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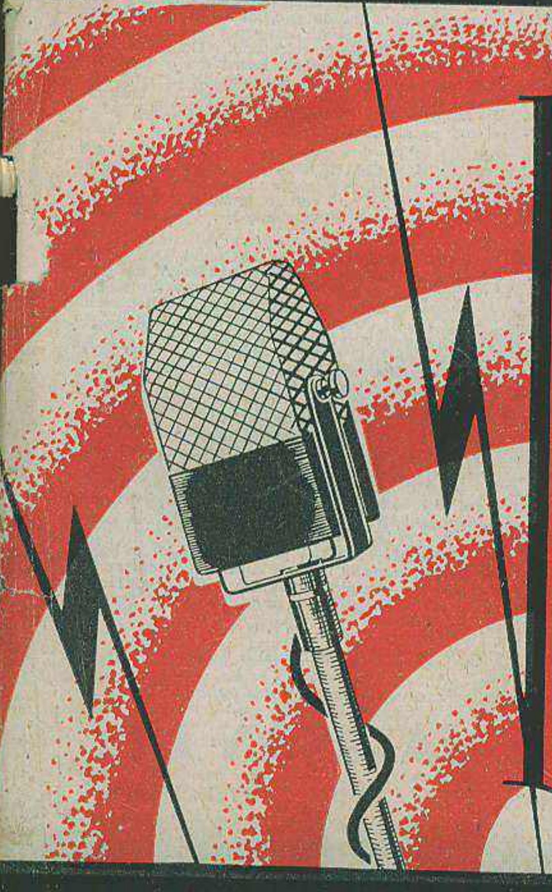
NOVEMBER
1948

# RADIO CONSTRUCTOR

*For Every Radio Enthusiast*



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AN AMALGAMATED SHORT WAVE PRESS PUBLICATION

# Radio Constructor

Vol. 2, No. 4 Annual Subscription 16/- November, 1948

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## Editorial

# American Amateur Transmitter Design

THE September number of the American Amateur Radio Journal " CQ " contains an extremely interesting article entitled " What Makes the DX Man Tick ? " in which the results of a recent poll into the various methods used by famous DX workers are analysed. A lot can be learnt from this article, but the section which interested us particularly was that dealing with the design of the transmitter. The design of a suitable transmitter for amateur use must always be a compromise, and the success or otherwise of any particular design will depend on the skill with which that compromise is struck.

To be really efficient and convenient to operate, a transmitter should be designed for one band only. Amateur requirements, however, demand operation on bands differing widely in frequency. One oft suggested method of getting over the difficulty is to use separate final amplifiers, or even separate complete transmitters.

On this subject the poll showed that only 19% used separate transmitters on each band and only 6% used a separate final amplifier. The writer of the article draws the inference from these figures that few American amateurs can afford the time and expense involved in using separate transmitters, and he goes on to say that it would appear that a separate final amplifier is not as attractive as would at first appear.

On the question " Does your Transmitter have complete band-switching or just partial band-switching ? " 21% said " Yes," 30% said " No," and 49% said " Partial." These figures are interesting, as at first sight, bandswitching would seem to offer tremendous advantages. On this point the author comments :—" Bandswitching also posed a constructive problem, and the returns tell us that only 21% of those who regularly participate in the sweepstakes were using direct complete bandswitching arrangements."

American Amateur Radio technique has always been very much to the fore, and whilst some might disagree if we said that it set the pattern for amateur radio technique throughout the rest of the world, there can be no doubt that much equipment in this country is based on American example. It is most interesting, therefore, to learn the result of a poll such as the one referred to, and those who are designing new equipment during the coming winter months, should bear its lessons in mind.

Incidentally, the article " What Makes the DX Man Tick " contains a wealth of other most interesting information on such subjects as aerials and receiving equipment, locations, and QRM, average age of the DX fiends, and so on. It should certainly be read by all who can lay hands on a September copy of " CQ."

A.C.G.

## NOTICES

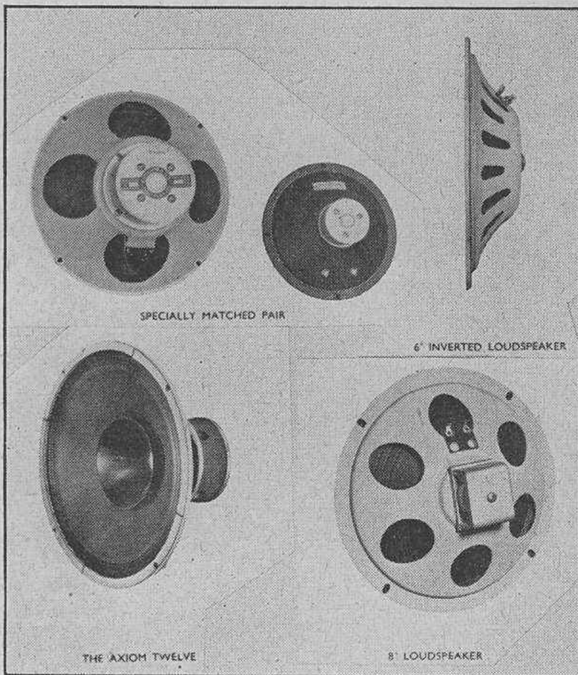
THE EDITORS invite original contributions on construction of radio subjects. All materia used will be paid for. Articles should be clearly written, preferably typewritten, and photographs should be clear and sharp. Diagrams need not be large or perfectly drawn, as our draughtsman will redraw in most cases, but relevant information should be included. All MSS must be accompanied by a stamped addressed envelope for reply or return. Each item must bear the sender's name and address.

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

ALL CORRESPONDENCE should be addressed to *Radio Constructor*, 57, Maida Vale, Paddington, London, W.9. Telephone: CUN. 6579.

# TRADE REVIEW

## New Range of Loudspeakers of GOODMANS INDUSTRIES LTD.




**GOODMANS INDUSTRIES LIMITED.—New Range of Loudspeakers.** The illustration shows several of the new speakers marketted by Messrs. Goodmans. Foremost amongst these is an entirely new 8″ speaker (Type T17/824/3) which was designed in the first place for use in Television receivers. It has an exceptionally low leakage field and with a flux density of 7,500 Gauss and a total gap flux of 30,000 Maxwells this model is small light and efficient to a degree that will be difficult to beat.

The 6″ inverted speaker is an unusual unit with the magnet mounted at the front, inside the cone, instead of at the rear. By this means the overall depth has been reduced from $2\frac{3}{4}''$ to $1\frac{9}{16}''$, effecting a substantial saving of space. This speaker will obviously be most interesting to those considering the building of portable and midget receivers, car radios and so forth. The design, we understand, has presented some intricate problems in both mechanical and electrical engineering.

For those demanding a high quality of reproduction, there is the specially matched pair which affords maximum fidelity with minimum trouble due to distortion products that may be present in the input signal. This matched pair consists of a 12″ low frequency unit fitted with a low resonance curvilinear diaphragm, and an 8″ treble speaker in which the back of the diaphragm is enclosed to maintain adequate air loading. The magnetic gap is saturated so that the iron surrounding the speech coil plays practically no part in raising its inductance with frequency. The impedance characteristics and relative efficiencies of the two units have been arranged to provide balanced reproduction over the range of frequencies from 40 to 12,000 cps. with a smooth cross-over achieved by means of a simple filter circuit. The overall impedance of the matched pair is 15 Ω and the power rating is 15 watts peak AC.

The Axiom Twelve is another interesting model. This is a high fidelity speaker with a patented dual exponential diaphragm assembly. A complete range of PM speakers, ranging in size from $2\frac{1}{2}''$ to 18″ diameter are also available, with power ratings from $\frac{1}{2}$-watt to 50-watt peak AC. The smaller models are, of course, primarily intended for receivers of the type normally built by the radio amateur.

Readers interested in any of the models discussed may obtain further details and prices on application to the manufacturers at Lancelot Road, Wembley, Middlesex. (Telephone WEMbley 4001).

W.N.S.

# A Radical Franklin

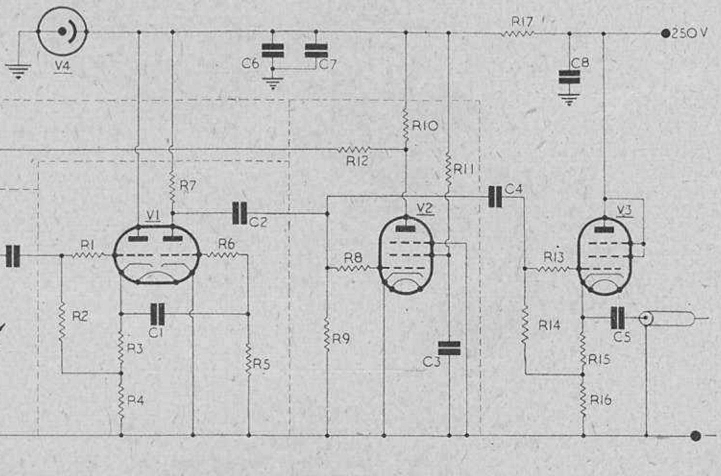
## *A development of this popular oscillator*

By L. F. SINFIELD

THE Franklin type of VFO is now so well known and popular that little need be said regarding its operation. It is, perhaps surprising, however, that there has been no radical changes in its circuit during its long use, all known methods of the amateur incorporating a high gain conventional amplifier very loosely coupled to a stable turned circuit.

It is recognised that the turned circuit must be of heavy mechanical construction, and kept cool, or is possible, at a constant temperature. If this is achieved, the only drift will be due to changing constants in the amplifier. The loose coupling keeps this drift very low, and a low drift oscillator of normal design was described by the author in the February, 1948 issue of the "Radio Constructor." Since this, however, the author has been toying with the ideas to bring the maintaining amplifier up to date with modern developments.

Firstly, let us consider the input of the first valve. The grid cathode capacity of this valve is the main factor determining drift, as this changes due to expansion of the cathode. Although the small series coupling capacity reduces this, there is a limit due to attenuation through input impedance of the valve. Take, for example, an inpit capacitance of $18\mu\mu$F. Then with a coupling capacitor of $2\mu\mu$F a capacitative alternator is formed, giving a grid input of $\frac{2}{2 + 18}$ or 1/10th of the tank circuit voltage, and has the immediate effect of reducing the effective amplifier gain by that amount, and so keeping these coupling capacities high. The feedback capacitance is not necessarily affected, as at the resonent frequency the tank circuit is resistive, and with high Q its impedance may be kept high in comparison with the feedback capacitor impedance.




**COMPONENT VALUES.**

**Resistors:**

R1, 6, 8, 13: 100 Ω
R2, 9, 14, 5: 1 M Ω
R3: 1,000 Ω
R4: 4,700 Ω
R7, 10: 47,000 Ω
R11: 100,000 Ω
R12: see text.
R15: 150 Ω
R16: 220 Ω

**Capacitors:**

C1, 2, 4: 100 $\mu\mu$F silver mica.
C3, 7: 0.01 $\mu$F mica.
C5: 0.005 $\mu$F silver mica.
C6: 4.0 $\mu$F paper
C8: 0.1 $\mu$F paper

**Valves:**

V1: 6SN7GT
V2: 6SJ7 (or 6AC7)
V3: 6AC7 (or 6L6)
V4: VR150/30

Therefore, the author contemplates using a cathode follower input to precede the normal amplifier circuit. The input capacitance is then effectively reduced to the absolute minimum, due to the input capacitance and input impedance being modified by a factor determined by the GM of the valve and the cathode resistor.

Then as well as the input capacitance being kept low and reducing drift due to its changes, there is also the additional advantage that the high input impedance allows the coupling input capacitance to be reduced to an absolute extreme.

