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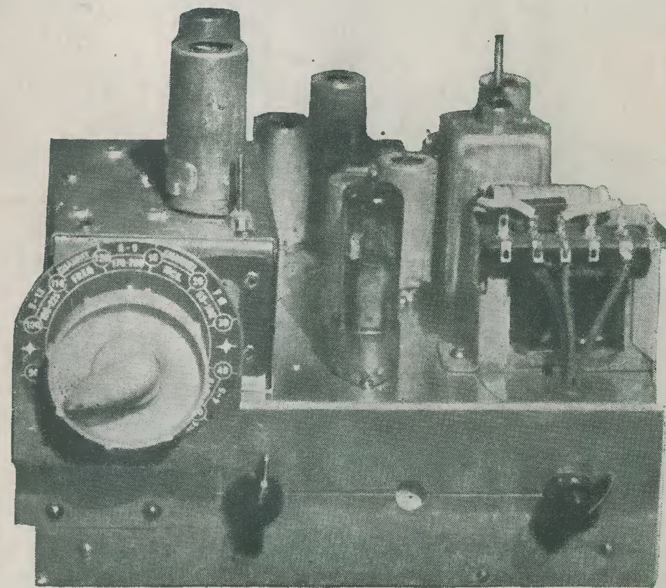
Volume 8
Number 12
JULY
1955

The RADIO CONSTRUCTOR

for the Radio and Television Enthusiast

BAND III TELEVISION *for the* HOME CONSTRUCTOR



ALSO IN THIS ISSUE

- V.H.F. T.V. AERIALS
- HIGH QUALITY TUNER UNIT, Part 2
- THE 1955 TWO, Part 2
- CORONA PROBE
- THE VERSATILE BUZZER
- BC-221 POWER UNIT
- RADIO CONTROL NOTES
- Let's Get Started * Radio Miscellany
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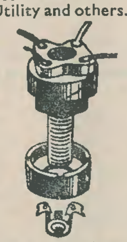

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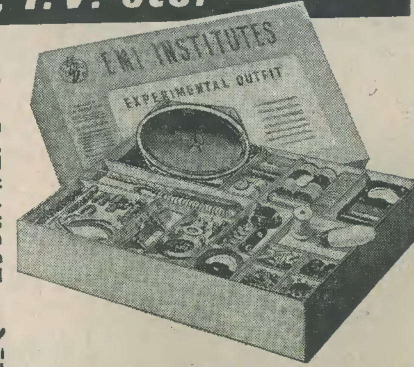

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The
Radio Constructor
incorporating THE RADIO AMATEUR

CONTENTS FOR JULY

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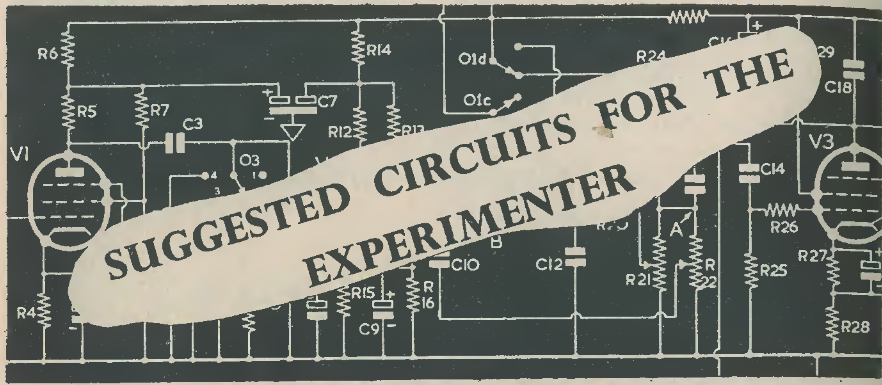
NOTICES

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 products for review in this section.

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



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. 56 A "Corona Probe" For Television Servicing

One of the most prevalent sources of trouble in television receivers is given by faults in the circuits which carry extra high voltage. These can include not only the e.h.t. transformer and the wiring to the c.r.t. anode but also the connections to the line output valve anode, the deflector yoke, and any remaining components in the line output transformer circuit which may be used for width and linearity control. At some or all of these points it is possible to have complete breakdown or corona.

Complete insulation breakdown usually prevents the televisor from working at all, and its location and cure is normally fairly easy to carry out. Corona, on the other hand, may sometimes be more difficult to locate. Obvious cases of corona identify themselves by an audible "sizzling" or "frying" noise at the point of the circuit at which they are appearing. They may be located also by the visual blue glow to which they give rise. Unfortunately, however, corona does not always show itself as readily as this; and it can often be hidden by component housings, e.h.t. overwind "tyres," wire insulation, and the like. It is possible for quite a "mild" case of corona to completely spoil the received picture by reason of the white flashes it superimposes on the screen.

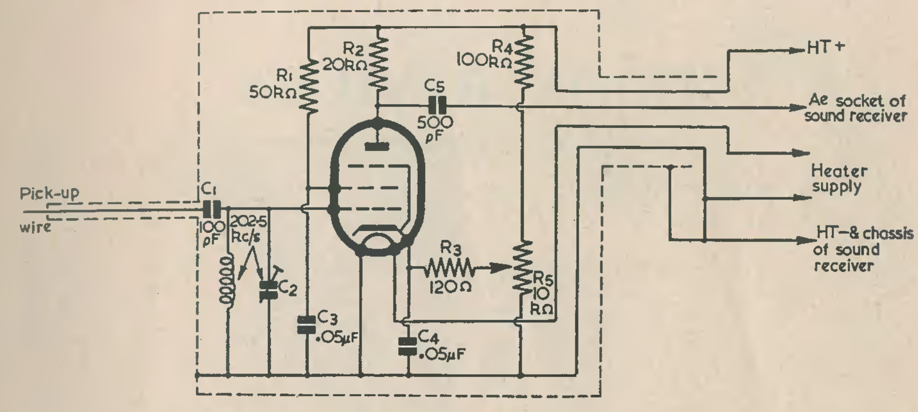
This month's circuit illustrates a "probe" which may be made up quite easily and cheaply, and which should be of considerable assistance in locating sources of corona which cannot be readily discovered by the normal methods.

Principle Of Operation

The principle of operation of the probe is very simple; and it takes advantage of the nature of the corona discharge itself.

This discharge may be either continuous, or recurrent at line frequency. If continuous, it usually results from a fault in the components or wiring carrying the e.h.t. voltage after rectification; this voltage being maintained at its full value by the e.h.t. reservoir condenser. Corona is recurrent at line frequency, on the other hand, when it is due to a fault at any high-voltage point except those just described. When recurrent, the corona discharge only takes place during the flyback period, this being the time when the high-voltage pulses appear in the line output circuit.

Since the corona consists essentially of a static discharge, it creates a considerable amount of r.f. interference over a very wide band. It is possible to pick up this interference with the aid of any high-gain r.f. amplifier. Owing to the fact that the repetition frequency of the recurrent type of corona is that of the line frequency, it is reasonably safe to assume that interference caused by this type of corona would be more intense at harmonics of the line frequency than elsewhere. Experiments undertaken by the writer appear to confirm this point, but he would hesitate to state that it might apply to all examples of interference caused by the recurrent type of corona.



Corona probe circuit

E173

The Circuit

In consequence of the points just mentioned, a suitable "corona probe" would consist of a mobile r.f. amplifier connected to the aerial and earth terminals of a conventional sound receiver. To take advantage of the fact that, in some cases, interference may be more intense at line-scan harmonics than at other frequencies, the pick-up frequency of the probe should preferably be chosen to lie at one of these harmonics.

A complete assembly is shown in the circuit which accompanies this article. As may be seen, the principle of operation is quite simple. The frequency at which the probe works, and to which the subsequent receiver is tuned, is 202.5kc/s; this being the 20th harmonic of the line frequency, when synchronised. It is also sufficiently close to the long-wave Light Programme frequency on 200kc/s to enable the probe, and the subsequent receiver, to be easily set up without the necessity of a signal generator.

The probe, itself, consists of an r.f. amplifier in whose grid circuit is connected a conventional long-wave coil pre-set to 202.5kc/s. A sensitivity control is also incorporated in the probe (R_5), this adjusting the cathode bias of the valve. The entire probe, including the lead to the sound receiver, is completely screened; the screening being connected direct to the chassis of the sound receiver. For obvious reasons, the latter must not be an a.c./d.c. type or have a "live" chassis.

The only part of the probe not screened is the "pick-up wire," this consisting of approximately half an inch of wire projecting from the screening of the probe.

The valve shown in the diagram may be any vari-mu r.f. pentode.

Operation

The operation of the probe is extremely simple. The faulty televisor is first of all switched on and the corona allowed to establish itself. The line timebase in the televisor should, preferably, be synchronised with a transmission or with the output of a reliable pattern generator. The sound receiver is next switched on and its gain control turned to its full setting, Any breakthrough of the Light Programme which may then occur need not necessarily upset the working of the probe, so long as it is not sufficiently strong to operate the a.v.c. circuits in the receiver and reduce its sensitivity.

The probe, set to maximum sensitivity, is next brought towards the televisor. As the pick-up wire approaches the source of corona, the "hash" heard from the sound receiver should increase. If the "hash" is very strong, the sensitivity control on the probe should be retarded as the search for the source of corona proceeds.

Warning

Before concluding, it cannot be emphasised too strongly that checking for corona will involve the normal television servicing risk of touching e.h.t. points with consequent shock. Of equal importance is the fact that most commercial televisor chassis are "live" and the metal case of the probe may be at earth potential. Care must be taken therefore to prevent the possibility of the mains voltage appearing between the probe case and the television chassis. Connecting the sound receiver chassis, which should be already isolated from mains and earth, to the televisor chassis may help; but the best plan of all, and one which should be carried out for all television servicing, would consist of supplying the televisor through a 1:1 mains isolation transformer.

BOOK REVIEWS

THE RADIO AMATEUR'S HANDBOOK, 32nd edition. Obtainable from The Modern Book Co., 19–23 Praed Street, London, W.2. Price 31s. 6d. post paid.

This handbook is so well known amongst the amateur radio fraternity that one feels almost apologetic for endeavouring to write of its merits. The 32nd edition is the latest of a long line of publications which have become the "bible" of amateur radio communications. For those of our readers who already know the Handbook, may we say that this latest edition contains quite a lot of new material and brings up to date previous contents; and even though you may have a recent edition, the new one is well worth investing in.

For those of our readers who do not yet know the Handbook, we would take this opportunity of introducing it to them. Whilst it is primarily a Handbook for the radio amateur interested in short wave communication, it is also a first rate theoretical text book and reference book. You will find all you want to know on the theory of radio communication, on propagation, on test methods, constructional techniques and so on. There are detailed descriptions written from the home constructional point of view on every item of equipment the radio amateur is likely to require for establishing an amateur radio station.

If you have not seen a copy you should take the first opportunity of doing so, and once you have, you will be certain to agree that it is a "must" for your bookshelf.

FROM THE ELECTRON TO THE SUPERHET, *by J. Otte, Ph.F. Salverda, and C. J. Van Willigen.* 700 pages, 722 illustrations, 11 circuit diagrams. Obtainable from The Cleaver Hume Press Ltd., 31 Wrights Lane, London, W.8. Price £2 15s.

It has been the good fortune of the writer of these notes to study and comment upon several books in the Philips Technical Library from time to time, as readers of this feature will have noticed. It has therefore become a pleasant task to appraise the work of the technical staff at Eindhoven, and this latest publication provides much to describe if only on the score of the size of the book. It is no mean task to read through a 1½-in thick book with pages measuring 7¼in × 11in, and say what one thinks about it all in a handful of words!

Limitations of space here naturally preclude a detailed description of all there is in the book. It is, as its sub-title states, a simplified course of instruction for radio service men, although one is immediately impressed by the fact that service men are not the only people who can learn a great deal of radio theory from it. However, for all its size and scope, the book is unable to cover completely every subject to which its 42 Lessons are devoted, and it would be ludicrous to expect it to. At least, it tells enough about each subject to indicate that the service man who really knows his job has a more detailed knowledge of a very wide field than he is generally given credit for.

The first nine Lessons deal with basic electrical theory, and cover direct current and alternating current principles, their application to radio, and the behaviour of components. In the next twenty-nine Lessons the principles and operation of various types of radio receiver are developed. This includes discussions on various components, circuit principles, testing, test gear, and complete receiver designs. The remaining four Lessons are concerned with service workshops and tools.

As is to be expected, much of the circuitry is typical of that found in Philips receivers, and such test instruments as are described are also of the same make. It must be conceded, however, that the authors have succeeded in their intention to impart essential knowledge in a form that facilitates self-study, and the only criticism that can really be given notice is the absence of typical component values in many of the circuit diagrams.

