage of the effect of decreased current in high voltage transmission lines.

For example, power is generated at, say, 11kV. For transmission over great distances the voltage is stepped up to 132 kV. The current is stepped down, however, by the same ratio, and the losses in the lines are accordingly reduced.

Receivers

In receivers, matching is important only at one or two points. The aerial may be represented as before by an equivalent circuit of generator and resistance. The generator voltage is the signal voltage developed in the aerial. In this case, however, the series resistance is not quite correct. In actual fact, an aerial has an 'internal' impedance consisting of inductance, capacity and resistance. This has to be matched to the input circuit (normally a tuned circuit) of the receiver. The problem of aerial to input stage matching is a little too difficult and extensive to tackle here and now.

IF transformers are adjusted, not for matching as we have dealt with it, but bearing in mind voltage output and bandwidth. The only IF transformer that feeds a load is the one connected to the rectifier. Due to the fact that the diode takes current when conducting, the IF transformer coupling must be designed to ensure maximum energy transfer from primary to secondary.

In the audio stages, voltage is the important thing and impedances are normally kept as high as possible, so power matching does not enter into the design.

The final match is, of course, between output stage and loudspeaker, which we discussed earlier in this article.

[END

RADIO CONTROLLED MODELS AT THE MODEL ENGINEER EXHIBITION

BOTH IN THE COMPETITION SECTION AND ON THE WATER TANK, radio-controlled models were again one of the most interesting features of "The Model Engineer" Exhibition, held at the New Horticultural Hall, Westminster, which H.R.H. Prince Bernhard of The Netherlands graciously consented to open.

The International Radio-Controlled Models Society were represented on the water tank and had a stand, in the Club centre, where experts were available to discuss problems.

The radio-controlled boats manoeuvring on the tank provided one of the more spectacular exhibits in the Exhibition. Among the models taking part this year was Norman Ough's H.M.S. *Curacoa* – this well-known model has been modified so that its guns fire and a smoke screen can be laid.

Entries in the competition section included a radio-controlled Metropolitan Police Launch, *Geebaa III*, a radio-controlled cabin cruiser and transmitter, and a steam-driven fishing trawler which has already had over 100 hours afloat and under radio control. An unusual protype, *The Royal Barge*, had been chosen for a 40*in* long model, which has radio-controlled steering; a model which is to have radio control installed later is the *Zwerke Zee*, a Dutch ocean going Salvage Tug. A luxury cabin cruiser model had radio control of clutch and throttle in addition to steering.

Some Observations on 1954 National

RADIO SHOW

ALTHOUGH THESE LINES ARE WRITTEN, of necessity, several weeks before the commencement of the Radio Show at Earls Court, they will appear just after its opening, on August 25th. Sufficient advance information has been promulgated by the exhibitors and by the Radio Industry Council to enable a preview to be prepared; and it is considered that this should be of interest and of value both to readers who are able to visit the Show personally and to those who are not.

Twenty-First

This is the twenty-first National Radio Show, and will occupy more space than ever before. There are over a hundred exhibitors, about forty of which are manufacturers of radio and television receivers. The remainder are, mainly, manufacturers of components, sound reproducing equipment, aerials and valves. The R.I.C. is exhibiting special equipment for industry and commerce, together with radio-controlled models.

The BBC is expected to supply many items of interest; these including the "roving eye" camera – a portable camera and transmitter designed on "walkie-talkie" lines. Other cameras exhibited will be of the commercial closed-circuit class, together with miniaturised models. An arena, intended especially for demonstrations by the BBC of outside broadcast technique, will be a new feature; and particular prominence is being given at the Show to camera and studio equipment suitable for export.

One of the most interesting features of the Show is invariably given by the central control room. This is the glass-walled room which handles and routes all programme material used during the ten-day period over which the Show remains open. The control room this year is situated on the first floor above the Warwick Road entrance, and may be reached by means of the escalator behind the turnstiles at this point. It will handle TV signals emanating in the Show, passing these on for outside transmission over the BBC television network; and it will receive TV signals from Alexandra Palace in the reverse direction, piping these around the exhibition. It will also deal with productions intended purely for the Show itself, such as interviews at the Celebrity Dais, films, and continuity by the staff of three announcers. The control room will also look after the usual PA and sound receiver channels.