Due to high gain and high input impedance, care must be taken to reduce stray coupling between input and output circuits. The stages must be individually screened and a screen incorporated in the tank circuit box between the two coupling capacitors, so that it is impossible for any feedback to occur except through the tuned circuit. The last valve of the maintaining amplifier is a pentode, and the anode is very effective screened from changes caused by cathode heating.

Another point is the generation of parasitics and harmonics. Due to the coupling being capacitative the impedance of these series components is reduced at higher frequencies. Grid stoppers should be used in all amplifier grids, but should not be too high as they will then give appreciable attenuation and phase shift. A resistor should also be placed in series with the feedback capacitor to limit its minimum impedance at high frequencies. These resistors will also help to maintain a constant output amplitude over the tuning range of the VFO About 100 Ω should be a good value for grid stoppers, and 1,000 Ω or more for the feedback resistor, to be determined experimentally.

The output buffer stage is a cathode follower with cathode constants giving an output impedance to match into a low impedance axial cable. The output is very low, but that is how it should be. The VFO is normally remote, and it is a bad thing to pipe *too* much RF all over the place at drive frequency. The necessary amplifiers should be incorporated in the transmitter.

For maximum isolation the output cathode follower should be fed from the grid of the pentode amplifier. Increased output can be obtained by taking it to the anode, but this places the grid-cathode capacitance of the output stage in parallel with the anode-earth capacitance of the driving stage, and as already pointed out, grid-cathode capacitance is the main cause of drift. C5 is kept high to prevent attenuation due to cable capacitance.

The resistors should be of high stability cracked carbon type, and non-inductive. They should be at least double the rating dissipated, in order to remain as cool as possible. Capacitors should be of protected silvered mica from .005 to .01$\mu$F and paper types above .01$\mu$F. All non-inductive.

# History Repeats Itself!

Recently, the Bell Telephone Laboratories, U.S.A., demonstrated the " cats-whisker crystal " in a new, and revolutionary role, as a replacement for the radio valve. The fact that many of the leading radio journals in the U.S.A. have recently carried articles on this development suggests that this ' crystal,' termed the ' TRANSISTOR,' will have a far-reaching effect on radio design and circuits of the future. Essentially, the ' TRANSISTOR ' consists of a piece of germanium crystal with a three contact holder, and investigations have shown that it will even oscillate and amplify. No source of power is required, such as for the cathode in a normal radio valve, and therefore it will be an advantage where compact and light-weight design in equipment is essential, i.e., deaf aid apparatus, pocket receivers. Experiments using the 1N34 germanium crystal in the above role, modified accordingly, have given promising results. The voltage gain is approximately 10, which is as good as that of an ordinary triode. Frequency and power limitation have not so far been fully exploited, but in suitable circuits it was found possible to reach 10 Mcs., and powers developed averaged 50 milliwatts. Experiments on these lines were being investigated as far back as 1923 by various bodies, but results were not very promising. There is no doubt that the " cats whisker and crystal " is back in the news, and maybe it will not be long before the " crystal set " will be the amateur's most prized possession, and his super-duper DX communication receiver will be " under the table."

## FIVE NEW MULLARD VALVES.

Five new Mullard Valves have now been released for distribution through Home Trade channels. They are the UAF41, UAF42, UCH42, UL41, and UY41.

These valves are AC/DC types on the new B8A base. The UAF41 and the UAF42 are variable-mu pentodes with single diodes, having 12.6-volt heaters taking 0.1 A.

The UCH42 is an AC/DC triode hexode with a 14-volt, 0.1 A heater.

The UL41 is an AC/DC output pentode with a 45-volt, 0.1 A heater, and is capable of giving 4.2 watts output, with 10 per cent. total distortion when used as a single Class A amplifier with 165 volts applied to its anode and screen.

The UY41 is a half-wave rectifier suitable for AC/DC operation, its heater taking 0.1 A at 31-volts. At maximum anode voltage of 250 volts, this valve will supply a recrified current of 90 mA.

Technical data sheets regarding these valves can be had on application to the Mullard Technical Service Department.

# Radio Miscellany

By *Centre Tap*

ONE of the chief assets I find in remaining anonymous is the advantage of listening to readers' views of the magazines I write for and their contributors, uncoloured either by the faintest flattery or restrained criticism which the reader might fear would hurt someone's feelings. Recently I have had the opportunity of hearing the views of a number of readers from whose conversation I was able to get a fair idea of their radio knowledge; each one of them was enthusiastic to the point of eagerly looking forward to the date of publication each month. They all thought the "balance" (the proportion of constructional, theoretical and general reading) was "about right." I was particularly curious to know their views especially on "readability." The value of a book is not the total number of pages but the number you enjoy—and was pleased to learn they read "practically everything."

Unfortunately with present paper restrictions, unless you have an "ordered" copy your chance of getting one is very remote indeed. This is not only unfortunate for the would-be reader but highly irksome to a progressive Editorial Staff. It is not possible for a new publication to find it's natural circulation and with the "Constructor" the potential readership must remain a mystery. The one consoling thought is that circulation alone is not a guide to worth—the true index is prestige and influence, whether the test be applied to newspapers or technical journals!

One odd point I discovered—of five enthusiasts who had bought copies of my booklet "The Basic Superhet" none of them had, or intended to construct it. They bought it apparently because they wanted to know something of the practical side of superhet receivers and every one of them used ex-W.D. receivers such as the 1155, BC348, etc.

**System.**

I have just spent an evening with an old friend and while there, helped him to get his newly built converter up to it's anticipated performance. We finally tracked it down to his failure to earth one side of the heaters—just one of those silly things we all do at times and then look for all sorts of obscure reasons which *might* cause the trouble instead of making sure it isn't one of the simple things. I believe he had already spent some time checking everything else several times before I got there!

It is surprising how much time constructors waste over stupid little slips and omissions in wiring, most of which could quite easily be avoided if a pencilled copy of the circuit was made first and each connection inked in as it is made. Even if you have to leave the job a dozen times before completion or suspend operations until you have had time to buy that odd value resistor, you can always return and carry on from where you left off without wasting time re-checking or the risk of leaving out some taken-for-granted connection.

Another variation of the same idea is to use a sheet of tracing paper clipped over the circuit and draw in the components and connections as they are wired. If you have not used either of these ideas previously, check for yourself what a saving in time and trouble you can make on your next constructional job.

**Spiv-ish.**

I was pleased to see the advice recently given in the RSGB Bulletin to those thinking of purchasing scarce items of ex-W.D. equipment. The B2 was the instance quoted—a deservedly popular item ideally suited for the newly-licenced amateur or for use as a stand-by. As these were sold for £2 (many complete with receiver as well) to members through the disposal schemes, it is disturbing to feel that it may be many of these now being offered in small ads. for prices ranging up to £15, quite apart from the fact that it is a breach of the conditions under which they were sold.

We used to like to think that amateur radio was the friendliest hobby in the world and for many years this was undoubtedly true, but in this and other ways our fine traditions are being undermined. A united stand should be made against black sheep exploiting scarcity values, especially against those profiteering out of a privilege to *bona fide* amateurs by the Ministry of Supply.

The suggestion put forward by the RSGB that intending purchasers should ask to see the original receipt when high prices are demanded is an effective answer and should be acted upon. Other items becoming scarce show the same tendency, notably the type 37 Oscillator, and prices should be watched.

**Not too little—Not too much.**

As an inveterate bargain hunter in the junk market I think the most noticeable trend at the moment is the fall in prices of equipment which has only breakdown value for its components. The great bugbear in dismantling this stuff is removing the nuts and bolts, the threads of which have been daubed with shellac, etc., to secure

# FROM THE MAILBAG

### DODGES

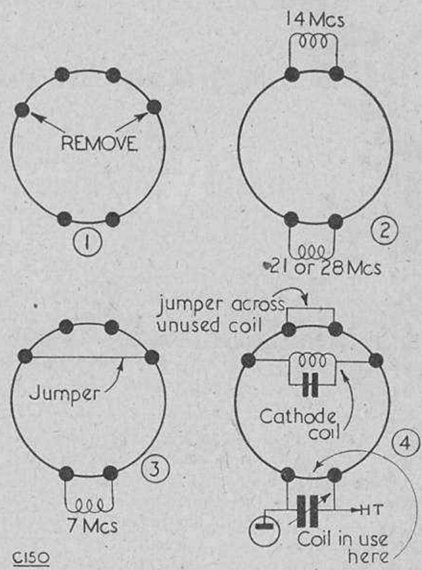
*(Further to our editorial of last month, we have received some interesting comments from readers. Here is a very useful dodge for the transmitting enthusiasts. More dodges will be published in future issues).*—Ed.

The following is a space and money-saving idea which I use in a small transmitter. The anode coil of the Tritet crystal oscillator (using a 7 Mcs. crystal) is a standard 6-pin plug-in receiving coil type. Since, however, only two pins are normally in use, I thought it would be possible to utilise it more efficiently.

The pins are arranged as Fig. 1 and, if the centre pair are removed, the coil becomes reversible in its socket so that by connecting a 14 Mcs coil to one pair of pins and a 28 Mcs coil (or 21 Mcs) to the other pair—a former is saved. (See Fig. 2). Suitable identification marks are made on the top of the coil.

A jumper may be arranged across the sockets of the unused coil to avoid absorption effects. Additionally, the cathode coil of the oscillator is mounted on the two unused sockets and a 7 Mcs coil is wound on a former with a jumper across the corresponding pins so that by simply plugging it in the cathode coil is shorted and it becomes a "straight through" oscillator.

Incidentally, the two pins are best removed by tapping gently *inwards*. This leaves them




undamaged and ready for use on a 5-metre self-supporting coil. Fourth harmonic output from the oscillator can best be obtained by a high L and low C cathode tuning circuit.

Best wishes,

R. BUCKERIDGE, G3BZA (Coventry).

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against loosening. It is remarkable how nuts will loosen merely by expansion and contraction in varying temperatures even in domestic use, unless some locking device is used. The heavy handling, frequent transport, and often mobile uses subject to vibration under Service conditions made this treatment essential.

That they require real hard work removing them is only natural—they were intended never to come off, but one cannot help feeling annoyed at the enthusiasm of the shellac daubers. The only part that helps to secure the nut is that immediately behind it. The daubers usually smeared it over every turn of exposed thread and it is this unnecessary daubing that irritates when dismantling.

It also raises the old problem of whether it is easier to drive home (or loosen) a screw with a long screw-driver than it is with a short one. The obvious answer, the long driver is correct of course, but the reason often given by those with an incomplete knowledge of mechanics "that it is because of greater leverage," is unsound.

The only "leverage" which takes place is at the point of the screw driver and even here it is restricted to the breadth of the screw. The long screw drivers superiority is on account of firstly the better grip enabling greater weight and force to be applied and secondly, the additional torsion of the long shaft supplementing the force used.

Elementary, my dear Watson, when you come to reason it out.

### NEXT MONTH.

Part 4 of "Inexpensive Television" will contain details of the vision and sound receivers and also the tube network for the 5CPI tube. We also have for you a compact table-top transmitter, described and constructed by "Centre Tap" and a Local Station Receiver by Len Miller. Some useful hints on Improving Selectivity, Query Corner, etc., are also scheduled. Finally, we will publish an article which strikes an entirely new angle as far as this magazine is concerned. This article will illustrate how to make attractive wooden cabinets for your receivers in a most unusual way.