The type-face, known as Varitype, is not unlike typewriter characters, and in consequence the text is rather wide-spaced. This makes for ease in reading but no doubt accounts for the large number of pages. The Index is particularly good, as also is the detailed list of Contents.

This is a commendable book for its intended purpose, and is quite up to the usual standard of Philips publications for authenticity.

REMOTE CONTROL BY RADIO, 2nd Edition, *by A. H. Bruinsma.* 104 pages, 74 illustrations. Obtainable from The Cleaver Hume Press, Ltd., 31 Wrights Lane, London, W.8. Price 8s. 6d.

The first edition of this popular book on radio control was reviewed in the March 1953 issue of *Radio Constructor*, and much that was said then is equally applicable to the present second edition.

The opportunity has been taken to revise some of the text and the circuit designs to incorporate smaller valves, especially battery types such as DK96, DF96 and DF92. In addition, the improved characteristics of germanium diodes have been recognised, so that they are now specified in preference to the physically larger silicon diodes employed in the designs given in earlier editions. Simliarly, more modern valves have been incorporated in the controlling transmitters, so that equipment is more in line with modern practice.

It is still considered that this book is perhaps the best of its kind for those who wish to embark upon the most ambitious designs for the radio control of model boats. Apart from being an authoritative treatise of this particular branch of the subject, the book can easily whet one's appetite to make replicas of the fine models described.

There is so much detail and proven practice in this book that one wonders how anyone interested in the technique can resist purchasing a copy at the modest price asked for it.

W. E. THOMPSON

IN YOUR WORKSHOP

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

JUST DOWN THE ROAD FROM THE R.E.C.M.F. Radio Component Show at Grosvenor House this year was another little exhibition all on its own. This was the Belling-Lee Exhibition of Band III Aerials at Park Lane House. Belling-Lee had a stand at the Radio Component Show as well, of course, but this separate exhibition enabled more room to be given to the actual aerials developed by this progressive firm.

Our Staff Reporter was not able to include a description of the Belling-Lee Aerial Show in his R.E.C.M.F. report, and so I am taking this particular job off his hands in the present contribution.

Band III Aerials

The Belling-Lee aerials were displayed in a large room at Park Lane House, and gave a good idea of the appearance our future skylines will present. Indeed, an almost surrealistic effect was given by the fact that the exhibited aerials were mounted on full-size "chimney-stacks" standing on the floor. There was an extensive range; and it included aerials which were intended purely for Band III reception and aerials which were capable of receiving both Band I and Band III signals at the same time.

In all the Band III aerials shown, the aerial element proper consisted of a folded dipole. At the lower end of the scale were three-element aerials; these consisting of a director, folded dipole, and reflector. Such aerials could be mounted in or outside the viewer's house according to signal strength and other local factors. If mounted on an outside wall such an aerial should be capable of giving good results, theoretically, up to 25 miles from the transmitter. However, as the reader will appreciate, it is difficult to specify the ranges which will be achieved in actual use owing to the fact that little practical information is available at the time of writing.

The next largest aerial was a six-element array having four directors, a folded dipole, and a reflector. This aerial could also be fitted indoors or outdoors. The charm about arrays having even as many as six elements is that, due to the small size of the individual parts, such aerials may be fitted into quite a small loft or attic without taking up too much room. A further application of the six-element array was given by an aerial which employed two of these in broadside; that is, the two arrays were mounted parallel to each other and spaced by several wavelengths.

Finally, there was a nine-element array; this consisting of seven directors, the dipole, and a reflector.

The combined Band I—Band III aerials were most interesting. One method of combining the two aerials was given by having the Band I dipole function as a reflector on Band III. The requisite Band III folded dipole and director were then mounted directly to the centre of the Band I dipole. This type of aerial was also available in six-element form. Also shown were more complex aerials, consisting of two Band III aerials in broadside combined with a Band I "H."

Another most ingenious method of obtaining Band I–Band III reception was given by adding small rods forming effective Band III dipoles to an existing Band I dipole. The additional assembly was held by four polythene spacers and no additional electrical connections were required at all.

Also visible at the Aerial Exhibition was a receiver displaying the experimental transmissions from Belling-Lee's transmitter at Croydon. In making these transmissions available at the present time, this firm has made a most generous contribution to the benefit of the trade and the community.

Just before sending this article off for typing I heard some most encouraging reports of the coverage of the transmitter. Belling-Lee themselves report strong signals at Clacton and Southend. One of our contributors, Gordon J. King, is getting good signals at Oxford. Also, W. E. Thompson, another contributor, reports reception a dealer at St. Leonards-on-Sea. If the coverage of the experimental transmitter is as good as this, we can all have high hopes of the results given by the I.T.A. transmitter when it commences operation.

The American Scene

When Band III starts up this year there is no doubt that some weird and wonderful aerials will appear on the country's rooftops. However, it is doubtful if any of these will match up to some of the almost staggering arrays that are at present in use in the U.S.A.

In the States the situation is complicated by the fact that, to be really effective, an aerial has to receive *all* the frequencies in Band I and Band III. Because of this, some strikingly ingenious designs have been produced. In addition to the requirement of all-channel coverage, it is also necessary in some localities to have the aerials rotatable so that they may then be directed to whichever transmitter the viewer wishes to receive. In consequence there are a relatively large number of aerial rotating motors available, each with their own special arrangement of electrical control from the viewing room inside the house.

A friend of mine spends a lot of his time putting up television aerials, and he has been as pleased as Punch recently at the thought of rigging Band III arrays instead of the same old Band I "H" aerials. He was extremely impressed when I showed him an advertisement for a really "super-dooper" rotatable antenna published in an American magazine. Together, we counted its thirty-four elements; then he looked up. "There," he said, at last, "Now that's what I call an *aerial*!"

Temperature Coefficient

One of the points that is sometimes overlooked by the amateur experimenter when working with condensers is the question of their temperature coefficient. This coefficient can be of extreme importance in the functioning of certain particular radio circuits, and it is of especial importance in tuned circuits working at frequencies above 5 Mc/s or so.

As is to be expected, the capacity of a condenser varies with its temperature. The variation in capacity is due to the fact that the integral parts of the condenser expand in volume as the temperature is raised, and contract when it is lowered. It is also possible for the dielectric constant of the material separating the plates of the condenser to alter with temperature; thus providing a further factor towards change in capacity.

For most radio applications, this change in capacity with temperature causes little inconvenience. To take an example, an a.f. decoupling condenser in a particular circuit may have a nominal value of 0.1 μF. In practice, a condenser for this application is usually chosen to have a value well in excess of the minimum required for effective decoupling. In such instances, alterations in capacity due to temperature variations cause no trouble at all.

The same applies to many other condenser applications. So long as the capacity of the condenser employed does not drop below a certain level (or, in some cases, does not also rise too high) the relatively small changes exhibited due to temperature variations can be forgotten completely.

When we come to tuned circuits, however, the situation changes appreciably. Examining the question from the point of view of reception only, we immediately come across the importance of temperature coefficients. Nearly all receivers these days, whether intended for broadcast, f.m., or television reception, employ superhet circuits; and have, in consequence, a relatively large number of tuned circuits. It might be as well to examine such circuits from the second detector, working back to the frequency-changer.

The first sets of tuned circuits we would encounter are the i.f. transformers. Nowadays, these are almost always adjusted by iron-dust cores, these having been found to give better results than capacitive trimmers. In consequence each i.f. transformer usually requires one or more fixed condensers to tune its various coils. (This does not necessarily apply to television i.f. transformers.) The condensers employed for such a job are, almost invariably, silvered-mica components; these being chosen because they are relatively cheap, have low losses, and because their temperature coefficients are low. (A low temperature coefficient infers a low change in capacity due to temperature variations.)

Whilst low temperature coefficient condensers (such as silvered-mica types) are *advisable* for the 465 kc/s i.f. transformers employed in sound receivers, such condensers are *essential* for i.f. transformers working at 10.7Mc/s and higher, as met in f.m. and television receivers.

Even more important than the i.f. stages of a receiver is the oscillator tuned circuit. The frequency at which this circuit functions

governs the signal frequency picked up and reproduced by the receiver. In consequence, great care has to be taken to ensure frequency stability of the tuned circuit in this particular stage.

With broadcast receivers covering the normal long, medium and short wavebands the question of oscillator drift with temperature variation does not raise too many problems. A sensible layout combined with silvered-mica padding condensers is usually quite adequate. With more specialised sets (such as communications receivers) and sets working on frequencies between, say, 30 and 300 Mc/s, the problem begins to assume much larger proportions, It is at this point that designers start to consider employing condensers having temperature coefficients which are negative-going.

When a tuned circuit is subjected to a temperature rise, as occurs in a receiver after it has been switched on and allowed to warm up, its resonant frequency usually drops. This drop is normally caused by a rise in inductance of the tuned coil combined with an increase in capacity of the tuning condenser. The rise in inductance of the coil, incidentally, is due to the fact that its turns expand with the rise in temperature and become consequently larger. One way of overcoming the drop in frequency would be given by *preventing* a change in temperature of the tuned circuit. However, this would involve the use of such things as temperature-controlled enclosures, and would be far too expensive and unwieldy for normal receiver work.

A much cheaper solution consists of employing a negative temperature coefficient condenser connected across all or part of the tuned circuit. The capacity of this condenser would then *decrease* as the temperature of the tuned circuit rose, and would thereby counteract the drift of resonant frequency.

Practical Components

Most negative temperature coefficient condensers employ special ceramics to provide the dielectric. The temperature coefficient is defined as the change in parts per million of capacity for one degree Centigrade rise. Thus a 500 pF condenser having a negative temperature coefficient of 200 would decrease by

$$\frac{200}{1{,}000{,}000} \times 500 \text{ pF}$$

(=0.1 pF) for every degree Centigrade rise.

It is conventional to precede the negative temperature coefficient number with the letter "N." One may then refer to an "N.750 condenser," inferring that it has a negative temperature coefficient of 750. A positive temperature coefficient condenser (i.e. one whose capacity increases with temperature rise), would have the number preceded by the letter "P." However, positive coefficient condensers are not encountered very frequently.

Due to the difficulties of production, a wide range of negative temperature coefficient condensers is not offered for normal commercial applications. The two coefficients most frequently met are N.330 and N.750. There is also the T.C.C. SPM1 range, this having the very high coefficient of N.3000.

In practice, a wide range of temperature coefficients is not really necessary in any case, since it is possible to obtain almost any coefficient required by paralleling a negative temperature coefficient condenser with one having high stability. Thus, if a 100 pF N.750 condenser is paralleled with a 100 pF condenser of negligible coefficient, the effective result would be a 200 pF condenser with a negative coefficient equal to 375. Similarly, if a 67 pF N.750 condenser were paralleled with a 133 pF condenser of negligible coefficient, the resultant 200 pF condenser would have a negative coefficient equal to 250.

Practical Applications

We introduced the subject of negative temperature coefficient condensers from the point of view of the receiver because this is the application in which such condensers are encountered most frequently. They are also, of course, often employed in the oscillator stages of laboratory test gear, transmitters, and similar equipment.

In practice, so far as receivers are concerned, negative temperature coefficient condensers make their appearance most usually in the oscillator stages of communications and f.m. receivers. At the higher working frequencies encountered in manufactured Band III tuner units, the employment of such condensers is almost inevitable.

G6CL BECOMES MAYOR

The new Mayor of the Borough of Southgate is Alderman John Clarricoats, O.B.E., General Secretary of the Radio Society of Great Britain.

Alderman Clarricoats has held an amateur transmitting licence—callsign G6CL—since 1926, and recently completed 25 years' service with the Society.

* * *

IAN ORR-EWING RETURNED

Another well-known member of the Society, Mr. Ian Orr-Ewing, was returned at the recent General Election as Member of Parliament for Hendon North.

Mr. Ian Orr-Ewing has often demonstrated his interest in the cause of amateur radio in the House.

Query Corner

A *Radio Constructor* Service for Readers

Frame Non-Linearity

I have been modernising my "Inexpensive Television" receiver by replacing the 6in tube by one of the 12in magnetic type. This has involved completely changing the timebase unit, a modification which has in the main proved satisfactory, apart from poor frame linearity. I am using a frame timebase circuit of conventional design with an EL41 valve in the output stage. The trouble takes the form of severe cramping at the bottom of the picture, and in spite of checking the valve for poor emission and modifying one or two component values, I cannot clear the fault.

F. Forsythe, Crewe

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.