As always, this room is on full view to the visitor, affording a fascinating glimpse of what occurs behind the scenes during an actual telecast. It cannot be denied that a certain amount of the fascination given is provided by the sudden "panics" which occur when something goes wrong at the last minute! However, the fact that the control room, with its complicated equipment and wiring, has been set up successfully in the short time available is always an achievement worthy of praise.

The TV outlets to the stands inside the Show will be working on the Birmingham frequency (Channel 4), this being done to prevent any interference occuring from Alexandra Palace transmissions. The signal level at each outlet will be 1mV at 70 ohms unbalanced. Superimposed along the cable network carrying the Band I programme will be a Band III signal. This will have approximately the same strength as the Band I programme but it will only carry a fixed picture; the picture taking the form of a caption with a suitable background. The provision of a Band III carrier will, of course, allow receivers with "commercial" channels to be examined and demonstrated.

Frequency Modulation

VHF FM receivers and adaptors will also be on show, but, at the time of writing, there is no evidence as to whether they will be in operation. It is to be hoped, for the good of the trade itself, that FM demonstrations will be given, since the public demand for these receivers is bound to be lethargic until convincing evidence of the advantages of FM is made available.

The Television Society has its own stand (No. 205) and will exhibit equipment which has been the subject of lectures in the Society's programme. These exhibits will illustrate industrial and broadcast techniques, together with circuit developments. Also on this stand will be reprints of important papers read during the Society's recent session, books written by members, and the newly-published Bibliography of Colour Television. Non-members are welcomed to the stand.

Training

Technicians and engineers are always required in the electronic industry. To emphasise the importance of present training for the filling of future establishment, the RIC Technical Training Committee, with the help of the Ministry of Education and representatives from the colleges participating, are staging a special Technical Training Display. This will feature the use and working of test gear, together with information on machine-shop practice, components, circuitry, and glass manipulation (including build-up of valves and CRT's).

The Services will, as usual, be putting on their own exhibits (with recruiting staff at the ready!) To be especially commended this year is the Royal Navy. The Navy stand will feature, amongst other things, a ship's wireless cabin and part of a shore station, working models of a 3 *cm* high definition warning radar set, a Decca Navigator, and typical examples of what is most recent in teleprinter and facsimile equipment. An imaginative demonstration of under-water television cameras operated by remote control will be presented, the public having full view of the equipment used since the camera is immersed in a glass-sided tank. Of especial interest will be an electronic clock displayed on a cathode ray tube. Although operated entirely by waveform generators, this gives a picture of the hands and markings found on a normal clock-face.

Manufacturers

As is to be expected, many manufacturers do not give details of their exhibits until after the opening of the Show. However, some advance information has been received and is recorded here.

Mullard have passed on, for instance, preview details of their main exhibits. Of particular interest to readers of the *Radio Constructor* will be a demonstration of the 5-valve, 10-watt, high-quality amplifier described recently in these pages. The amplifier may be heard in Demonstration Room D3A (admission by tickets obtainable from Mullard stand No. 59). Readers whose visits to the Show are inspired by business as well as by interest should also visit Demonstration Room D29 ("Dealers' Rendezvous"), where Mullard aids to dealers are exhibited.

The Telegraph Condenser Co. will also be to the fore on stands 101 and D17. TCC developments shown here will include six new ceramic condensers designed especially for Band III, Band IV, and other tuners.

TCC have, in addition, produced a new electrolytic condenser – the "Superlytic". This condenser is primarily intended for grid coupling in AF amplifiers, its exceptionally low leakage current allowing this application to be made feasible. A working exhibit illustrating the use of condensers for Power Factor Correction will also be on show.