# Short Wave AC TRF5

## A supplement to the original article in the August issue

By F. K. PARKER

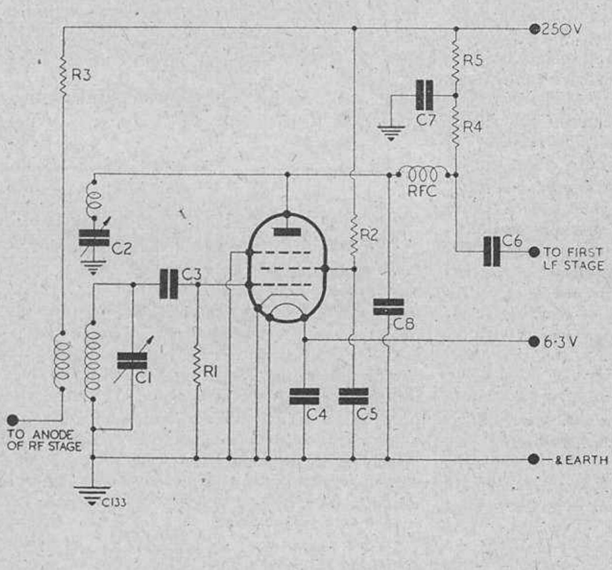
SINCE the article was written on the TRF5, several experiments have been made, which have resulted in an improved overall performance. The main alteration has been in changing the triode detector for a pentode. The finally chosen circuit is shown in Fig. 1.

Since the gain of a pentode is extremely high as compared with a triode such as the 6C5, the use of such a valve in an RF stage is liable to produce some instability. Therefore, all the earth return leads in the new circuit have been taken to one common earthing point. This is not guaranteed to effect a complete absence of instability, should any be present, but it certainly will help considerably. Probably the better prevention can be effected by adequately screening between the anode and grid of both valves. The obvious way is to use the chassis as a screen, i.e., to keep the grid wiring one side and the anode wiring the other. If attention is paid to the layout and all grid wiring is short and direct, little trouble, if any, should be experienced.

If the detector valve is of the non-metallic type, the use of a valve screening can may materially assist in the stability. In order to ensure that hum is not introduced into the detector, a consideration in a high-gain valve, it is essential that the heater wiring is kept away from other wiring as far as is possible. The use of screened cable for the heater wiring is an effective method. The heater decoupling capacitor C4, should be efficient and its outer foil connected to the earth line.

It may be found that regeneration is too fierce. If this occurs try reducing the value of the screen-grid resistor as this will raise the voltage on the screen and thereby " tame " the detector. For an EF39, the value of 500,000 will usually be found to be satisfactory.

The improved performance of the receiver, after the installing of the new detector circuit, was very marked on the 14 and 28 Mcs. amateur bands and the selectivity was found to be much better, especially on the low frequency bands, where one certainly needs selectivity these days. To those who have constructed the original receiver and are contemplating modifying it according to this article, I would stress the importance of spending a little extra thought and care on layout before attempting to make the conversion. The time spent will be more than repaid.




**COMPONENT VALUES**

C1: 160 $\mu\mu$F
C2: 100 $\mu\mu$F
C3: 150 $\mu\mu$F
C4: 0.01 $\mu$F
C5: 0.01 $\mu$F
C6: 0.1 $\mu$F
C7: 8.0 $\mu$F
C8: 150 $\mu\mu$F

R1: 2.7 M $\Omega$
R2: 0.5 M $\Omega$
R3: 50,000 $\Omega$
R4: 0.3 M $\Omega$
R5: 50,000 $\Omega$

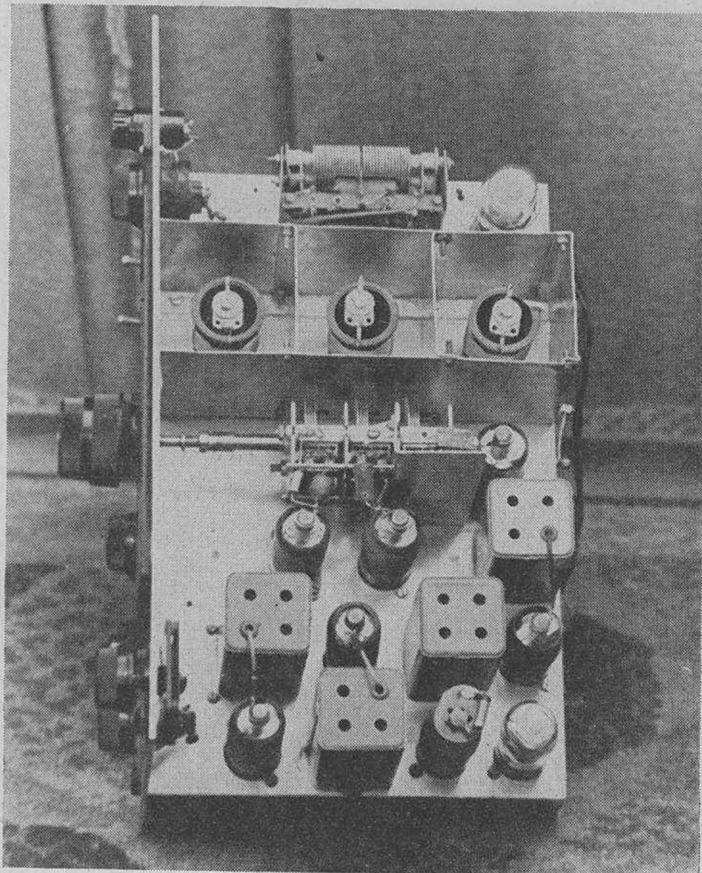
Valve may be:—
EF39, 6J7, 6SJ7 or EF36.

# The R 109

## *Rebuilding for the Amateur Bands*

By

A. Hitchcock



**Introduction.**

AS the army 109 receiver can now be obtained for around £7 from surplus stores, the writer thought that one would form the basis of a good battery communications receiver. Prime consideration was given to battery operation as the writer has no mains. The original receiver was considered unsuitable in its existing condition for several reasons. Firstly the wave lengths covered are only 35—160 metres, thus omitting the most interesting part of the bands from 10—35 metres. Also the output obtainable from the speaker fitted was very mediocre. Due to feeding the valve filaments from the same battery as the vibrator H.T. unit, a large amount of "hash" was introduced and this made the noise level very high when the volume was turned up. Lastly, the receiver had no refinements such as RF gain control, AVC switch and tone control. Due to these reasons it was decided to completely rebuild the whole receiver on a different chassis, fitting plug-in coils, pentode output, and a power pack suitable for either mains or batteries.

**Circuit.**

The circuit of the modified receiver is roughly the same as before, but with many minor changes. Since by careful design it is possible to obtain a 2.1 tuning ratio with a 160$\mu\mu$F tuning capacitor, the variable capacitor was stripped of all but four of its moving vanes, thus reducing its capacitance to the required value. This operation is easily performed by levering the vanes out with a screwdriver. As no suitable commercial ones are available the coils are home wound on standard 4-pin formers.

Starting at the RF end of the set, provision is made for input from either an end-on or dipole aerial. The RF gain control varies the screen voltage of the valve, as the bias is obtained from the AVC line. Although decreasing the screen voltage is not usually recommended since it reduces the signal handling capacity of the valve, no trouble from cross-modulation has been experienced. The mixer is coupled to the RF valve by RF transformer coupling. This gives better selectivity and signal-to-noise ratio than the original tuned anode coupling. Due to

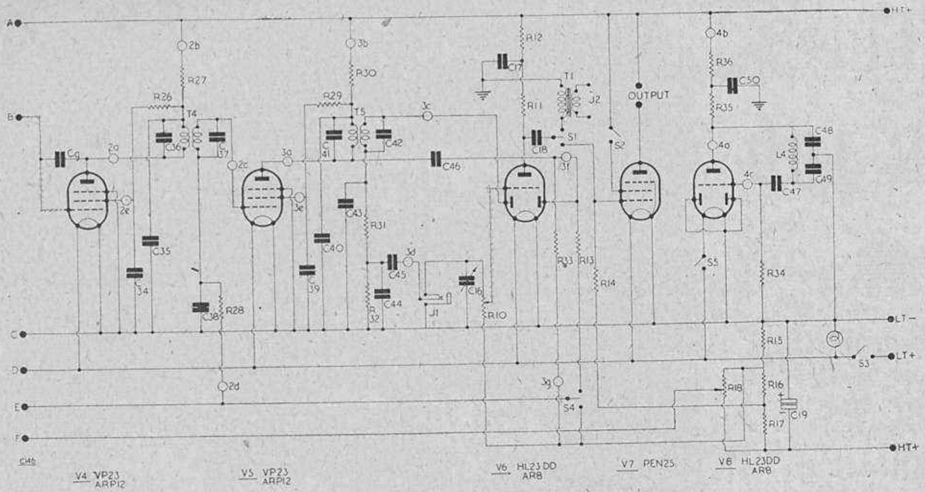



*Fig. 1. Original Circuit.*

tracking errors inevitable in home made coils, a small variable trimmer is inserted in parallel with the main tuning capacitor. Such a refinement was not found necessary in the RF stage as the aerial damps the circuit and it tunes comparatively flatly. The local oscillator is a parallel fed tuned grid circuit, this being found most satisfactory after much experimenting. The suppressor grid of the mixer is fed through a small capacitor from the anode of the oscillator. If it is fed from the grid, severe pulling will occur, it being possible to tune the oscillator with the mixer trimmer.

The IF stages are the same except that the anode and screen resistors are reduced to the values shown to obtain increased gain. This is also done in the mixer stage, the original 250 K Ω resistor in the anode circuit being removed. Controlled regeneration is introduced into the first IF valve as this gives greatly enhanced selectivity. By careful adjustjment of this, results equal to those of a crystal filter are easily obtainable.

The AVC diode is fed from the anode of the second IF stage as double the signal is obtainable here. The detector diode is fed from the secondary as before. In this circuit however are inserted a pick-up jack, and tone control. The latter is a 500$\mu\mu$F bakelite variable capacitor. The anode of the triode feeds either the phones, or the output valve and speaker. Audio volume at this point is ample for phone reception and the noise level is less. Parallel feeding ensures less noise and hum. Since low impedance phones were used by the writer, a matching transformer was obtained, but if high impedance ones are used, this transformer is not necessary.

The output valve is a Mazda PEN 25, which is very economical, and gives adequate output for normal purposes. The anode is taken to a four pin valve holder at the rear of the chassis, and the external speaker is plugged in here. No output transformer is fitted in the set, as this is contained with the speaker.