Vertical non-linearity in a television receiver must have given many constructors hours of tedious fault tracing, in some cases the effort being to no avail. Where a constructor is aiming at a better than average degree of linearity the position is often complicated because no test pattern is available at a time when work is in progress. In this respect it is perhaps worth repeating that a very useful check on vertical linearity can be obtained by allowing the frame timebase to slip out of sync so that the blanking bar moves slowly up or down the raster. A good idea of the degree of non-linearity can be obtained by noting the change in width of the bar as it moves across the image. It is also worth noting that bad frame linearity can move the mean level of the scanning waveform from its normal mid-position causing the whole picture to be shifted either up or down on the screen. Efforts to re-centre the image by a centring device on the focusing unit, or by tilting the unit, may then result in corner cutting. Even if corner cutting does not occur, the offsetting of the focusing unit invariably produces astigmatism in the picture tube which shows up usually as poor corner focus.

Apart therefore from the obvious aesthetic advantage of good vertical linearity, there are other secondary picture faults which can appear if the linearity is not good. For the sake of this analysis the frame timebase will be divided into three sections, the oscillator, the output stage and the feedback circuit. The oscillator delivers a near-sawtooth waveform having an amplitude in the region of 30 volts peak-to-peak to the output stage. This waveform must have a reasonably linear working stroke, although there may be quite a sharp peak on it during the flyback period. Should the voltage be of more-or-less correct amplitude but have a tendency to bend over

towards the end of the stroke, resulting in cramping at the bottom of the picture, it suggests that the voltage applied across the charging circuit is inadequate. Check the charging capacitor (C_2) for poor insulation and the valve (V_1) for grid-to-cathode leakage. The circuit references given apply to the typical frame timebase circuit shown in Fig. 1. In other types of timebase the comments refer to components fulfilling the same function.

If the oscillator is found to be functioning correctly, attention is turned to the output stage where a valve having poor emission or too large a bias resistor (R_7) can cause the trouble. A frame output valve normally obtain a linear scan would become a very critical, and in some cases an almost impossible, task. If the feedback loop becomes open circuit, the scan will be very cramped at the top with the remainder very stretched. This fault is easily recognisable and is not difficult to trace (check C_5 and R_5). A very likely cause of cramping towards the bottom of the picture arises if the capacitor C_5 becomes short circuit. Due to a relatively high peak voltage at the anode of the output valve the capacitor may become faulty.

Apart from those defects already mentioned it is worth noting the effects of varying the major component values in the feedback loop,

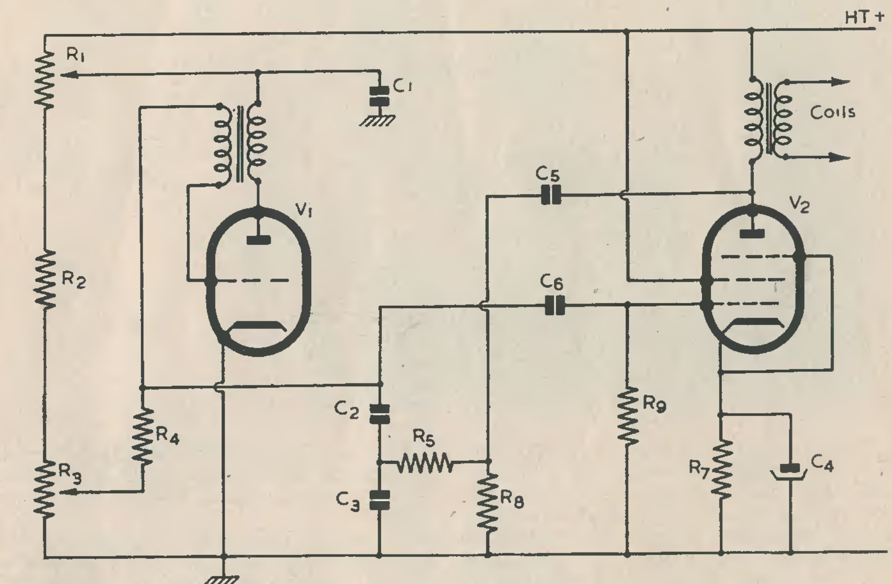


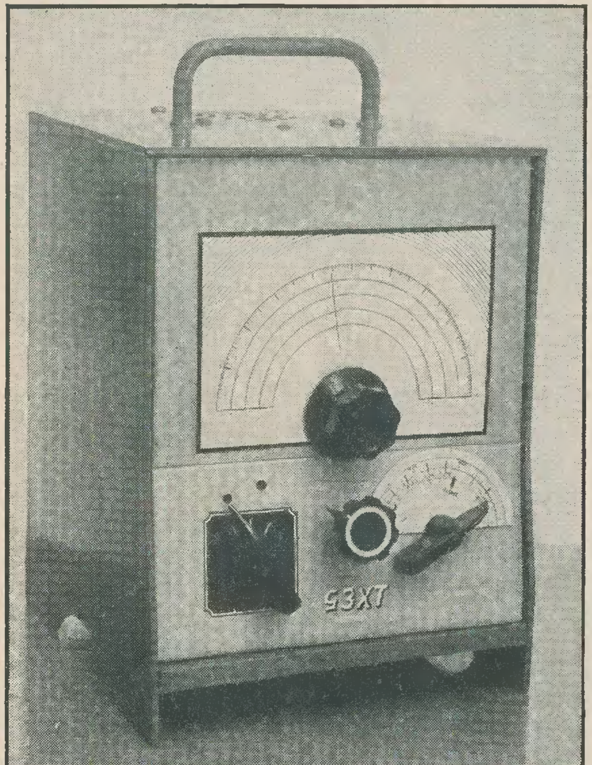
Fig. 1

A typical frame timebase employing a blocking oscillator

E183

takes an anode current in the region of 15–25mA. This current is best measured by inserting a milliameter in the h.t.+lead to the primary of the frame output transformer.

If the circuit has been found to be in order so far, the cramping at the bottom of the picture will most probably be traced to a fault in one of the feedback loop components. The application of feedback to the frame output stage assists in improving the linearity of the stage, whilst rendering the circuit less critical of tolerances on components. Without feedback the adjustment of circuit values to as such data is useful when making final adjustment to get the best from the timebase. Should R_5 become shorted, or be of too low a value, the top of the picture will be cramped. If R_5 is open circuit or too high in value the image will be cramped at the bottom, the degree of distortion becoming gradually less from bottom to top. Similarly, if C_5 is of too large a value the same gradual increase in cramping from top to bottom will occur. Should the capacitor become shorted the distortion will be accompanied by a 30% reduction in picture height.



The 1955 TWO

By

G3XT

PART 2.

The cabinet-top is drilled with perforations (or a decorative grille cut with a fretsaw) and lined with a dustproof fabric. The loudspeaker unit (the size of which must of course be chosen to suit the cabinet) is mounted horizontally under the cabinet-top, and this rather unorthodox positioning of the speaker was found to give a more natural and pleasing distribution of sound than is obtainable with the more usual vertical mounting.

The rear flange of the chassis fits over the piece of wood or hardboard closing in the back of the cabinet at the bottom—i.e., the space below the "deck." A single screw (which may be the self-threading type) effectively locks the whole chassis in position when it is pushed home into the cabinet. Provided the chassis and panel are a reasonably accurate fit, no other fixing is necessary, strictly speaking; but a couple of extra screws can be inserted through the front panel into wooden fillets fixed to the side walls of the cabinet if desired.

If any whistles, etc., due to i.f. "breakthrough" are experienced, a Maxi Q i.f. Filter can be tried in the aerial circuit. A Maxi-Q mains filter is another useful addition, in the mains leads to the power pack.

When receiving weak signals on the amateur bands, you may find it preferable to use headphones instead of the speaker. For morse signals, the reaction is adjusted so that the circuit is just oscillating. The reaction thus serves a dual purpose by acting as a substitute for the b.f.o. normally used in amateur-band superhet receivers of a more ambitious type.

Power Supplies

Details of the power-pack can be left to the choice of the individual constructor. Plenty of suitable types have been described from time to time in *The Radio Constructor* for use with other sets. Current requirements for the two valves at different h.t. voltages can be obtained from the manufacturer's leaflets. One point should be borne in mind: if the set is to be used with headphones, the power-pack should most certainly be of a type incorporating a double-wound mains transformer to isolate it. Power-packs having a rectifier running direct off the mains (such as those often found in AC/DC sets) are definitely not suitable for a set with which headphones are, even occasionally, to be used. In any case, the headphones should be of an all-insulated type, not metal-cased ones.

No fuses and no on-off switch are shown in the circuit diagram, but of course both should be included in the power-pack. The best type of switch to use is a double-

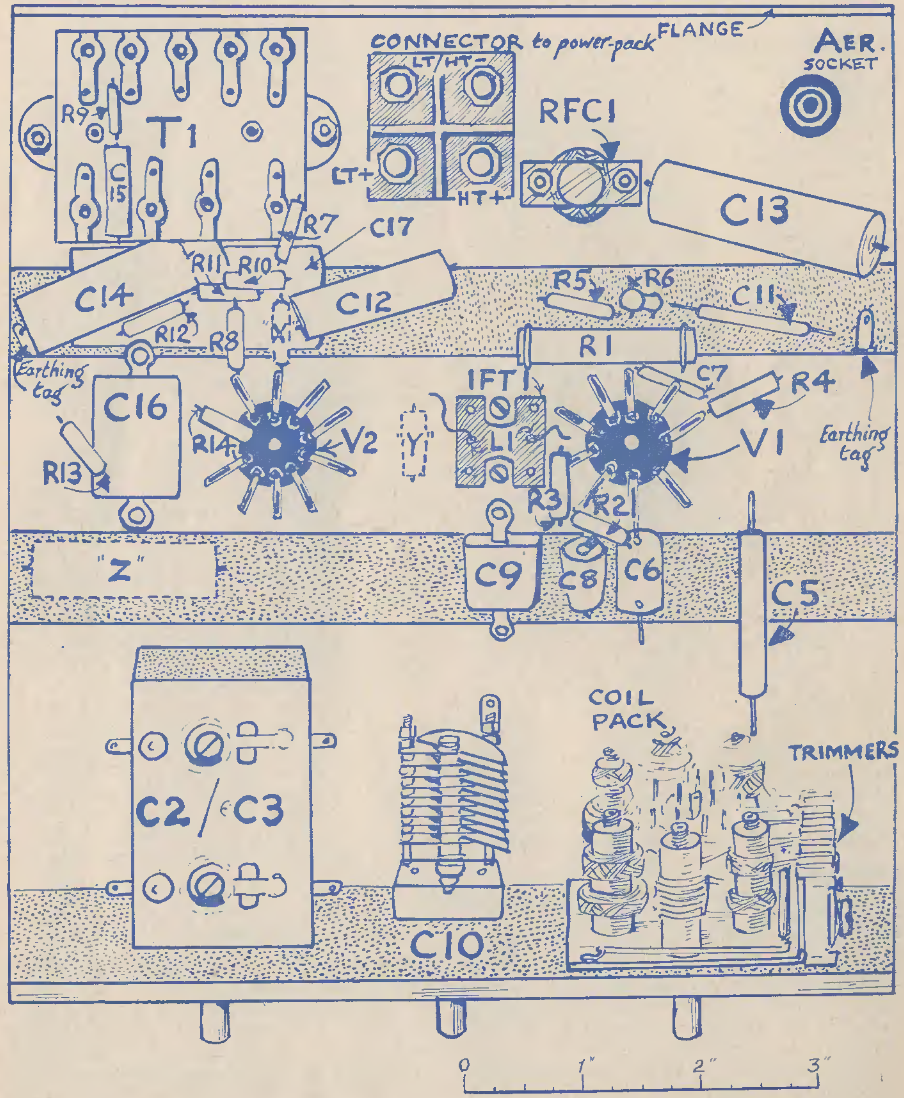


Fig. 3. Under-chassis layout, showing approximate positions of components. The bandspread condenser (C_1–C_4—not shown) is mounted on the upper surface of the chassis just above the reaction condenser (C_{10})

pole one breaking both mains leads to the primary of the transformer.

Optional refinements which can be added are a ruby indicator-lamp on the power pack and a small pilot-bulb on the front panel of the receiver, the bulb-holder being fitted with a little semi-circular shade or cowling fashioned out of sheet tin or aluminium, so arranged that light is cast downwards on to the tuning-dials.

Scope for Experiments

The coil-pack and valves should be exactly as specified. There may, however, be some scope for experiment in regard to some of the other components. Resistor and condenser values as shown in the key to Fig. 1 are those approved by the valve manufacturers, and should give optimum results, but in some cases minor deviations are possible without greatly affecting the strength or quality.

For instance, neither the negative feedback (R14) nor the tone correction (R9, C15) are essential to the working of the set, though both help to improve quality of reproduction, at some sacrifice of volume. If you want maximum volume at all costs, omitting these "extras" will increase the strength, though with some loss of quality.