GEC have also released advance news of their exhibits, one of the more intriguing of which is a mains portable receiver, the BC4644, which is housed in a plastic cabinet. The plastic used is polystyrene; and colour is applied to the inside surface of the cabinet, thus allowing a lustrous appearance to be attained and obviating wear on the colouring material.

The General Electric Co. Ltd. has developed a circuit for a new high quality Amplifier to give realistic reproduction of gramophone records in the home. This Amplifier, designed for home construction, is intended to operate in conjunction with the G.E.C. Metal Cone loudspeaker, for which a special cabinet has been designed, and the two units operating together give a quality of reproduction, of both speech and music, of startling realism and clarity.

The Amplifier, known as the "Osram 912," has been introduced as a practical sequel to F. H. Brittain's *Art and Science in Sound Reproduction*, and a comprehensive booklet describing the wiring in full detail is available from the Osram Valve Department of the G.E.C.

This Amplifier with its accompanying loudspeaker is being shown on the Osram Valve Stand and demonstrated in the G.E.C. Demonstration Room at the show, where the descriptive book "Osram 912" will be on sale, price 3s. 6d.

We hope to publish a report, from the constructor's point of view, in our next issue. [END

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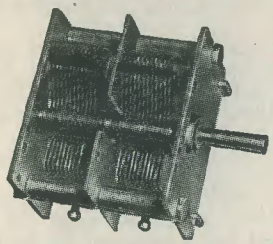

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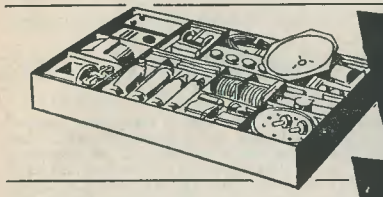

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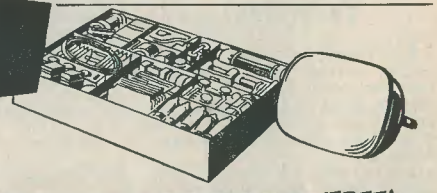

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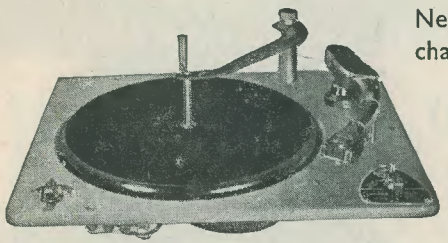

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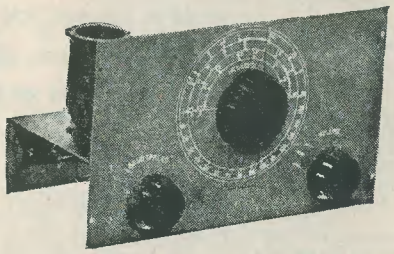

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[*continued on page 127*

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1R5	7/9	6K8G	8/6	25A6	8/–	EF80	10/6
1S5	7/9	6K8GT	8/6	57	7/6	EF91	7/6
1T4	7/9	6L6G	9/6	58	7/6	EF92	8/6
3S4	7/9	6N7	6/9	5763	8/6	EL32	7/6
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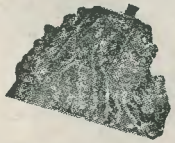

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SMALL ADVERTISEMENTS

continued from page 125

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[*continued on page 128*

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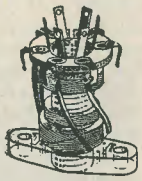

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1R5	8/6	6BW6	6/6	11D3	6/–
1S5	6/6	6CH6	8/6	12AT7	7/–
1T4	6/6	6J5	5/–	12BE6	7/–
1U5	6/6	6K7	4/–	*1299	5/–
3Q4	7/6	*6H7	5/–	1299	5/–
3V4	6/6	6V6	7/–	15D2	4/–
6AL5	7/6	6X4	6/6	19AQ5	10/–
6AM6	6/6	6X5	7/6	AL60	4/6
6AT6	7/6	7D5	6/–	CV181	6/–
6A8	8/–	7D8	6/–	EF50	5/–
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