The BFO circuit is exactly the same as before,

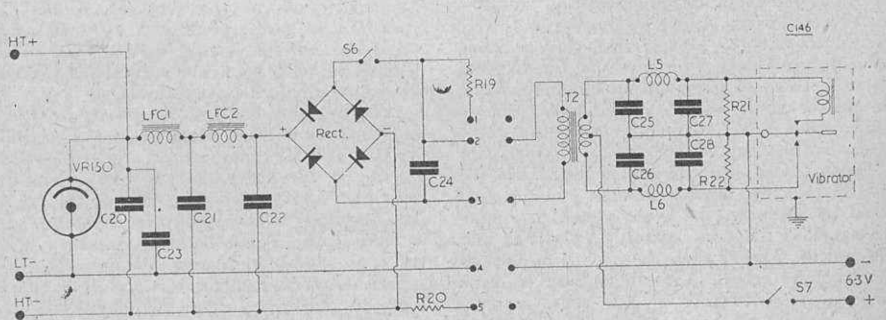



*Fig. 3. The power pack.*

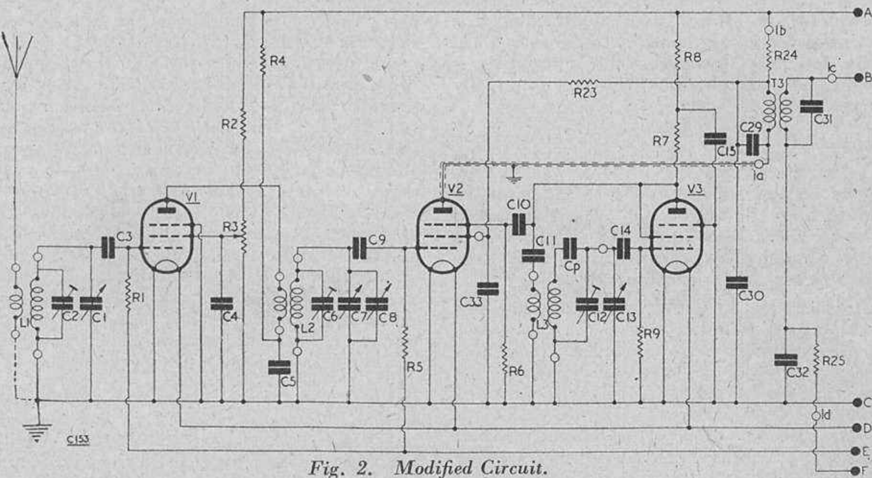



*Fig. 2. Modified Circuit.*

## COMBINED COMPONENT LIST.

### Capacitors.

| | |
|---|---|
| C1, 8, 13. | 160$\mu\mu$F variable. |
| C2, 6, 12. | 15-40$\mu\mu$F trimmer. |
| C3. | 300$\mu\mu$F mica. |
| C4, 5, 15, 30, 32, 33, 34, 35, 38, 39, 40, 50. | .01$\mu$F tubular. |
| C7. | 15$\mu\mu$F variable. |
| C9, 11, 29, 36, 41. | 150$\mu\mu$F mica. |
| C10. | 50$\mu\mu$F mica. |
| C14, 43, 44, 47. | 100 $\mu\mu$F mica. |
| C16. | 500$\mu\mu$F variable bakelite. |
| C17. | 2$\mu$F electrolytic. |
| C18, 23, 25, 26, 27, 28. | .1$\mu$F tubular. |
| C19. | 25$\mu$F electrolytic. |
| C20. | 8$\mu$F electrolytic. |
| C21, 22. | 4$\mu$F electrolytic. |
| C24. | .025$\mu$F tubular. |
| C31, 37, 42. | 160$\mu\mu$F mica. |
| C45, 49. | .002$\mu$F tubular. |
| C46. | 200$\mu\mu$F mica. |
| C48. | .0022$\mu$F mica. |

### Resistors.

| | |
|---|---|
| R1, 5, 13, 25, 28, 32, 33. | 1M Ω |
| R2, 31. | 100K Ω |
| R3. | 250K Ω potr. |
| R4, 12. | 5K Ω |
| R6. | 50K Ω |
| R7. | 27K Ω |
| R8, 20. | 1K Ω |
| R9, 11. | 47K Ω |
| R10. | 1M Ω potr. |
| R14. | 500K Ω |
| R15, 16. | 100 Ω |
| R17. | 200 Ω |
| R19. | 1.5K Ω 2 watt. |
| R18. | 50K Ω potr. |
| R21, 22. | 150 Ω |
| R23, 26, 29. | 150K Ω |
| R24, 27, 30. | 2.7K Ω |

### Inductors.

| | |
|---|---|
| L1. | Aerial coil. |
| L2. | HF coil. |
| L3. | Oscillator coil. |
| L4. | BFO coil |
| L5. | Vib. chokes |
| L6. | Vib. chokes. |
| T1. | Phone transformer. |
| T2. | Vibrator transformer |
| T3, 4, 5. | IF transformers. |

### Miscellaneous.

| | |
|---|---|
| J1, 2. | Closed circuit jacks. |
| S1, 4. | S.P.D.T. |
| S2. | Closed by LS plug. |
| S3, 5, 6, 7. | S.P.S.T. |

1 chassis 15″ x 9″ x 2″.
1 front panel 16″ x 9″.
1 Wilkins and Wright Utility Microdial.
9 Mazda octal valve holders.
1 international octal valve holders.
5 knobs 1″ diam.
1 pilot lamp and holder.
$\frac{1}{4}$″ diam. rod for extension spindles.
2 $\frac{3}{8}$″ brass collars for same.
5 valves type ARP 12 or VP 23.
2 ,, ,, AR 8 or HL 23/DD.
1 ,, ,, Pen 25.
1 ,, ,, VR 150/30.
Quantity 4 and 6 B.A. nuts and bolts.

but no coupling was found necessary. The noise limiter was omitted as it was not effective.

Of the power pack, the rectifier and smoothing arrangements are built on the receiver chassis, and the vibrator unit is built in a separate metal box. When used on mains, the latter are connected to the rectifier through a resistor. When on batteries, the vibrator is connected to the rectifier. These connections are made through a power socket at the rear. A separate accumulator is always used for feeding the filaments whether on mains or batteries. When on the former, however, a voltage stabiliser is brought into circuit, but this is not really essential.

**Construction.**

The original receiver is first completely stripped, all resistors and capacitors being removed from the tag boards. Those contained in the IF transformers are left however, as this greatly simplifies wiring. Some of these have later to be replaced as seen above.

After stripping, the IF transformers are opened and the replacements performed. The leads that originally connect to the test panel are also removed. It will be found that in the last transformer the secondary winding is connected to a small coil wound near the primary. This is to overcouple the windings and provide broader selectivity. This is removed to increase the selectivity. On the other two transformers this winding is brought out to a tag, so the connecting wires are removed and only the secondary connected up.

After this has been done, construction can be commenced. The writer used a chassis 15″ x 9″ x 2″, but any of about the same size will serve. The front panel was obtained ready cut from an ironmonger. Thin sheet aluminium for the coil boxes was also obtained from the latter source. Since the chassis as obtained will be very easily marked, it is first given a matt finish by gently rubbing it with steel wool.

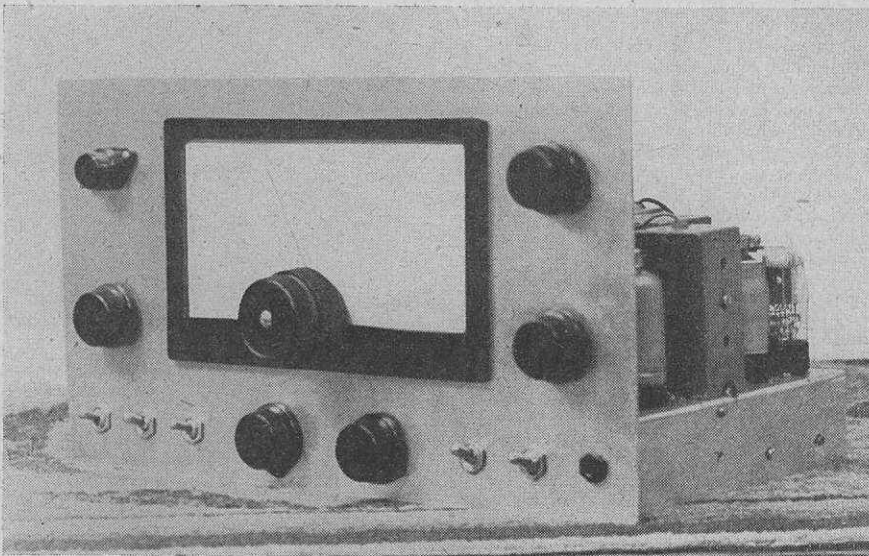
The method of construction can be left to the reader, but it is best to start by cutting out all the valve holder holes. These are all $1\frac{1}{8}$″ diameter and are easily cut with one of the many cutters on the market. These are followed by the IF transformer holes, etc. The coil boxes may then be made to suitable dimensions, bending being easily accomplished on a vice. After all the valve holders, IF transformers and coil boxes have been fixed, the holes in the front of the chassis for switches are drilled. These can be widened with a tapering bit. The front panel can then be drilled with the corresponding holes, and affixed to the chassis by mounting the switches and phone jack. All the major components such as the rectifier, chokes, and potentiometers can then be fixed. The tuning capacitor is fitted with the extension spindle, and mounted on brackets of suitable height to align the end of the spindle with the hole in the front panel. The end of the spindle is held by a collar. The mixer trimmer is mounted on a piece of the thin aluminium, and an extension spindle fitted to coincide with the hole in the panel.

Wiring can then be commenced. It is best to wire all cold leads first such as power supplies, and to keep these near the chassis. The hot leads can then be kept away from the chassis. 22 swg tinned copper wire is used for all wiring except that of the RF section which is carried out with bare 18 swg tinned copper. The grid capacitors and leaks for the first three valves are mounted as closely to the top caps as possibly. The capacitance for the IF regeneration is formed by twisting a lead from the anode of the first IF valve round the grid lead.

The vibrator is built in a lighter fuel tin which can be easily obtained from a tobacconist. The vibrator holder is mounted on the bracket used originally to hold the spare vibrator.

By using suitable pins on the power input socket, the rectifier is connected straight to the vibrator transformer, or through the resistor to the mains. When used on mains, the pins 4 and 5 are shorted by a wire in the plug. This connects R20 across the bias resistors and compensates for the current taken by the voltage stabiliser.

| Pin. | ARP 12. | AR 8. | Pen 25. | VR 150. |
|---|---|---|---|---|
| 1 | Filament & E. | Filament & E. | Filament & E. | — |
| 2 | — | — | — | Cathode. |
| 3 | Anode. | Anode. | Anode. | — |
| 4 | Screen. | — | Screen. | — |
| 5 | Suppressor. | Diode 1. | Control grid. | Anode. |
| 6 | Metallisation. | Metallisation. | — | — |
| 7 | — | Diode 2. | — | — |
| 8 | Filament. | Filament. | Filament. | — |
| TC. | Control grid. | Control grid. | — | — |



*Front view of the modified reeeiver. Along the bottom, reading left to right, the switches are Filament on/off, HT on/off, BFO on/off, AVC on/off, Phone/speaker switch. At the extreme right is the phone jack—the speaker plug being situated at rear. The two lower knobs are for Mixer Trimmer and IF gain. The left-hand side control is RF gain, with the pilot indicator above it. On the right-hand side is the Tone control (top) with the audio gain below it.*

# COIL DATA

The Coils have been so designed that the amateur bands fall at the HF end of each range. This ensures maximum performance at these frequencies. The coils for the first three ranges are home wound on standard formers, while for the two low frequency ranges, commercially made coils are used.

| | Aerial and HF. | | Oscillator. | |
|---|---|---|---|---|
| | Grid. | Coupling. | Grid. | Coupling. |
| Range 1. 10—20 metres. | $3\frac{3}{4}$ turns, | $2\frac{3}{8}$ inter. | $3\frac{5}{8}$ turns. | $2\frac{1}{2}$ Inter. |
| ,, 2. 18—40 ,, | $6\frac{7}{8}$ ,, | 4 turns. | $6\frac{1}{4}$ ,, | 4 close. |
| ,, 3. 36—80 ,, | $16\frac{1}{2}$ ,, | $9\frac{1}{4}$ ,, | $15\frac{1}{2}$ ,, | 8 close. |
| ,, 4. 75—155 ,, | Wearite | PA6, PHF6. | Wearite. | PO6. |
| ,, 5. 190—370 ,, | ,, | PA2, PHF2. | ,, | PO2. |

On the first two ranges, no padding capacitors are used. The values for the other ranges are:—

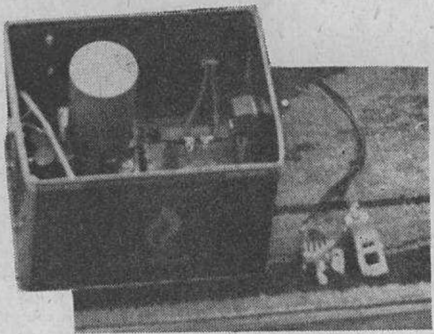
Range 3. 0.0014 F mica.
,, 4. 900$\mu\mu$F.
,, 5. 450$\mu\mu$F.