Owing to restrictions of space, the twin-gang bandset or main tuning condenser *must* be a miniature type. (The one in the prototype is a Polar.) The bandspread and reaction condensers should also be miniatures, but there is some latitude as regards capacity.

Three extra components, marked "X," "Y" and "Z" in Fig. 3, are optional; "X" is a grid-stopper, say 10kΩ, of smallest possible size and soldered direct to the triode grid socket on the valveholder of V2 (the ECL80). A screen resistor, marked "Y" in Fig. 3 (with a suitable by-pass condenser, marked "Z"), arranged to lower the voltage on grid 2 in the output pentode, was found to increase the gain appreciably. (This was not, however, one of the items approved by the valve manufacturers).

Aligning the Circuit

As there is only one i.f. transformer to deal with, the task of aligning the i.f. is easy, except for the fact that the i.f. tuning is liable to interact to some extent with the reaction, owing to the reaction winding being on the transformer secondary instead of on a tuning coil. No particular difficulty should be experienced; but it is essential to see that all trimmers and adjustable iron-cores throughout the circuit are correctly adjusted to their optimum setting, as there is little margin of amplification to spare in this simple receiver, compared with a full-size superhet.

The i.f. cores are readily accessible, and so are the trimming condensers on the coil-pack. The dust-iron cores on the oscillator coils in the pack are also perfectly easy to reach, but those on the grid coils are unfortunately a little inaccessible with the special chassis (because the "valve-trough" rather gets in the way, although it gives excellent accessibility to the valveholder connections).

The difficulty can be overcome in either of two ways. You can use a specially shortened trimming-tool to get into the confined space; or you can drill three small holes in the front panel exactly in register with the centres of the grid coils. As the iron cores have trimming-tool slots at *both* ends, the trimming tool can be inserted through the panel-holes and the coils lined up from the front of the set!

One could even go a step further and drill panel-holes for core-adjustment of the three oscillator coils as well. These holes would not exactly enhance the appearance of the panel, but from a practical point of view they would be very convenient as they would enable one to keep the coils peaked at optimum setting without bothering to take the chassis out of the cabinet!

The type of finish applied to chassis and cabinet is of course a matter for individual choice; but in the original the upper surface of the chassis is enamelled glossy black, the outside of the cabinet is pale grey and the front of the panel pale blue. Grey could be used throughout, or if the cabinet is of wood it could be french-polished, wax-polished or stained and varnished. In that case one could use either a hardboard panel polished or varnished to match, or else a metal panel enamelled brown.

This little set has been in daily use for several months now, and has proved very reliable. As the circuit is such a simple one there is little to go wrong with it, and it is certainly economical to run. Performance on the amateur bands did not quite come up to expectations, but apart from this point, results on the whole have been consistently good.

Alternative Coil-pack

Since this set was designed and the foregoing description prepared, a new version of the Maxi Q coil-pack has been put on the market. This covers an additional waveband of 50/160 metres, and if incorporated in this set will greatly increase its usefulness. The new pack, known as the four-waveband CP.3/F, covers the 80 and 160 metre amateur bands *without* recourse to the somewhat clumsy expedients described earlier on in this article. (It also covers shipping and aeronautical bands, including the trawler waves).

The new pack is slightly larger than the three-waveband type originally specified, and therefore the chassis and front panel must be deepened to accommodate it, as shown in the instructions added to Fig. 2. The only other snag is that it increases the total cost of the set by a little over a pound. But for anyone who wishes to listen regularly on the extra wavebands it covers, the CP.3/F should prove a worthwhile investment.

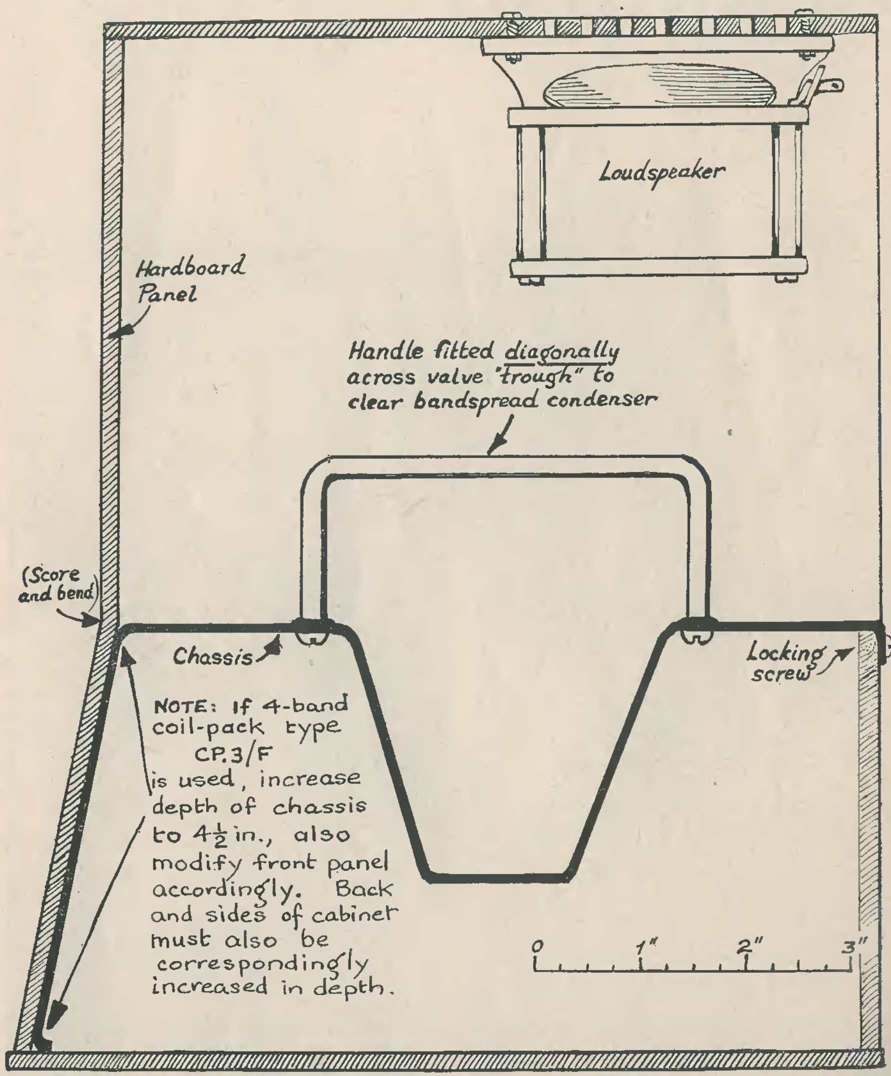


Fig. 2. Vertical section through chassis and cabinet (side view) showing position of loudspeaker

HIGH QUALITY TUNER UNIT

by **H. S. G. THORPE**

PART 2.

Layout

THE COMPLETE LAYOUT IS SHOWN IN Figs. 3, 4, 5, and 6. It will be seen in Fig. 4 that a logical layout and sequence of components has been followed.

The complete r.f. and oscillator sections are as close to their switch wafers and coils as possible, and each section is completely screened from its neighbour. The first i.f. transformer is contained in the oscillator compartment, and as the intermediate frequency is widely separated from that of the oscillator, no interaction will occur. Tag strips are used in the r.f. compartments only to mount anode and screen resistors; all other components are taken direct.

V_4 is mounted outside the screened compartments, and wiring is taken through the screen by rubber grommets. I.F.T.$_2$ follows in line with V_5 and V_6, and allows for an easily wired layout. C_{23} and C_{29} are anchored to the chassis by Terry clips.

The mains input socket is at the extreme end of the chassis, short connections going to the mains fuses and mains transformer, which is directly above the input socket. The anode surge limiting resistors for the EZ80 rectifier are taken from a Bulgin T80 tag strip directly to the pins on the EZ80 valveholder.

The 6.3 volts supply for the dial lamps is fed through the rubber grommet alongside V_7, and the leads should be twisted. An octal valveholder is fitted to the rear of the chassis to enable power (6.3 volts and 250 volts) to be taken to a tone control unit if required, also the mains on-off switch can be taken to the chassis if none is fitted on the front of the tuner. Figs. 4 and 5 show the octal socket.

Fig. 3 shows the plan view of the tuner, and it will be seen that components on top of the chassis form a neat and workmanlike appearance.

It will be seen from Figs. 4 and 5 that a co ax socket is used for the aerial lead-in, and that it feeds directly into V_1 compartment.

Tuning Indicator

If a tuning indicator is required it may be fitted to the right hand top corner of the Osmor dial. Figs. 5 and 6 show the method of fixing.

A $1\frac{1}{8}''$ dia. hole is made with a Q-Max cutter in the dial backplate, and four 8-BA clearance holes are drilled on a $1\frac{1}{2}''$ dia. pitch circle, as shown in Fig. 6. These four holes are countersunk on the front face. Paint round the cut metal with a dead black paint when drilling is finished.

An aluminium ring is made up as shown in Fig. 6 and screwed to the dial backplate with four 8-BA countersunk screws.

Two lengths of 4-BA screwed rod are fitted into the 4-BA tapped holes in the ring, and tubular spacers slipped over them. The octal holder for the EM34 is then fitted to the rod and held by two 4-BA nuts.

The mounting of the components is quite straightforward, all being mounted on the octal holder.

Pin 1 has no internal connection made to it, so it is used to anchor the two 1MΩ resistors. Five leads are brought down through the chassis, these being laced or passed through wide systoflex to the grommet provided. The leads should be coloured P.V.C. for easy identification.

Wiring

Before commencing the wiring of the unit, see that all components are mounted and checked, especially the switch wafers. Check that the correct wafer is mounted in its correct position, as only sections 2, 3, and 5 have shorting plates. Note that shorting plates are used on V_1 grid coils,

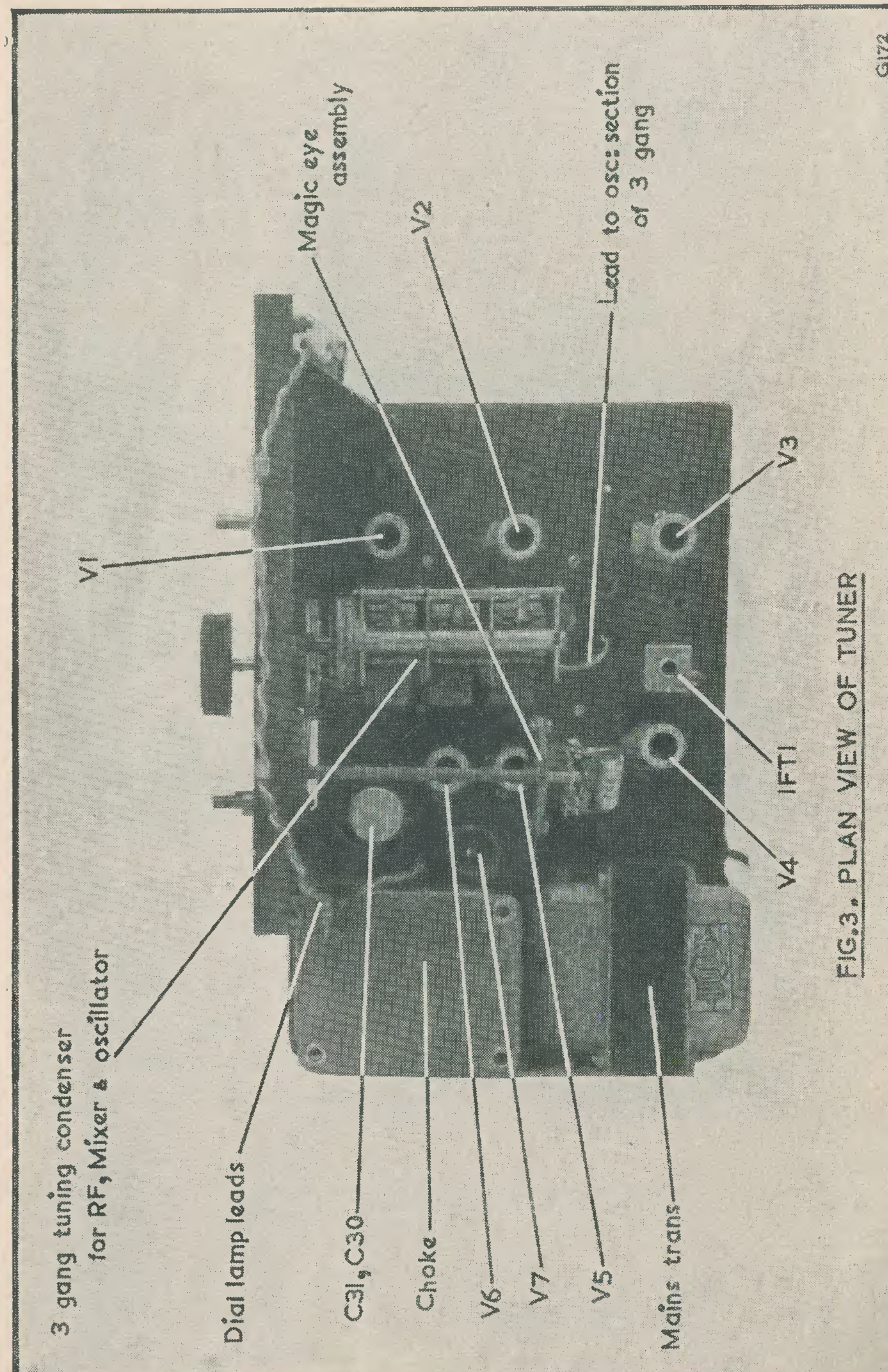


FIG. 3. PLAN VIEW OF TUNER

V_2 mixer grid coils, and V_3 oscillator grid coils. If wafers with shorting plates are used to switch the H.T.+ it may (especially if a 30° spaced switch is used) cause a short to earth, and damage the coils. Remove the switch spindle and indexing plate by taking out the two bolts holding the indexing plate and wafer No. 1 to the chassis. When the spindle and indexing plate are removed, bolt wafer No. 1 to the chassis again. Start wiring the valve heaters first, starting at V_1, through screen to V_2, through screen to V_3, and then out of compartment through a rubber grommet (close to C_{23}). Keep heater wiring tightly twisted, and as close to the chassis as possible.

pins also. This allows thinner wire to be used on the valve heaters, as only three heaters are fed from each wire.