For the last two ranges the coils used are Wearite P type mounted in bases from discarded four pin valves. The coils themselves can be fixed through the unused centre pin hole.

All grid windings are wound with 20 swg. tinned copper wire. The coupling coils for the aerial and HF coils are wound with 26 swg. wire in the normal thread, while for the oscillator, the winding is of 26 swg. interwound in the case of range 1 and 36 swg. close wound for the other two.

The dial is made by cutting out a piece of $\frac{1}{8}''$ thick aluminium. This can be accomplished with a fretsaw—and a little patience! This is then enamelled black, and bolted to the front panel with the dial for calibration held underneath. The slow motion drive is a utility "Microdial" with the original pointer removed and replaced by a piece of steel wire hammered flat to make it as narrow as possible. This wire is soldered to the large brass nut at the rear of the drive. The writer has found this simple dial sufficient, but readers may like to construct a better one.

As yet no cabinet has been made for this receiver, but one can easily be made from sheet aluminium or wood. The former material is very easy to work, and is easily bent in the jaws of a vice. Metal about $\frac{1}{8}''$ thick would be suitable.



*A view showing how the vibrator unit was built into a discarded lighter fuel container.*

Due to many of the resistors and capacitators being contained in the IF transformer cans, the external connections to these transformers have been shown with a circle drawn on the wires, with a number to indicate the transformer it belongs to.

**Notes on operation.**

It is strongly advised that the IF transformers be accurately lined up with a signal generator. As they will already be roughly so, it will be sufficient to inject a modulated 465 kcs. signal into the mixer grid, and tune the transformers by adjusting the iron cores until an output meter connected across the primary of the speaker transformer gives maximum reading. The signal circuits can then be lined up for each range by adjusting the trimmers for maximum output. A detailed account of lining up is not necessary here as it can be found in many textbooks.

The IF regeneration lead has to be adjusted in length and coupling until the stage oscillates with the IF gain control almost at maximum. If oscillation is erratic, detuning the grid and anode IF circuits slightly will cure it. Normally the gain is kept near the minimum position, but when QRM is present, increasing it to the point of oscillation will result in razor-edge selectivity.

## RSGB RADIO EXHIBITION.

Just to remind readers that the RSBG Exhibition will be opened by Dr. R. L. Smith-Rose at 2.30 p.m. on Wednesday, November 17th. On the next three days, it will be open from 11 a.m. to 9 p.m. Admission is by catalogue, issued free to RSGB members. Non-members may purchase catalogues at the door, price 1s. Last year's exhibition was visited by almost 6,000 amateurs and this year the show will be even bigger.

The exhibition will be held at the Royal Hotel, Woburn Place, London.

# TRADE NOTES

**Mullard.** The following changes in nomenclature, in valve types, have recently been announced by Mullard Electronic Products, Ltd.

QV0–20 becomes QQV04–20

QV07–20 becomes QQV07–20

This modification has been introduced in order that the type numbers may be brought into line with the Mullard system of nomenclature as applied to reansmitting and industrial valves.

**A Push-pull Power Tetrode for V.H.F. Transmitters.** The push-pull power tetrode, QV07–40, recently introduced by Mullard Electronic Products Limited has been specially designed to give stable and efficient performance at very high frequencies and should, therefore, prove of very great interest to those amateurs intending to use the new 144–146 Mcs. band. A particularly interesting feature of this valve is that neutralisation is not usually necessary. This advance in valve design results from special construction of the electrode assembly and the inclusion of a decoupling condenser between the second grid and cathode. As a result of this, it has been possible to reduce the anode-to-grid capacitance of the valve to less than 0.1$\mu\mu$F. These features, together with the low internal lead inductance, ensure stable operation at very high frequencies, and an output power of 83 watts can be obtained at 200 Mcs. with an anode voltage of only 500. For reduced input it is possible to operate the valve economically and efficiently at frequencies up to 250 Mcs.

Another important feature of the QV07–40 is that it requires only a very low driving power. For example, working as a Class C amplifier with an anode voltage of 500, it requires only 0.7 watts grid drive to give 83 watts V.H.F. This means that it is possible to reduce the number of driving stages, a feature which leads to economy and simplicity in equipment design. The low anode voltage required adds to the safety and reliability of the equipment.

This valve is directly equivalent to the American type 829B. The list price is £7/10/0.

**W. J. Lloyd joins Philips.** Former Tannoy man for amplifier Department. W. J. Lloyd, Esq., B.Sc., A.M.I.E.E. has now joined Philips Electrical Ltd., as Chief Engineer of the Amplifier and Public Address Department. He resigned his position of Chief Engineer of Guy R. Fountain Ltd., in March of this year.

During the war Mr. Lloyd was in the B.B.C. Recording Department where his work in developing the War Correspondents' miniature disc recording machine has become widely recognised.

A graduate of University College London, he served a three years, student apprenticeship at the B.T.H. Co. Ltd., Rugby.

# NOTES ON COMPONENTS

## A MISCELLANY OF COMMON FAULTS

By " Leo "

**Switches** (Leaf Type)

The cam may become worn or misadjusted, leaves may lose their springiness, or contact points become dirty, causing open circuit or high resistance circuits.

(Rotary Type). The " fingers " may lose their springiness causing poor contact, or may become misplaced and short to the adjacent one. Faulty switches will be noisy in operation and can generally be detected by slowly rotating them. Faulty switches may cause loss of volume or possibly no results on one waveband. Intermittent results, crackling or a noisy background may also be caused.

**Resistors** (Wire Wound).

These components can be made to a high degree of accuracy and to carry any predetermined current. Adjacent turns may short circuit due to damage or overheating—the wire may become brittle and break. Resistors carrying current should be placed where they can be adequately ventilated and where their heat will not damage nearby components.

Metallised types usually are made only in high values, will carry little current, are easily burnt out by a small overload and resistance value may increase.

Moulded Carbon composition types will carry current for all normal radio needs, usual sizes being in 1/10, $\frac{1}{4}$, $\frac{1}{3}$, $\frac{1}{2}$, 1, 2 and 3 watt ratings.

These resistors may become noisy in operation and increase or decrease in value or open circuit. Faulty resistors may cause no results, distortion, " fading," crackling, hum, etc.

**Variable Resistors.**

The resistance element may be wire or hard graphite. The latter is normally used where high values are required and the former, if current flows in the circuit. Poor connections to the moving arm and poor contacts between the moving arm and resistance element are the most common faults.

**Fixed Capacitors.**

Solid dielectric types usually consist of a selected number of sheets of aluminium, tin or copper, foil, separated by mica or waxed paper. The latter now frequently made in tubular form. After rolling, the foil and paper are enclosed in a tubular carton and hermetically sealed. Most modern types are non-inductive and this is acheived by short-circuiting all the ends of the foil. The component may also be enclosed in a moulded or metal container.

A ring round one end of a tubular capacitor indicates that the outer foil is connected to that end and would normally be connected to a point of low RF potential:—i.e., earth to chassis. Paper dielectric capacitors are usually employed

(*continued on page* 428)

# Inexpensive Television

## By G2ATV & G3AYA

### Part 3

SO far, we have reached the position where we can obtain a spot on the screen, and the next step is to convert this spot into a raster. Thus the next constructional item is the time bases, phase splitter and synchronising circuits, and whilst we can use surplus components for these, there is no easy conversion which will do the trick. First, let us have a look at the theoretical circuits.

**Phase Splitter and Synch Separator.**

Fig. 1 shows the circuit of the phase splitter and synch separator, V1–2–3. The output from the video amplifier in the vision receiver is taken via a coupling capacitor C1 to the grid of the triode phase splitter. A 6J5 was used in the original, but any similar triode should do the job. Across the grid leak R1 will be noticed a diode with the anode taken to HT— and the cathode connected to grid. This is a DC restorer, and can be one of the VR54 valves from the 6A unit, or more conveniently an EA50. DC restoration is necessary to maintain picture quality but it might be found, as in the case of 2ATV, that removal of the diode makes little difference. This was quite a puzzler at first, as the capacitor C1—which was suspect—was found to be up to the usual standard and, indeed, held a charge for some ten seconds. However, substitution of a different capacitor which held a charge even longer made the presence of the diode necessary. It seems that what is good enough in the way of insulation for an ordinary radio receiver is not good enough in this instance.

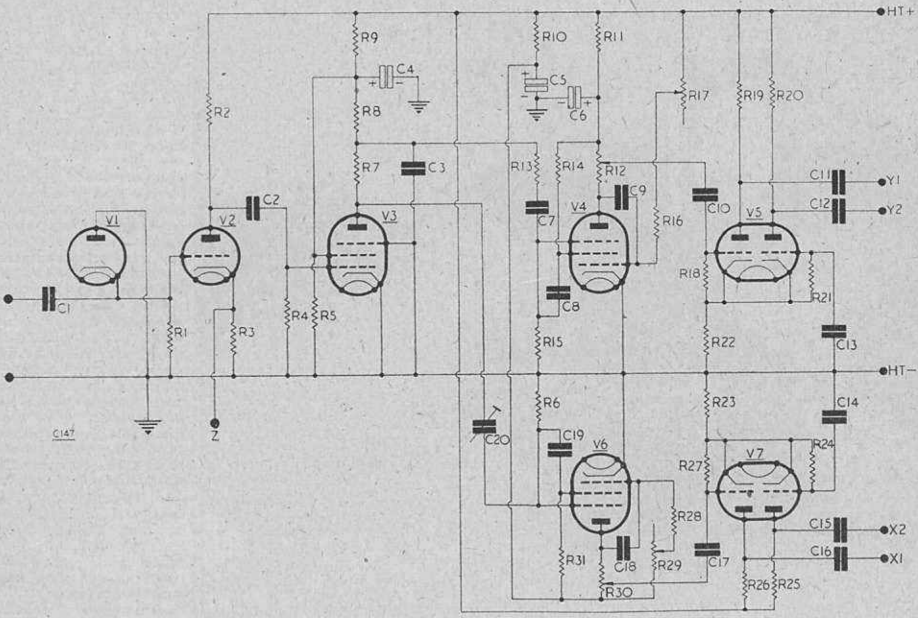
The phase splitter does exactly what one would expect it to do. A positively phased picture signal is needed to modulate the grid of the cathode ray tube, and this is obtained from the cathode of V2, which is in the same phase as the input to the grid. At the anode of this valve the picture signal will be negative and the synch pulses positive. For best synchronisation of the Miller transitron integrator time bases which are used, a negative going pulse is required, and this we have at the anode of V3. R2 and R3 are given in the component list as 10 k Ω and 5k Ω respectively, these having been found to be good average values, but it may be found that some experimenting with these values may be beneficial.

V3 is the synch separator, and though it is resistance—capacitance coupled to the phase splitter—it is unbiassed and is therefore self restoring so that the DC component is not lost. The function of this valve is to separate the synch pulses from the vision signal. Separation is automatically carried out in the grid circuit, and only the negative synch pulses appear in the anode circuit. These pulses are of the correct phase for synchronisation of the time bases. It will be noticed that the screen grid is operated at a higher voltage than the anode—this also helps to remove the picture content of the signal, the presence of which would cause instability of the synchronising, particularly in the line time base.

The line and frame synch pulses are taken from a split load in the anode circuit. The line pulses are taken from the anode resistor R7 through a differentiating circuit—that is, one which does not respond to low frequencies very well—consisting of C20 and R6, to the suppressor grid of the line time base oscillator V6. C20 has a very low capacitance, and an air spaced trimmer of the concentric type does very well here. The frame pulses are taken from the other anode resistor, R8, through an integrating circuit—that is, one which does not very well respond to high frequencies—consisting of C3, R13, and via C7 to the suppressor grid of the frame time base oscillator V4. Finally, in the anode circuit of the synch separator we have the decoupling resistor and capacitor R9 and C4. Decoupling was found essential in this stage, and also in the two time bases, and should on no account be omitted.

**Frame Time Base and Amplifier.**

V4 is an RF Pentode used as a Miller integrator transitron time base, and V5 a double triode used as a push-pull amplifier. R11 and C6 are the decoupling resistor and capacitor. The output from this stage is taken from the anode, and by using a potentiometer for the anode resistor R12 we have a variable amplitude control. The frame frequency control is potentiometer R17 in the grid/HT circuit. We have room here for only a brief description of the action of the time base, but some idea of its working may be found useful should any snags arise.




## COMPONENTS LIST

**Capacitors:**

C1: .25μF
C2: .1 μF
C3: .1 μF
C4: 8 μF 500v
C5: 8 μF 500v
C6: 8μF 500v
C7: .05μF
C8: .01 μF
C9: .05 μF
C10: .1μF
C11: .25 μF 3,000v
C12: .25 μF 3,000v
C13: .1 μF
C14: .1 μF
C15: .25 μF 3,000v
C16: .25 μF 3,000v
C17: .1μF
C18: 100 pF
C19: 100 pF
C20: 30 pF

**Resistors:**

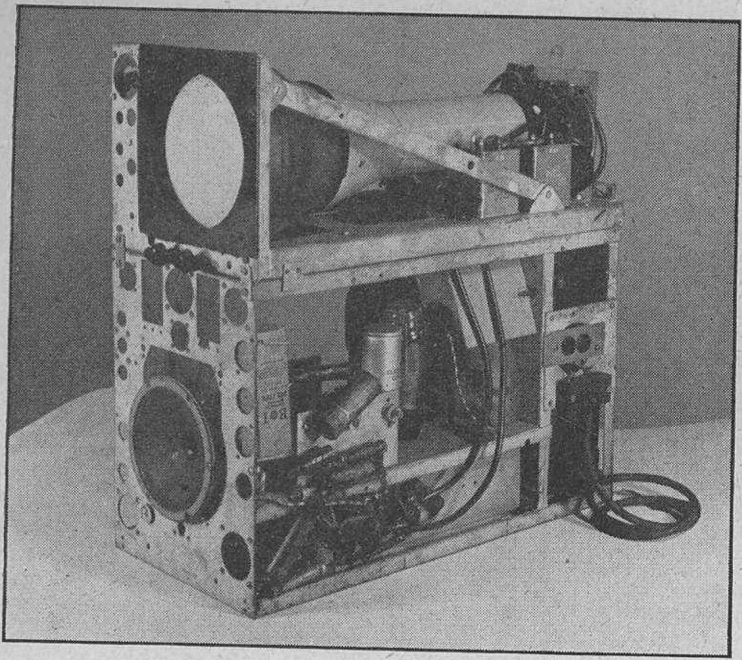
R1: 1 M Ω ½w
R2: 10 K Ω 1w
R3: 5 K Ω 1w
R4: 1 M Ω ½w
R5: 68 K Ω 2w
R6: 75 K Ω ½w
R7: 6 K Ω 2w
R8: 20 K Ω 2w

**Resistors**—*continued*

R9: 47 K Ω 2w
R10: 30 K Ω 2w
R11: 68 K Ω 2w
R12: 50 K Ω pot.
R13: 47 K Ω ½w
R14: 100 K Ω ½w
R15: 47 K Ω ½w
R16: 500 K Ω ½w
R17: 2 M Ω pot.
R18: 1 M Ω ½w
R19: 100 K Ω 2w
R20: 100 K Ω 2w
R21: 1 M Ω ½w
R22; 2 K Ω 1w
R23: 47 K Ω 1w
R24: 2 M Ω ½w
R25: 100 K Ω 2w
R26: 100 K Ω 2w
R27: 2 M Ω ½w
R28: 0.5 M Ω ½w
R29: 2 M Ω pot.
R30: 20 K Ω pot.
R31: 47 K Ω ½w

**Valves:**

V1: EA50, 6H6, VR54
V2: 6J5, 6C5
V3: 6AC7, 6SH7, EF50.
V4-6: 6AC7, 6SJ7, EF50
V5-7: 6SN7



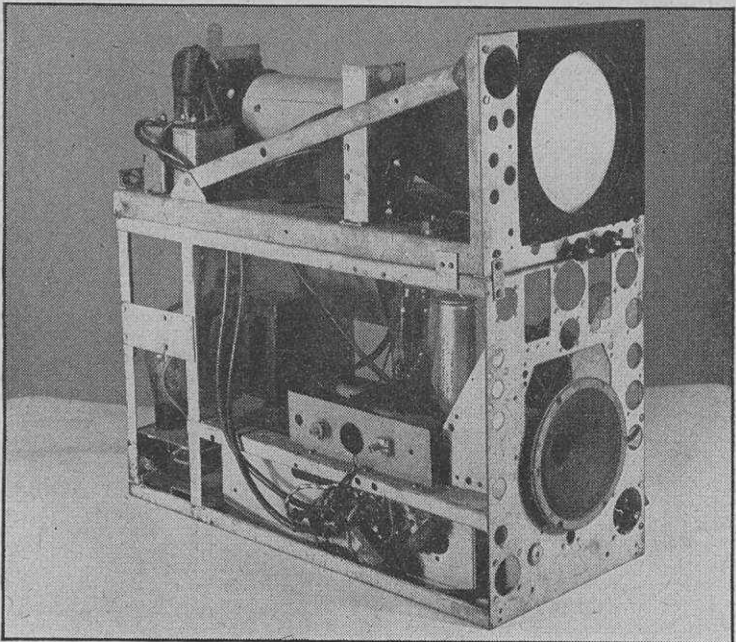
*This illustration shows the Time Base and Tube chassis as built by G2ATV. The two controls under the tube face are Brilliance on left and Focus on right. The two capacitors by the tube base are C15 and C16. At the rear of the lower chassis will be seen the mains lead taken from a multi-way connector which is used as a junction point for the power leads from the other chassis. Above can be seen a couple of panel mounting fuses. The chassis is fitted with two vertical strips running along its length, on which the time base valves are mounted horizontally. The components which can be seen here are those associated with the phase splitter, synch separator, line time base and amplifier. On the partition at rear is the paper reservoir capacitor, rectifier, and smoothing capacitor of the time base power supply. On the front panel is mounted a 5½ inch speaker.*

The voltage on the anode of V4 charges up the capacitor C9, and this capacitor discharges through R16–17: The time taken for this action is the scanning period. During this discharge, the anode current steadily increases, the anode potential decreases, and the screen potential decreases; all this as the grid potential increases. There comes a point where any further increase in the grid potential causes no extra increase in anode current. At this point the screen current experiences a surge, accompanied by a sudden drop in potential. The suppressor grid is connected to the screen via C8. The potential of the suppressor grid, which has hitherto remained fairly constant, now decreases, and this in its turn still further decreases the screen potential. This action is cumulative, with the result that the anode current cuts off. At this point there is no drop in potential across R12, and C9, which has become almost discharged, now rapidly charges up again. The time taken from the point where the anode current ceases to rise, through the drop to cut-off, and to the point where the capacitor C9 again becomes charged, is the fly-back period.

Summing up, the scanning period depends upon the time constant of C9, R16, and the variable R17, the latter being the frequency control. The fly-back period depends upon the time constant of C8–R15, and the scan is commenced at the correct time by the synch pulse applied to the suppressor grid via C7.

V5 is a double triode valve used as a push-pull amplifier. With a low EHT supply to the tube, it is possible to obtain a full size picture by taking the output of V4 to one of the deflector plates, and connecting the remaining plate of the pair direct to the final anode. With an EHT supply of 2,000v or over, which gives a smaller spot and better definition, the sensitivity of the tube decreases and a larger output is needed from V4. Again, trapezium distortion—a picture which is not rectangular—will be obtained if the deflection is not symmetrical. Also, the amplifier can be so arranged to correct any non-linearity in the sawtooth obtained from the time base. For these reasons, the small extra expenditure involved in using push-pull deflection is, in our opinion, well worth while.

The output from V4 is taken to the grid of V5(a) via the capacitor C10. V5 operates as a cathode coupled amplifier, and the action is as follows: with positive input to V5(a) this section conducts, and the cathode voltage therefore rises across the resistor R22. This component being common to both cathodes, V5(b) cathode rises and therefore cuts the valve off, as its grid is returned to ground. If a negative voltage is applied instead, V5(a) cuts off and V5(b) conducts, therefore the waveforms appearing across the anode load resistors R19–20 will be opposite to each other, which is correct for application to the vertical deflector plates.



*This photo taken from the opposite side shows the components associated with the frame time base and amplifier. Note the frame frequency and amplitude controls mounted on a small panel for easy access. Just behind the two co-ax leads running up to C11 and C12 can be seen the time base power pack smoothing choke. At the rear of the lower chassis one of the EHT rectifiers is just visible. Half way along the top chassis, the vertical bracket is used to mount the vertical and horizontal shift controls.*

**Line Time Base Oscillator and Amplifier.**

V6 and V7 are almost identical in operation and design to their counterparts V4 and V5, the only difference being in component values. The negative synch pulse is taken from across the resistor R7 in the anode of V3. Differentiation is carried out by C20–R6 before being passed on to the suppressor grid of V6, the operation of this valve being similar to the frame time base oscillator V4. The output from V6 is taken via a potentiometer R30, capacitor C17, and to the grid of V7(a), the line time base amplifier, and from the anodes of both sections, it is fed via the capacitors C15–16 to the horizontal deflector plates. R29 is the frequency control, and R30 controls the amplitude. The trimmer C20 can be adjusted to approximately half capacity, and any further adjustments, if necessary, can be made during the testing and running up of the complete equipment.

**Queries.**

This series has already resulted in a flood of letters from readers building this or similar televisors, and some points are of sufficiently general interest to warrant inclusion here. First, then, with regard to testing for the " spot " as mentioned in the October issue. No mention was made about the modulating grid, with the result that several readers left it " up in the air " and as a result got all manner of interesting " blobs " instead of a spot. We took it for granted that constructors would ground the grid to chassis through a suitable resistor, which just goes to show. For testing purposes, try a 5 k Ω, the value which will be used in this position—see the diagram on p. 421.

Readers in the Birmingham area have been making enquiries about the suitability of this televisor for the transmissions from the station now being erected at Sutton Coldfield. The answer is, that no alterations are necessary with the exception of the sound and vision tuning. The Birmingham sound will be transmitted on 58.25 Mcs, and the vision on 61.75 Mcs. In order to cover these frequencies, it will be necessary to remove a couple of turns or so from the RF25 unit coils, or alternatively an RF26 unit can be used without modifications.

Another question is, what is the likely range. Well, it all depends ! We know a reader who is building this televisor in Yorkshire. He doesn't expect to get a lot in the way of pictures, but says he will at any rate get some fun out of it. A chappie in Guernsey " looks in " most evenings, and there is a keen viewer in Liverpool. All we *can* really say is that the generally accepted service area is reckoned at about 40 miles radius from Alexandra Palace.