When all heaters are wired, starting at V_1, do all the wiring close to the valve-holder base, making sure that all earths are taken to one point only on the chassis, in that compartment. Repeat for V_2 and V_3.

When all connections are made to the three valve bases (V_1, V_2, V_3), start with the wiring of the coils and switch. It is recommended that flex of different colouring is used for the coils and switch; 7/036 P.V.C. covered is ideal.

It is a good idea to slip the switch spindle into the wafers now and again to ensure

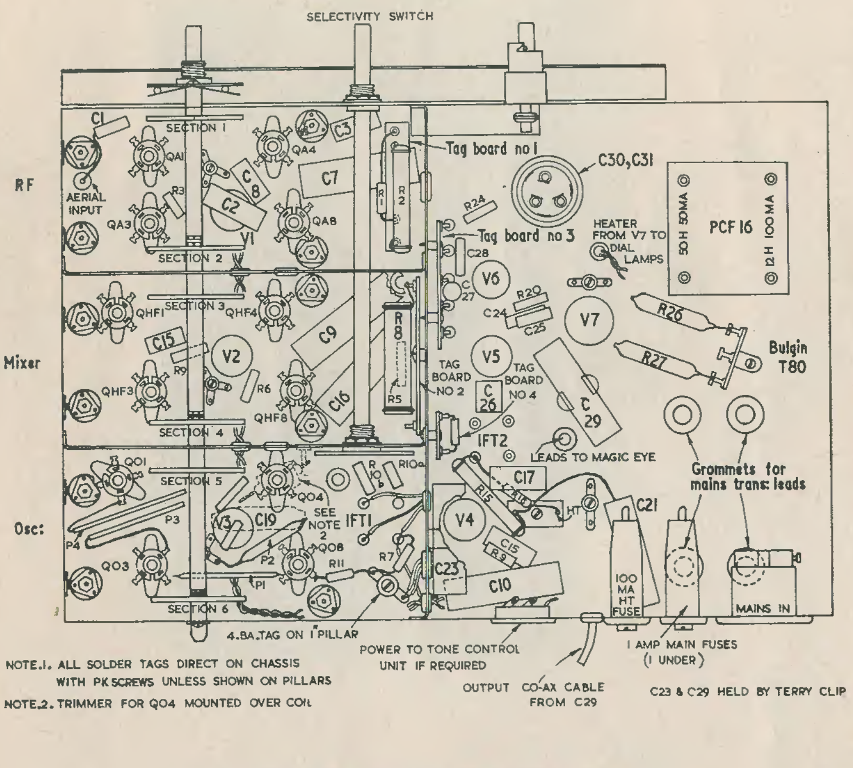


FIG.4. PLAN VIEW OF UNDERSIDE OF CHASSIS, LOCATING COMPONENTS

The heaters of V_1, V_2, V_3 are taken to pins 2 and 7 on the octal valveholder (used for taking power to the tone control unit), and heaters of V_4, V_5, V_6 are also taken to these pins. The heater supply from the mains transformer is then taken to these

that all components and wiring are quite clear of it. The trimmers are mounted close to their associate coils, and leads are short.

The Osmor coils are numbered 1 to 4 in a clockwise direction from the slot.

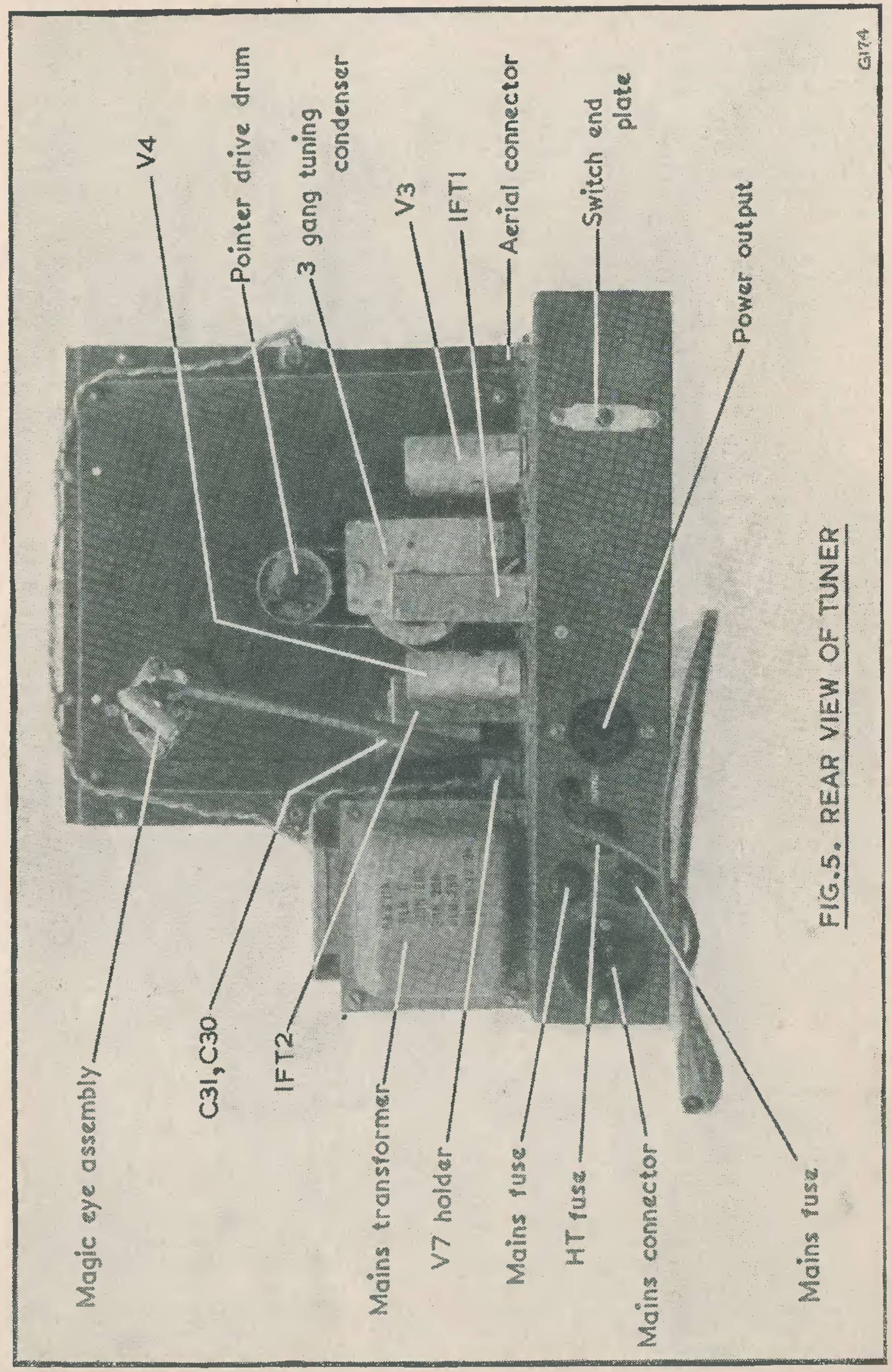


FIG.5. REAR VIEW OF TUNER

The resistors on tag boards No. 1 and No. 2 are wired in last.

The i.f. transformer damping resistors R_{10a} and R_{10b} are now wired in, making sure that the resistors are both switched across the i.f. transformer for local station reception only. Keep the leads as short as possible; the layout of the selectivity switch allows short direct connections to the i.f. transformer.

Before passing on to the rest of the wiring make sure that no leads are longer than they need be, and that all earths in a compartment are all taken to one point in that compartment. When all wiring in the screened compartments is finished, replace the switch spindle and indexing plate.

The next stage of the wiring is V_4, V_5 and V_6.

It will be seen that a number of components are mounted on tag panels. Leave these for the moment and wire the valve bases of V_4, V_5 and V_6 as far as possible. While it is not so important to keep leads as short as those in the r.f. section, it is desirable to keep them as short as possible.

Tag Boards

These are made from $\frac{3}{32}''$ Tufnol sheet. The tags or turret lugs are obtainable from Belling Lee Ltd. The mechanical construction is quite straightforward and no difficulty should be experienced.

Tag boards No. 1 and No. 2 will have been mounted in the r.f. section, and No. 4 and No. 5 should be mounted before wiring up. Tag board No. 3 is wired before it is mounted in the chassis.

C_{25}, C_{24}, R_{20}, and R_{24} are mounted on the tag panel by one lead only, the other lead going to a valve base.

The rectifier V_7 is the next stage to wire. R_{26} and R_{27} are surge limiting resistors, one in each anode supply lead. The centre tap of the mains transformer is fused to protect the rectifier valve in case of overload.

The output of V_7 is smoothed by the filter network C_{30}, 50H choke, and C_{31}. The condenser specified consists of 32+32+16μF, 350 volts working. One 32μF section is paralleled with the 16μF section to give 48μF for C_{30}. The other 32μF section is C_{31}.

A 50μF and 32μF condenser could be used separately if required.

The smoothed h.t. voltage should be approximately 250 volts.

Check all wiring when complete, especially h.t. connections and connections to coil and wavechange switch.

Lining-up Procedure

1. Remove V_1 and V_3. Connect phones from output of receiver to earth.

2. Set signal generator to give an output of 465 kc/s and feed into pin 7 (grid) of V_2 through a small condenser. Switch "Selectivity Switch" to "narrow" ($S.W._2$ open, no resistors across $I.F.T._1$). Short out the a.v.c.

3. Adjust cores on the i.f. transformers, starting with $I.F.T._2$, and then $I.F.T._1$. It will be necessary to reduce the signal generator output as more of the i.f. amplifier is brought into use. It is desirable to use the minimum signal that will give useful output. Move from $I.F.T._2$–$I.F.T._1$ in turn until maximum output is obtained.

4. Replace V_3. Feed output of signal generator into pin 1, V_2 (grid 1). Switch to Range 4 (MW) on the Receiver, and set the dial to the high frequency end.

Then set the signal generator to the frequency indicated by the receiver dial.

Adjust the QO8 trimmer in the receiver to give maximum response, then reset the receiver dial to the low frequency end of the dial. Set the signal generator near the frequency indicated by the receiver dial and tune the generator until its signal is heard in the receiver. If the frequency of the generator is higher than that indicated by the receiver dial, the core of QO8 needs screwing in; if the frequency is lower it needs screwing out.

Set the signal generator to the frequency indicated by the dial, and then adjust the core of QO8 for maximum output.

After making this adjustment, go back to the high frequency end of the dial as previously described, making adjustment to the QO8 trimmer. It may be necessary to go back and forth between the high and low frequency range several times before a proper combination is secured.