*To be continued.*

# Query Corner

## A "Radio Constructor" service for readers

**Pick-Ups.**

*"The commercial radiogram which has been in use for many years still gives satisfactory radio reproduction but the gramophone reproduction has fallen off in both volume and quality. Can you help me trace the fault?*

*—E. Stone, Guildford.*

This is a fairly common type of complaint which in 99 cases out of a hundred may be traced to the deterioration of the needle armature suspension of the gramophone pick-up. In the normal type of moving iron pick-up the needle holder and armature are made in one part which is suspended between the two pole pieces of the permanent magnet by means of rubber pads. After the pick-up has been in use for some time the rubber perishes and becomes hard, thus preventing the free movement of the armature. This seriously damps down the vibrations of the needle as it attempts to follow the record groove, and results in poor quality reproduction. This effect, incidentally, also causes excessive record wear as the increased inertia imparted to the needle, causes it to wear away the sides of the record groove. The remedy for this trouble is to renew the rubber suspension pieces. The little rubber sleeves used to insulate the pivot arm of the armature may consist of the rubber insulation taken from a piece of flex having a suitable diameter. In order to preserve a fairly free needle movement, it is necessary to chose a rubber sleeve which is reasonably thick, and not too hard. The type of sleeve used on good quality flex will be found to be admirable for the job. The top suspension may generally be made from an elastic band of suitable size. Great care must be exercised when dismantling and assembling the pick-up to ensure that the coil and its associated leads do not become damaged, it being only too easy to break one of the coil lead wires whilst adjusting the pole pieces. It is good practice to remove the coil leads from their connections before commencing to dismantle the pick-up. When reassembling care must be taken not to clamp the pole pieces too tightly on the armature suspension, on the other hand if the suspension is slack the magnet will pull the armature over until it touches one of the pole pieces. This will result in poor reproduction and excessive chatter. Also the air gap between the pole pieces must be as small as possible otherwise the sensitivity may be seriously reduced. These two latter requirements are conflicting but a little experimental work will soon provide the best compromise.

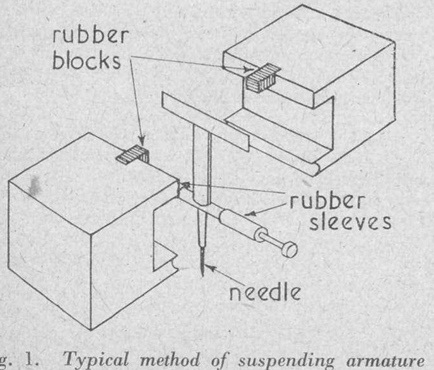



*Fig. 1. Typical method of suspending armature between pole pieces.*

Before leaving the question of gramophone reproduction we would stress the need for using screened cable when making connections to pick-ups and also the need for earthing the motor frame. In many cases this latter precaution is omitted and results in mains hum or general interference from the commutator.

**Short Wave Converters.**

*"I have an ex-RAF battery operated receiver Type R.1224 which tunes down to 30 metres. Can you supply me with a simple single valve converter which will enable me to get down to 19 metres?"*

*—L. Dumble, Growborough.*

The R.1224 is a five valve battery operated superhet designed to cover the wave range 30 to 300 metres, and intended for operation from a standard 120 volt HT battery and 2 volt accummulator. The receiver provides a reasonable good degree of sensitivity and it is well worth while extending its wave coverage by means of the simple single valve converter about to be described.

Firstly, however, a word of warning regarding single valve converters and especially those of the type which work on the autodyne principle. This type normally make use of a single triode or pentode valve connected in an oscillator circuit, so arranged that the oscillations beat with the incoming signal so as to produce an intermediate frequency. The result is a low signal to noise ratio and poor sensitivity, coupled with a radiated signal which is sufficient to interfere with reception for miles around. Fig. 2 shows a converter built around the Osram triode hexode type X24. In this circuit the valve is functioning in its normal capacity as a mixer and local oscillator and in this particular case its output or intermediate frequency is 1 megacycle (300 metres) Although only one signal tuned circuit is employed the use of the relatively high intermediate frequency reduces the possibility of trouble due to second channel interference to negligible proportions. The signal tuned circuit is flatly tuned and hence no difficulties will be experienced due to slight tracking errors, the preset capacitor connected across the signal section of the main tuning capacitor is sufficient to provide the required difference between the signal frequency and the local oscillator frequency. The coils may readily be of the standard Eddystone plug-in type, both coils being identical for 19 metres band operation. In order to prevent instability and that most troublesome defect known as "pulling" care must be taken to screen the two tuned circuits from one another, this is best achieved by placing a screen between the two sections of the tuning capacitor and extending it to pass between the two coils. It is preferable to make all connections as short as possible; ensure that all solder joints are perfect and use clean 18 swg tinned copper wire for making connections.

The operation of the converter is perfectly straight forward its output lead being connected to the aerial terminal of the receiver via a short length of screened cable. The earth terminal of the convert should also be connected to the earth terminal of the receiver. If now the receiver tuning is set to about 300 metres and the volume control advanced to the maximum position, and assuming everything to be in order, the rotation of the tuning dial on the converter will bring in numerous stations on the 19 and 20 metre bands.

## "Query Corner" Rules

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

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

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

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

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

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

Should any trouble be experienced in obtaining results with the converter the triode section of the X-24 should be checked to ensure that it is oscillating. This is most easily achieved by inserting a one millimeter in the earthy end of the grid leak of the triode section. If all is in order a reading of 100 micro-amps will be obtained. Should this test indicate that the triode section of the valve is not in oscillation, the most likely cause of the trouble is incorrect connections to the oscillator coil. Reversing the leads to the feed-back winding of the coil should result in a cure.

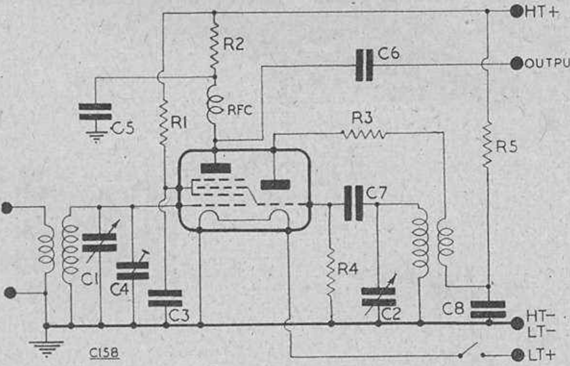



*Fig. 2. Circuit diagram of a single value converter. Values are:—C1, 2, 100 $\mu\mu F$ ganged; C3, 8, 0.01 $\mu F$; C4, 25 $\mu\mu F$; C5, 01001 $\mu F$; C6, 7, 100 $\mu\mu F$; R1, 3, 50,000 Ω; R2, 5,000 Ω; R4, 0.1 M Ω; R5, 20,000 Ω. Valve is an X24.*

# Biassing Problems
## IN AC/DC RECEIVERS
### Discussed by LEN MILLER

MOST readers are familiar with the fundamentals of the combined AC/DC-Battery operated receiver. The 0.05 Amp. valve filaments are wired in series and are heated with either rectified AC, the DC mains, or 'by the flick of a switch' by a dry battery.

In the ordinary AC/DC receiver with the heaters wired in series, biassing presents no problem, as the cathode of each valve is independant of its own filament, and it can be returned to earth or made to be positive with respect to earth as required by the inclusion of the normal cathode resistor, each grid now being returned to the earth line.

Now take a glance at Fig. 1 which shows the grid returns of a standard 4-valve battery operated superhet. The mixer and IF valves (of the 'all-dry' type) normally work at zero bias, and it will be seen that the grid returns of these two valves, after being de-coupled (C1, R1, C2, R2) return to the earth line via. the resistor R3 (the diode load). Under 'no signal' conditions no current is flowing through R3, therefore there is no potential difference across it, and the grids of the controlled valves are at earth potential.

As one side of the filaments of each valve is also returned to earth, the grids are at zero potential (with respect to the negative side of its own filament).

Now look carefully at Fig. 2, which is the identical circuit with the exception that the filaments are now wired in series, the diode triode following normal AC/DC practice being the most 'earthy' and the filament of the output valve being at the highest potential from earth.

If the valves in Fig. 2 were of the indirectly-heated type, the cathodes could be returned to earth *via* the cathode resistors, and the resultant receiver would be capable of working merrily, but as they are in fact directly-heated types, it certainly would not!

Let us find out why not, and take the output valve first, bearing in mind that we are concerned with providing the correct bias with respect to the valve's negative filament terminal.

This valve will almost certainly be 3Q5 or similar type, requiring 4.5 volts on the grid. This is provided for in Fig. 1 by returning the grid *via.* the grid leak to HT, a point 4.5 volts more negative than the earth line, the filament being returned to the earth line as shown.

Now refer to Fig. 2. The grid is still returned to the point 4.5 volts more negative than earth, but the negative end of the filament is 4.5 volts *more positive* than earth, due to the series filament arrangement. The net bias (the potential difference between filament and grid) is clearly 9 volts (*not* zero ! !)

This can easily, and very conveniently be remedied by returning the grid resistor direct to earth, and dispensing with the resistor network between LT and HT (as far as this valve is concerned), as shown in Fig. 3. (If the filament is 4.5 volts more positive than the earth line, and the grid is returned *to* the earth line, the grid must be 4.5 volts negative with respect to its own filament).

Going back to Fig. 2, the oscillator grid leak is returned to earth, but the negative end of the mixer valve's filament is 1.5 volts positive to

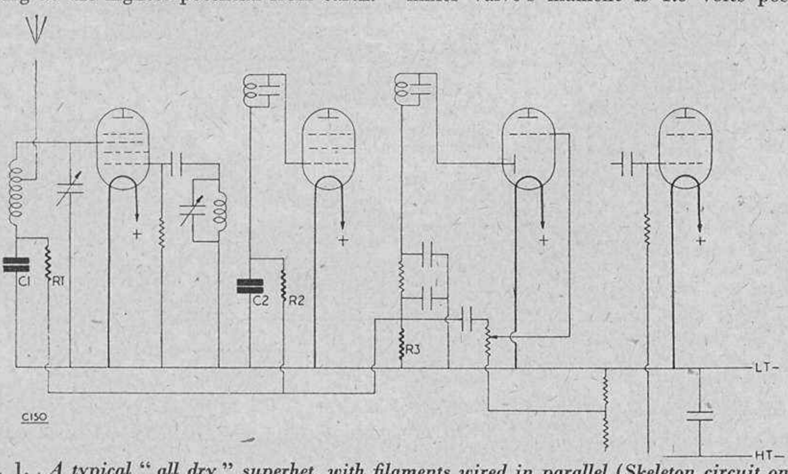



*Fig. 1. A typical " all dry " superhet, with filaments wired in parallel (Skeleton circuit only).*

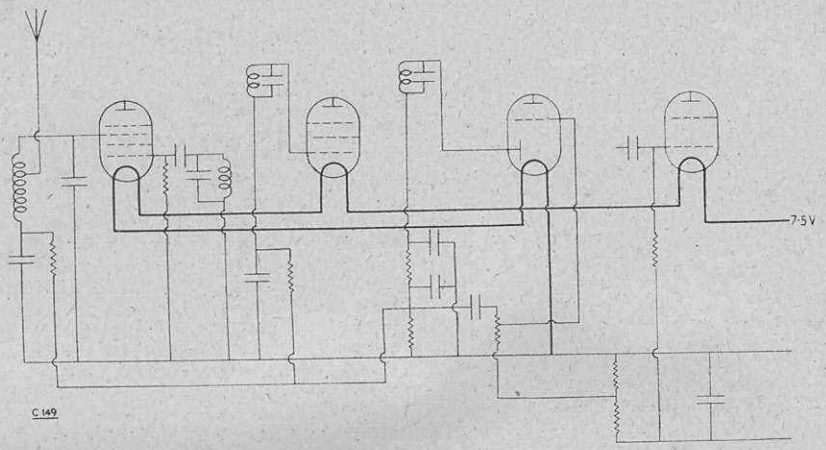



*Fig. 2. The same circuit as Fig. 1, with the filaments wired in series. This illustrates the incorrect biassing.*

earth, consequently the oscillator has a 1.5 volt negative bias, and would almost certainly not oscillate, under such conditions.