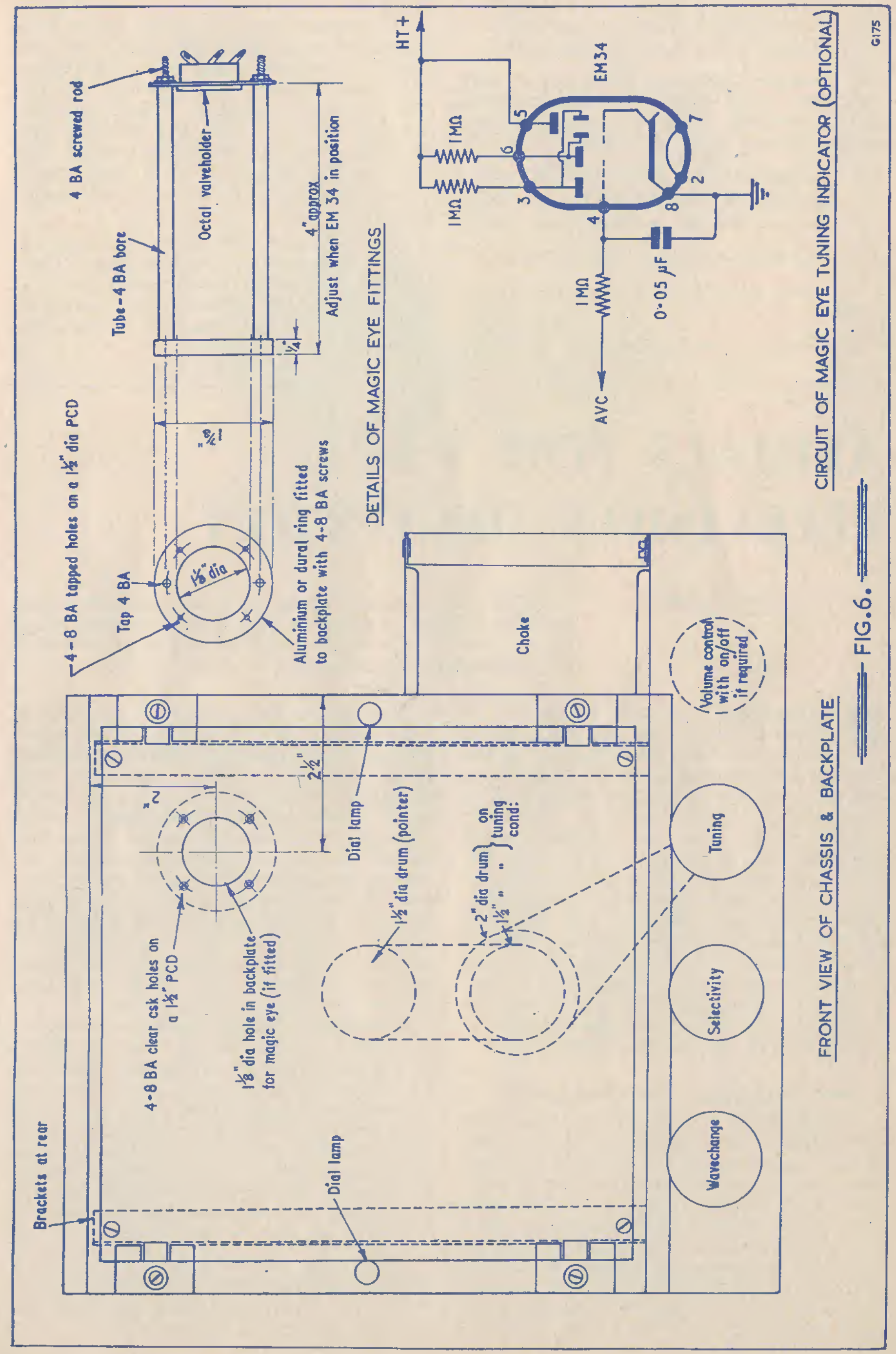
In most cases, it will be better if frequencies near, but not actually at the ends of the tuning range are selected, instead of taking the extreme dial settings.

5. Repeat (4) for Range 3, Coil QO4.
Repeat (4) for Range 2, Coil QO3.
Repeat (4) for Range 1, Coil QO1.

6a. Feed output of generator through small capacitor into pin 5, V_1 (Anode), V_1 still removed.

Set receiver dial and signal generator to the high frequency end of range 4 (MW) and adjust the QHF8 trimmer for maximum output.

6b. Reset the receiver dial and the signal generator to the low frequency end and adjust the core of QHF8. Repeat if necessary.



DETAILS OF MAGIC EYE FITTINGS

CIRCUIT OF MAGIC EYE TUNING INDICATOR (OPTIONAL)

FRONT VIEW OF CHASSIS & BACKPLATE — FIG. 6.

7. Repeat (6) for Range 3, Coil QHF4.
Repeat (6) for Range 2, Coil QHF3.
Repeat (6) for Range 1, Coil QHF1.

8. Remove generator from pin 5 and place on aerial terminal, using artificial aerial if possible. Place V_1 in its appropriate socket. Repeat 6b on QA8 coil.

9. Repeat (6b) for Range 3, Coil QA4.
Repeat (6b) for Range 2, Coil QA3.
Repeat (6b) for Range 1, Coil QA1.

10. Check i.f.t. settings and seal cores.

11. Seal all coil cores with wax, also trimmers.

12. Remove short from the a.v.c. line.

Notes

The author had all metal parts stove enamelled grey, before assembly, and used *Radio Constructor* Panel Signs for control knob identification, and also for "Aerial" and "Output" marking. These transfers are very simple to use, and add that professional look to the finished unit. The final result is a unit equal in performance and appearance to a good commercial model.

Errata

$I.F.T._1$ was shown incorrectly connected in Fig. 1a on page 675 of the June issue. There should be no connection between pin 5 of V_2 and R_{10b}. In addition, the junction of R_{14}–C_{17} should be connected to the other side of R_{10b} to that shown.

AERIALS FOR V.H.F. TELEVISION RECEPTION

by F. C. JUDD, G2BCX

PART 1.

Whilst the writer of this article is dealing with aerials intended for higher frequencies than those at present in use for t.v, much of the information given will be of interest to the constructor looking forward to Band III *reception.*

Requirements for the reception of television signals on the v.h.f. bands above 450 Mc/s are likely to be the same as the existing American band 54 to 216 Mc/s, and the present and newer U.S.A. allocation of 470 to 890 Mc/s. For more difficult fringe areas or locations where reflection may be severe, such as hilly districts and built-up areas, special types of aerial will be needed just as for normal v.h.f. transmission and reception, but with one difference; they will have to cover a wide band of frequencies. For example, if several stations are allocated spot frequencies within a band covering, say, 450 to 600 Mc/s it would not be very practicable to have a separate aerial for each frequency. Ref. 1.

General Requirements and Characteristics

Gain.—Aerials may have high or low gain (depending on their design) for use in strong or weak signal areas, and it should be noted that gain or loss measurements are usually given in db, the zero reference being the gain of a dipole adjusted to resonance at some individual frequency. The gain may also be calculated for an aerial covering a wide band of frequencies, and in this case it is usual to show a curve of the gain over the frequency band with the centre frequency as reference.

Directivity.—This may vary considerably from low gain omni-directional aerials which receive from all directions with approximately equal strength, to highly specialised uni-directional aerials which have a very narrow angle of reception from one direction only. Directivity can also be broken down into horizontal and vertical planes, but the descriptions in this article will be for horizontally polarised transmission. Since high directivity and high gain go hand in hand, the so-called fringe area type of aerial may be found useful in heavily populated districts to elminate reflections and multi-path conditions.

Bandwidth.—Aerials may be classified as to bandwidth, i.e. their ability to receive signals over a wide range of frequencies. Since the v.h.f. spectrum may cover a large number of channels, the design of suitable aerials may seem unconventional when compared to the single channel type of aerial at present used for t.v. reception on the lower frequencies. In view of multi-channel transmission the problem of bandwidth is very important.

It must the efore be considered:—

(*a*) whether the aerial is to be used in a densely populated area or a fringe area,

(*b*) what frequency coverage may be required, and on this will depend,

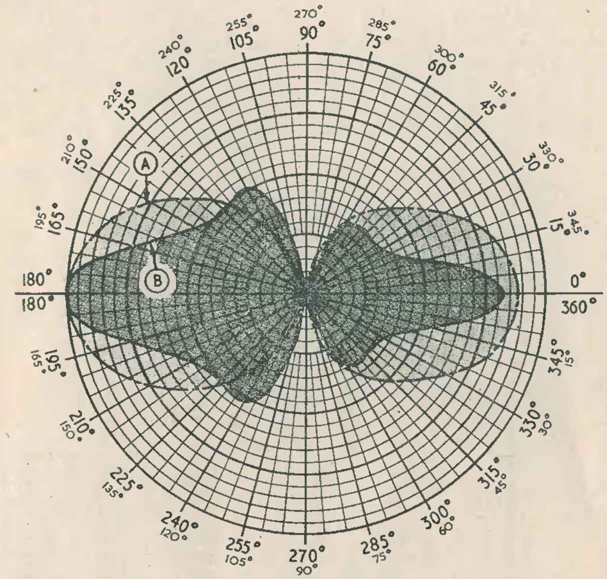


FIG.2. RELATIVE RADIATION PATTERNS
The fan dipole (A) 550 Mc/s (B) 850 Mc/s

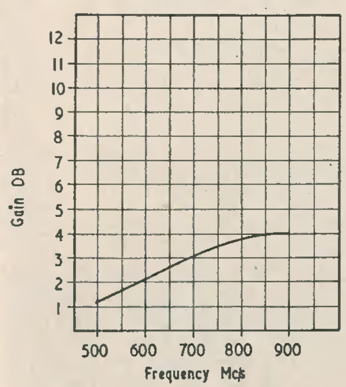


FIG.1. FAN DIPOLE GAIN v FREQUENCY

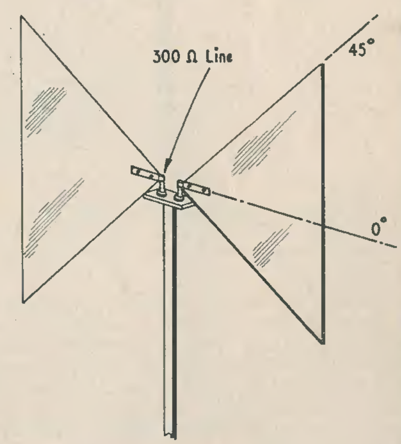


FIG.3. THE FAN DIPOLE

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(*c*) the gain, directivity and band width. Associated with bandwidth is the question of matching the aerial to the feeder and/or receiver input, since the feed point impedance will vary with the frequency.

Before constructing an aerial for v.h.f. t.v. reception, a careful study should be made of the radiation patterns and gain factors shown for each of the aerials described. Do they cover the areas from which reception is required? Would such directivity be of value if the aerial were made rotatable? Is the gain in the main lobe or lobes sufficient to cope with weak signals from distant transmitters from which reception may be desired? Could a directive aerial be used to advantage in overcoming reflection or multipath reception; this applies particularly in densely populated districts.

As an example, let us consider one or two points in connection with an individual requirement: Reception is available from 6 or 7 channels, some of which provide great signal strength while others place the point of reception at their fringe area; in other words, signal strength from the latter is weak. To make things more difficult, the stations are not all in the same direction. It is much easier to reduce signal strength than to build it up, and strong signals can be attenuated in the usual way. Therefore a high gain aerial should be used to take care of the weak signals. Now the problem of directivity. Can the aerial be made rotatable? If so, then the problem is fairly simple. Any high gain uni-directional aerial could be used and rotated as desired. If rotation is out of the question, an omni-directional aerial of high gain or one with selected directivity must be considered.