Once again, the remedy is simple, as the grid leak may be returned to its own negative filament, as shown in Fig. 3.

The bias arrangement of the triode section of the diode triode in Fig. 2 will be quite satisfactory, as the filament is returned to earth anyway, and it is convenient to include a small value of resistor between LT and HT to provide the 1 volt negative bias required for this valve.

The signal section of the mixer and the I.F. valves present quite a problem however, as it is considered desirable to provide AVC, and, because of this must be connected to the high potential end of the diode load.

The mixer grid (in Fig. 2) is biassed 1.5 volts (due to its filament being 1.5 volts positive to earth), and the IF grid is biassed 3 volts. Obviously, the sensitivity of such a receiver would be very poor indeed.

If the AVC were dispensed with, the answer would be a simple one, as each grid return could be joined to its own filament, but AVC is an essential feature of the modern superhet, so another way out must be found.

Fortunately, we learnt at school that if +1.5 is added to —1.5 the answer is zero, so all we have to do (in the case of the mixer grid) is to leave the AVC return to earth, as in Fig. 2 and to make another return to a point 1.5 volts *positive* to its own filament, and (in the case of the LF valve) make another return to a point 3 volts positive to its own filament, and the resultant bias will be zero.

This is explained more fully in Figs. 4 and 5. Fig. 4 shows the equivalent circuit, point " A " being the grid and point " B " the filament. R1 is the decoupling resistor, and, ignoring for the moment the right-hand section of the figure, point " A " is clearly 1.5 volts negative to point " B " (remembering that no current is flowing).

Re-Drawing, Fig. 4, another way round, we get Fig. 5., which is exactly the same as Fig. 4, and helps to explain that when R1 and R2 are equal, the potential at point " B " is the same as that at point " A "; in other words, when point " A " the grid, is connected *via* R2 (of equal value to R1) to an equal voltage of

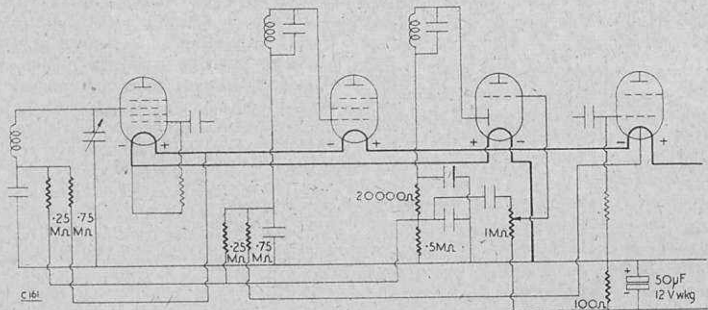
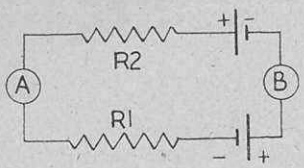



*Fig. 3. The grid returns re-arranged for correct bias.*



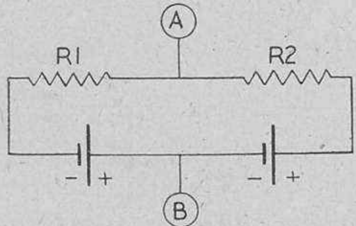




*Fig.* 4. (*Above*). *Fig.* 5. (*Below*).

opposite polarity, the resultant voltage on the grid is zero.

In this case " R1 " must represent the total resistance between grid and earth, namely the value of the de-coupling resistor plus the diode load. It follows then, that it is only necessary to make R2=R1, and to return R2 to a point of equal but opposite voltage to maintain the grid at zero potential.

Simple, isn't it? This can be achieved in practice by taking the second grid return of the mixer valve to its own *positive* filament terminal, which provides the required 1.5 volts positive to overcome the 1.5 volts negative provided by the AVC return.

Exactly the same remarks apply to the IF valve, except that in this case we have to provide a positive bias of 3 volts to cancel out the negative 3 volts in the AVC return of this valve. This is achieved by returning it to the centre tap of the 3Q5, as shown in Fig. 3, which gives typical circuit values.

This in no way adversely affects the AVC action, as when a signal appears across the diode load the negative bias increases which reduces the gain of the controlled valves in the usual manner, as the positive bias due to the extra grid returns remains constant.

In conclusion, the writer wishes to make it quite clear that he claims no originality in the construction of this article—this biassing arrangement is quite standard practice in many commercial receivers of this type—but he feels that some experimenters may be unfamiliar with these details, and may find this article of interest.



for by-pass and decoupling purposes. Mica dielectric types are usually contained in a plastic or moulded case and are used for AF and RF circuits where low-loss and leakage are of great significance.

Other types met with are the silvered mica ones, in which the plates consist of silver deposited on the mica dielectric. There are also the silver ceramic types.

**Electrolytic Capacitors.**

These may be of three types—wet, dry and semi-dry. They usually consist of two aluminium electrodes in contact with a suitable electrolyte. Upon connecting to a source of DC, one plate becomes positive and the other negative. A chemically formed film appears on the positive electrode and as this may be only a few molecules thick the capacitance per unit area will be large. The negative electrode merely serves to make contact with the electrolyte as this is really the negative electrode itself. These capacitors have the property of passing current in one direction only, i.e., from negative to positive. Care must be taken to connect them in the correct manner. There is always a slight leakage current, but this may develop into an excessive leakage, short or open circuit. Electrolytics may also lose capacitance.

# 60-Watt MODULATOR

## *Constructed and Described by*

LES COUPLAND, G2BQC

THIS modulator unit will modulate a transmitter of 150 watt input with care, and by making use of easily obtained valves, and not more than 500 volts HT, its initial cost is kept reasonably low.

The circuit is quite straightforward. A 6J7 is used as microphone amplifier, giving sufficient gain for a crystal microphone. Alternatively, a 6SJ7 could be used, which has its grid connection in its base, not on top of the envelope, as in the former type. The second stage is either a 6J7, 6SJ7, 6C5, or 6J5. A .5 Meg $\Omega$ potentiometer between the two stages acts as gain control for the modulator.

This voltage amplifier stage is resistance-capacitance coupled into a 6V6GT or 6V6G, triode connected as shown. This, in turn, is coupled by a step-down driver transformer into a pair of 807's running in Class AB2. The driver transformer should have a step-down ratio of 2 to 1. The output or modulation transformer used is a Woden UM3.

The power supplies required are 500 volts at 250 mA, 6.3V at 5 amps, and 5V at 3.5 amps for the 5U4G rectifier. The 807's require 25 volts grid bias, and this is derived from a battery. The rest of the power supply is built on the same chassis as the modulator itself. One single power supply will supply all stages, including the modulators, but the smoothing should receive particular care, and requires a certain amount of detailed comment. The power supply transformer is of 500-0-500V, 250 mA rating. A choke input filter is used with a 5-25H swinging choke (CH1), and two 10H 80 mA, smoothing chokes CH2 and CH3. Capacitors C1, C2, C3, and C4 are connected as shown, C1 being 4$\mu$F, 600V working, C2 and C3 8$\mu$F 350v working and C4 16$\mu$F 350v working. The resistor R is an adjustable 25 watt, 5,000 $\Omega$ resistor, which must be adjusted until there is approximately 310 volts on the 807 screens, and the 6V6G anode, with no signal. With a signal, this voltage should drop to approximately 300 volts, and the 807's should then draw up to 150 mA. At this rating, they would very adequately modulate a 130 watt carrier at the writer's station.

**Construction.**

The unit and its power supply are built on a standard chassis with panel as shown. The layout is not critical, but some care should be taken to ensure as short leads as possible. When wiring in paper coupling capacitors, see that the inside connection is made to the grid circuit. The general position of the components can be seen from the photo. The power supply, transformer smoothing chokes, capacitors and rectifier valve can be seen on the left of the photo, the driver transformer, modulation transformer, and the 807's can be seen to the right. The other valves are located close to the panel, with resistors and capacitors beneath the chassis.

The microphone input jack must be screened up to the grid of the 6J7. Particular care must be given to ensure that the screening is adequate.

**Testing.**

The modulator should be thoroughly bench-tested before putting it on to the transmitter. First of all, connect a speaker in the 6V6G anode, and listen to the speech from the microphone. Check for stability and lack of hum. Then connect a 60 watt 230 volt electric light bulb across the secondary of the modulator transformer as a load. Talking into the microphone should cause the bulb to light up. An anode to anode impediance of 3,800 Ω is needed for the 807's, the correct tapping for the secondary depending on the valves being used in the final stage of the transmitter. (See *Radio Constructor*, Vol. 1, No. 4—A Modulator for the Versatile 150 watt TX, p. 99).

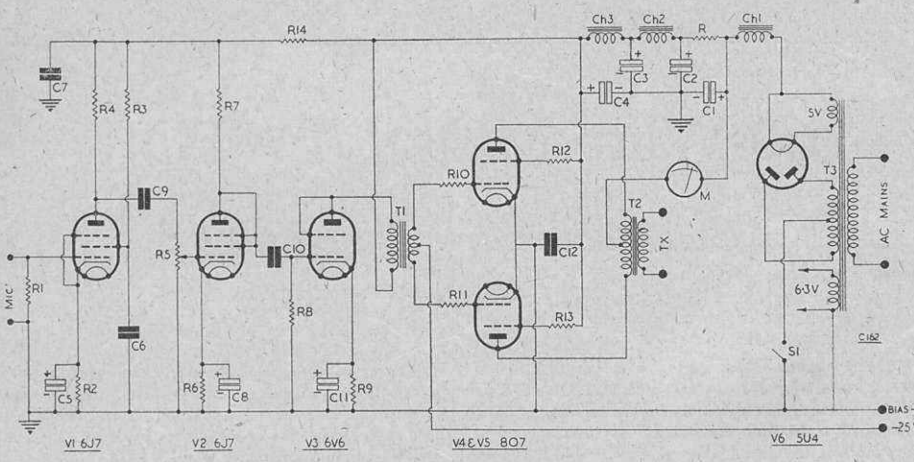



*Fig. 1. The Modulator and power pack circuit.*

**COMPONENT VALUES**

**Capaciotrs:**

C1: 4 μF, 600V wkg.
C2: 8μF, 350V wkg.
C3: 8μF, 350V wkg.
C4: 16μF, 350V wkg.
C5: 25μF
C6: 0.1 μF
C7: 8 μF
C8: 25 μF
C9: 0.05 μF
C10: 0.05 μF
C11: 25 μF
C12: 0.001 μF

**Resistors**

R See text.
R1: 2M Ω
R2: 500 Ω
R3: 1,500 Ω
R4: 250,000 Ω
R5: 500,000 Ω
R6: 500 Ω
R7 100,000 Ω
R8: 500,000 Ω
R9: 500 Ω
R10: 100 Ω
R11: 100 Ω
R12: 100 Ω
R13: 100 Ω

**Chokes:**

Ch 1: 5-25 H, 250 mA
Ch 2: 10 H, 80 mA
Ch 3: 10 H, 80 mA

**Transformer:**

Secondaries:—
500—0—500 V, 6.3V. 5A, 5V, 3, 5A.

**Meter:**

0—250 mA

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R1116 ALL-WAVE (15-2,000M) 8-valve Receiver, in working order. 2-v and 120-volt Batteries required. £7/10/0. Including carriage. Also R1224 Receiver (30-300M) as above. £5/5/0, including carriage. R. Allen, 75, Larkhill Road, Yeovil.

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