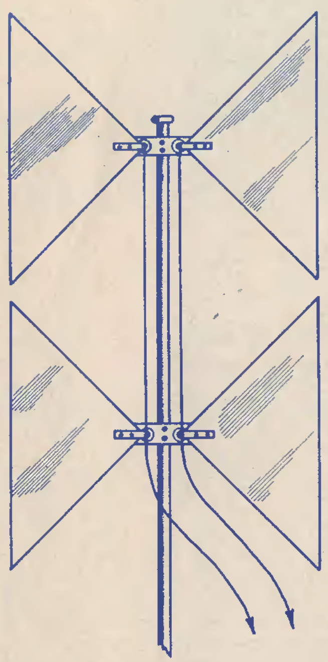

FIG. 4. A TWO STACK FAN DIPOLE

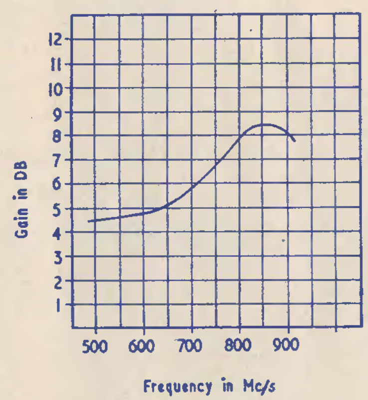

FIG. 5. TWO STACK FAN DIPOLE
Gain v Frequency

G177

1. E. O. Johnson *and* J. D. Callaghan. *Teletech.* Dec. 51. Receiving Antennas for U.H.F. Television.

(*To be continued*)

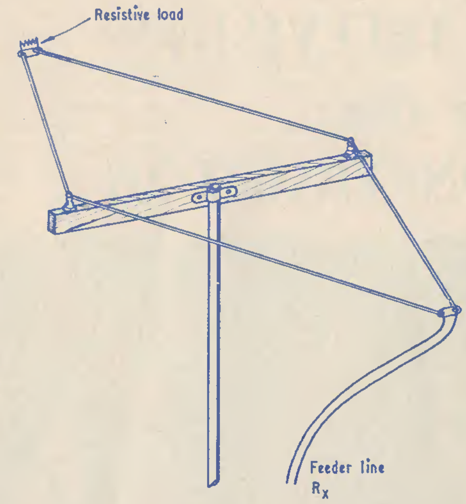

FIG. 6. THE RHOMBIC AERIAL

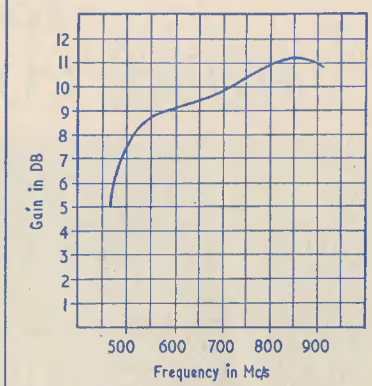

FIG. 7. THE RHOMBIC AERIAL
Gain v Frequency

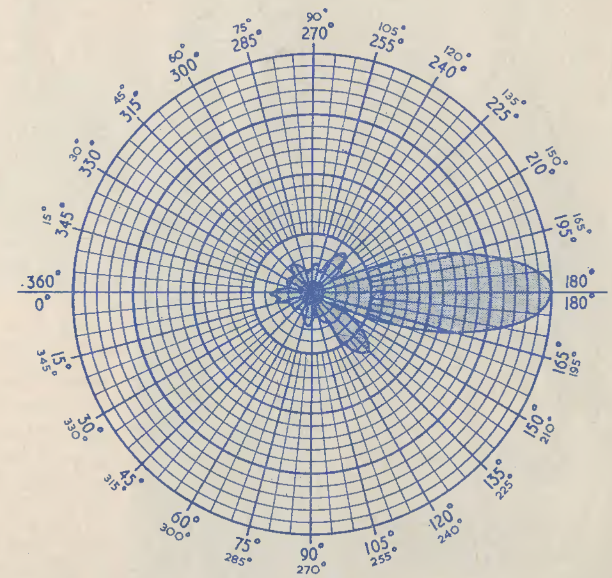

FIG. 8. HORIZONTAL POLAR DIAGRAM OF THE RHOMBIC AT 550 Mc/s

At 850 Mc/s the main lobe becomes narrow and the side and back lobes change position

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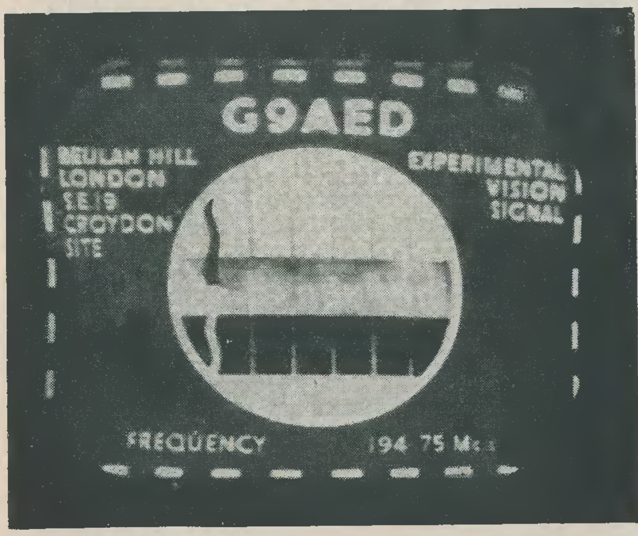
BAND III TELEVISION for the HOME CONSTRUCTOR

PART 1. *by* **S. WELBURN**

The first of a series of articles describing the conversion of home-constructor televisors for Band III operation

In 1954, when the possibility of television transmission in this country on Band III became a future certainty, *The Radio Constructor* immediately took steps to investigate the design of practicable and reliable conversion units to enable the home-constructor to adapt his existing televisor. A considerable amount of work has been done by the technical staff of this journal, and a number of different circuits and arrangements have been checked with regard to their usefulness for amateur television.

A particular disadvantage relating to amateur Band III design is given by the fact that the home-constructor seldom possesses the expensive test equipment which is needed for the manufacture and alignment of a complete cascode, triode-pentode televisor "front-end." When full-power transmissions on Band III commence and it is possible to work from transmitted signals with greater confidence (knowing from experience of the particular district in which the receiving aerial is erected that these may be received reliably) the situation may be eased; but at the present time experimental work on a "front end" without a good signal generator would be extremely hazardous, to say the least. Indeed, even with the arrangement described in these articles, it was not considered advisable to publish any reports on results obtained until actual aerial tests had been carried out.

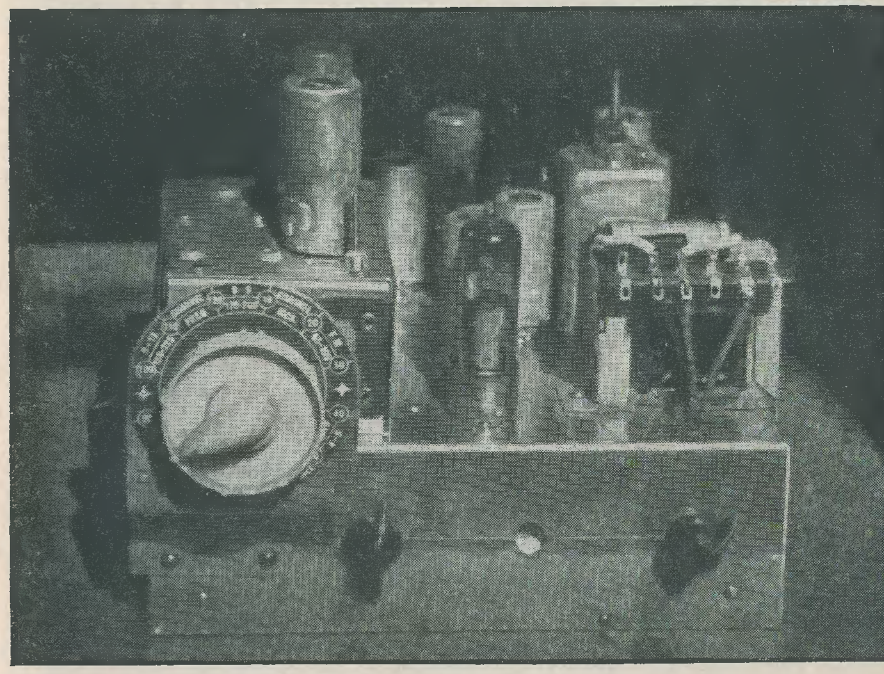


A photograph of the Belling-LeeTestPicture taken from the screen of the Magna-View with Valradio Converter, as described in this and the following article. Taken on HP3, 15 seconds exposure at f/4.5. The apparent fuzziness is due entirely to processing—the actual quality is on a par with that of BBC transmissions.

Such tests have now been made, using the experimental broadcasts from the Belling-Lee transmitter at Croydon.

Turret or Continuous?

In consequence of the difficulty of constructing a complete Band I–Band III "front end" in the amateur workshop, it was decided, after some experiment, to investigate the possibilities offered by manufactured tuning assemblies.



The Valradio Tuner Unit shown mounted on a chassis employing the Magna-View circuitry. The tuner occupies the space usually taken by the R.F. and F.C. stages

As readers will be aware, the most frequently employed Band I–Band III tuning assemblies used by manufacturers of television receivers in this country are turret tuners. These tuners employ pre-set coil assemblies which are brought into operation by means of a turret switching mechanism. Each coil assembly is pre-tuned to a channel, either on Band I or on Band III, and fine tuning (of the oscillator only) is achieved by means of a low-value variable condenser whose spindle is brought out to the front panel. The fine tuning control is necessary owing to the fact that it would be virtually impossible to ensure that the individual pre-set coil assemblies stayed adjusted to their exact frequencies over long periods of time.

However, it has to be remembered that turret tuners are fitted to television receivers *before* they leave the factories in which the receivers are made. This means that such tuners are tested finally in the sets in which they will be used, employing the test equipment available at the factory.

It is because of this that turret tuners do not, at present, appear to offer much attraction to the home-constructor. Without suitable equipment it would be extremely difficult to retune individual turret coils, should these become thrown out of adjustment during the normal conditions of mailing, storage and incorporation into a receiver.

It was decided, therefore, to investigate a tuner unit which gave continuous tuning over the Band I–Band III channels. An excellent unit of this type, and one which can be thoroughly recommended, is that manufactured by Valradio, Ltd. This manufacturer has now introduced a model especially designed for the Magna-View receiver, and has given us to understand that units suitable for several other home-constructor receivers can also be supplied. The details which follow in this and the succeeding articles apply to the fitting of the Valradio tuner unit to the Magna-View alone, but they are largely applicable to other home-constructor televisors as well. *The Radio Constructor* cannot, of course, deal with queries relating to specific points in the televisors described in contemporary publications. However, the information given in these articles should enable the knowledgeable amateur to fit the tuner unit successfully to most sets.

cascode, triode-pentode operation, and their omission does not detract from an appreciation of the functioning of the circuit.

L_1 is a centre-tapped coupling coil which enables either a 75 or 300 ohm aerial input to be matched into the grid tuned coils of the cascode amplifier, V_1. The tuned coils are provided by L_2, L_3 and L_4; and they are switched by S_1. Although only five positions are shown in the diagram, S_1 is a six-position switch, the sixth position corresponding to a blank contact. Automatic gain control is applied to V_1 in conventional manner via R_2. Contrast control is available, if required, by connecting a suitable potentiometer control

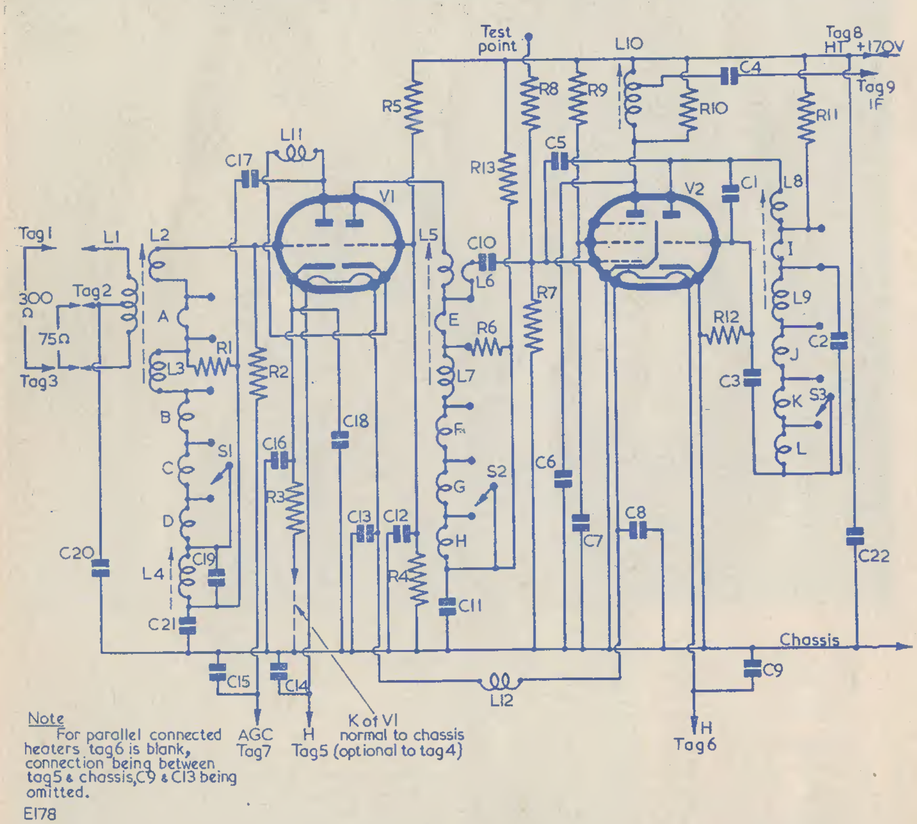


Fig. 1. The basic circuit of the Tuner Unit employed for the conversion (subject to modifications by the manufacturer)

The Circuit

The basic circuit of the Valradio tuner unit is shown in Fig. 1. Component values are not available for publication. Nevertheless, they are the conventional values employed for to the lower end of R_3. C_{17} and C_{21} provide the usual neutralising circuit for the grounded-cathode triode section of the cascode amplifier; whilst L_{11} is a series peaking coil ensuring constant gain over Band I to Band III.

The output of the cascode feeds the second series of tuned coils, L_5 and L_6. These are switched in the same manner as are the aerial tuned coils, and they connect, via C_{10}, to the control grid of the pentode section of V_2. The triode section of V_2 functions as the oscillator, the coils L_8 and L_9 operating in a Colpitts arrangement. The oscillatory voltage is fed to the control grid of the pentode section of V_2 via C_{11}, thereby allowing additive mixing to take place.

The i.f. voltage produced by V_2 is built up across the i.f. coil L_{10}. This coil is damped by R_{10} to give the bandwidth required. A tap into the coil enables the i.f. to be taken off to the subsequent receiver at 75 ohm impedance.

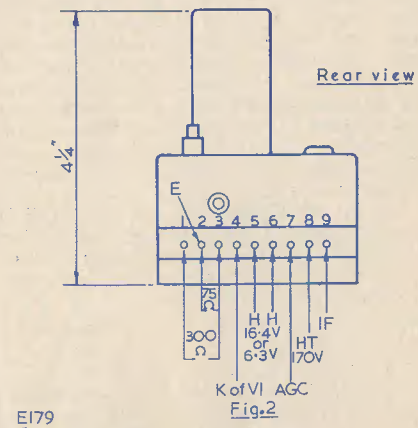


Fig. 2. Rear view of the Tuner Unit, showing tag positions and their functions

Practical Points

Readers who wish to convert the Magna-View will require a tuner unit type TP20P. This particular unit is specially designed to feed into the Magna-View i.f. strip; at 19.75 Mc/s video and 23.25 Mc/s sound. The suffix "P" infers that the valves employed in the tuner unit are the ECC84 and ECF80, and that the heaters of these valves are connected in parallel to work at 6.3 volts at 0.9A approx.

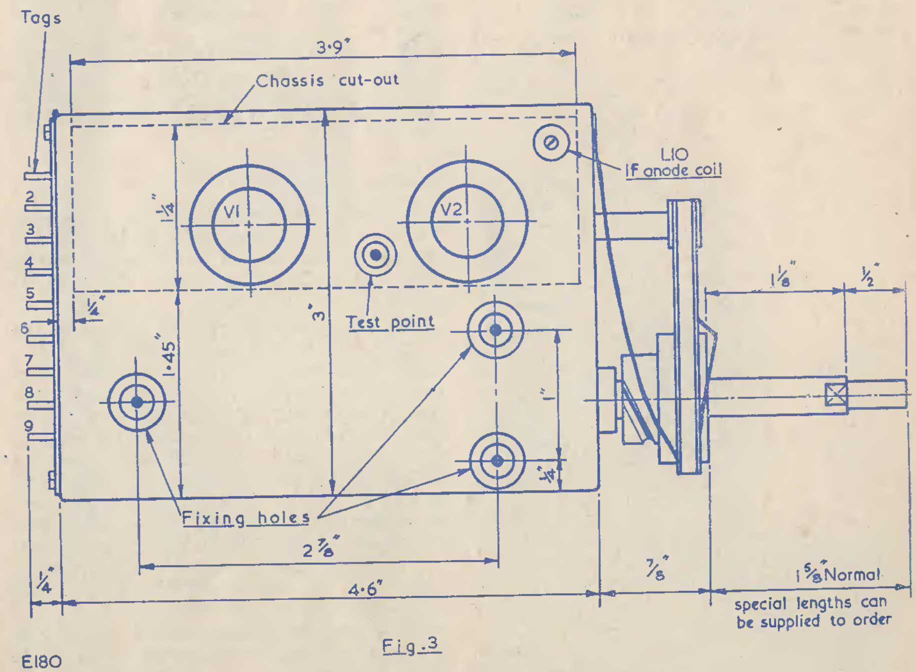


Fig. 3. Top view of the Tuner, illustrating the positions of the mounting holes

It is also possible to obtain the tuner unit with series-connected heaters and employing valves type PCC84 and PCF80. In this case, the heater voltage required is 16.4 volts at 0.3 amps, and the tuner unit type number has the suffix "S" instead. Such valve combinations will, of course, be needed only for receivers having series heater chains. If it is desired to employ the Tuner Unit for intermediate frequencies differing from those used by the Magna-View, the manufacturer's advice should be sought.

The h.t. requirement of the tuner unit is approximately 170 volts, current consumption at this voltage being approximately 25 mA.

The six switch positions of the tuner unit provide coverage as follows:—

Position	*Channel*	*Frequency*
1	1	40–50 Mc/s.
2	2–3	45–55 Mc/s.
3	4–5	50–70 Mc/s.
4	"F.M."	65–100 Mc/s.
5	6–9	170–200 Mc/s.
6	9–13	190–225 Mc/s.

Each switch position may be considered as a coarse tuning control only. Final tuning is then achieved by a ganged set of cores entering the various aerial, coupling and oscillator coils, as shown in Fig. 1. The operation of this tuning control is, incidentally, extremely simple, as an ingenious two-speed slow-motion drive is employed. The switch and tuning controls are co-axial, and a scale is provided.

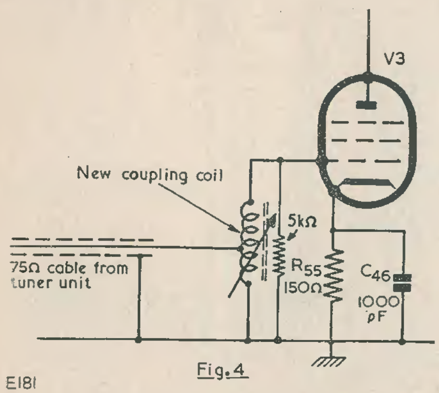


Fig. 4. The circuit which enables the Tuner Unit to be coupled into the grid circuit of V_3 in the Magna-View

The fitting of the tuner unit should raise few problems, owing to the fact that the i.f. coupling into the main receiver is at 75 ohms impedance. This enables the tuner unit to be mounted anywhere in the receiver cabinet, the connection to the receiver proper being made over 75 ohms co-axial cable. A special bracket is available, enabling the unit to be readily fixed in this manner. It is possible for the tuner unit to be fitted to the existing Magna-View chassis, if desired, but this course may not allow the tuning controls to project from the cabinet at a convenient point. Also, a considerable amount of alteration to the chassis would be required, with little subsequent advantage.

The connections to the tag-strip at the rear of the tuner unit are illustrated in Fig. 2. This tag-strip carries all the connections to the tuner unit, including power. In the conversion recommended for the Magna-View, an a.g.c. line is not employed and the corresponding tag (No. 7) is, in consequence, taken to chassis. Also, it is recommended that a sensitivity or contrast control be introduced to the cathode of V_1 in the tuner unit. The existing sensitivity control components used in the Magna-View can be employed, with slight circuit modifications, for this purpose.

Fig. 3 illustrates the top view of the tuner unit, giving also its main dimensions. As may be seen, it is intended to be mounted by means of three fixing holes in the top plate of its chassis. These fixing holes are 6-BA clearance and locate with the special mounting bracket mentioned earlier. The "Test Point" shown in Fig. 3 is used only during alignment by the manufacturer, and should not be interfered with by the home-constructor.

Receiver Coupling

Although fuller details will be given next month, readers will no doubt be interested in the general form taken by the conversion of the Magna-View to Band I–Band III operation.

Basically, the new tuner unit replaces the existing front-end of the receiver. V_1 and V_2 in the Magna-View, together with their components, are not now required. Instead, the tuner unit takes their place and feeds direct into the grid circuit of V_3, this being the first video and sound i.f. amplifier. The coupling into V_3 is achieved by means of the circuit illustrated in Fig. 4. As will be realised, a new coil is introduced at this point, the 75 ohm output of the tuner unit being tapped into some of its turns. The coil is the Denco type L3/3, and will be available by the time these articles appear in print.

With the possible exception of the contrast control, nothing else in the receiver is altered. However, further attention is given to this point in next month's article.

Photographs

Several photographs are included with this article. These show the Valradio tuner unit fitted to a development chassis employing similar circuitry to that used in the Magna-View. Also included is a reproduction of the signal transmitted by the Belling-Lee station on Channel 9, this having been photographed directly from the tube of a converted Magna-View using the Valradio tuner unit.

Components Required

The main components required for the conversion are as follows:

1 Coupling coil, Denco, type L3/3
1 500 Ω, 1 watt resistor
1 0.05 μF, 350V wkg miniature paper condenser
1 Tuner Unit type TP20P (Price £6)
1 Mounting Bracket (Price 2s. 6d.)

The latter two items are available from Valradio, Ltd., New Chapel Road, High Street, Feltham, Middlesex.

(To be continued)

Can Anyone Help?

E. G. Chambers, 9 Cranford Park Road, Hayes, Middx., who needs a service sheet for the Ekco T.C. 140.

* * *

C. Braund, 35 Fallows Road, Sparkbrook, Birmingham, 11, who wants to obtain information on a "Victory" receiver. The valve line-up is 6K8, 6K7, two 6B8 and p.p.–6V6.

* * *

W. Bell, of 26 Glenbryn Drive, Belfast, N. Ireland, needs a basic circuit or wiring diagram of a 15 watt amplifier using KT33C, KT33C, H63, 6J5G and U31 valves.

* * *

C. B. Raithby, G8GI, School House, Martin, Lincoln, needs the circuit and/or data (English or German) of the German Battery Communications Receiver type TORN.E.B.

* * *

F. W. Porter, Flat 1, 448 Banbury Road, Oxford, would like to obtain the circuit and data for the Belmont 3-Band table model receiver: valve line-up 6C6, 6D6, 76, 6B7, 42E and 80.

* * *

K. Mitchell, 933A Wimborne Road, Moordown, Bournemouth, would like the circuit (buy or borrow) and component values of the Philips type 660A-15 receiver.

* * *

H. C. Murfitt, 12 Heather Drive, Dartford, Kent, would like to buy or borrow the circuit, or other information, for the R.A.F. U.H.F. Receiver R1645 (10D/16179), using a series of interchangeable units (RF116-120) which probably cover a range of 300–900 Mc/s and incorporates the Calibrator 106 which is crystal controlled. He also needs information on the Modulator type 67 and the Receiver type 3547.

* * *

M. Lack, 42 Canonbury Court, Halton Road, London, N.1 needs the details of the conversion of the ex-R.A.F. Amplifier Unit type 165 to a gram amplifier.

L. Cooper, 1 Walton Terrace, Carlingford Drive, Southend-on-Sea, Essex would like to know the ratings of the H.18-3-1 (E.T.F.) 10D/1815 metal rectifier.

* * *

S. W. L. MacLauchlan, 14 Mannfield Avenue, Bonnybridge, Stirlingshire, would like details of the conversion of the RF26 Unit to 2 metres.

* * *

D. Hipkin, 13 Fifth Avenue, Hayes, Middlesex, wishes to borrow, or preferably buy, the circuit and/or data on the Army 17 Set.

* * *

C. W. Kirk, 20 Branksome Drive, Nab Wood, Shipley, Yorks., needs a circuit for a superhet using miniature valves, to cover 14–30 metres, and capable of being built on a chassis measuring 5in. × 5in. × 2½in. deep.

* * *

F. B. Miles, 54 Shenstone Road, Birmingham 16, would like the circuit, or information as to where to apply for it, of the Amplifying Unit type 111 Ref. No. 1OU/44, A.M. Serial No. GR66.

* * *

J. Anderson, 15 Langley Avenue, Coseley, Bilston, Staffs., wishes to obtain information on the Transmitter-Receiver TR3171, Ref. No. 100B-913 A.M., 80V input. He is willing to purchase.

Appreciation

A. E. Howard, 48 Hazlemere Road, Chiswick, London, W.1, writes as follows: ". . . The insertion brought many offers of help, to all of which I have replied bar one. This letter, posted in Liverpool, contained a photostat copy of the circuit required with a short note, but no name or address, ending with what looked like "C.W." So may I take the opportunity of thanking that person through your columns. It is nice to know that so much help is available through the medium of your most excellent Magazine."

SIMPLE STABILISED POWER UNIT FOR A BC-221

By W. E. THOMPSON, A.M.I.P.R.E.

As is well-known, the BC-221 frequency meter is intended to derive its power supply from primary batteries, provision being made to accommodate suitable batteries in the instrument case. A mains-driven power unit can be much more convenient, and if it is stabilized it will be beyond reproach so far as reliability of the instrument is concerned. The simple unit described here has been in use for more than a year, the BC-221 being worked long and often over the period.

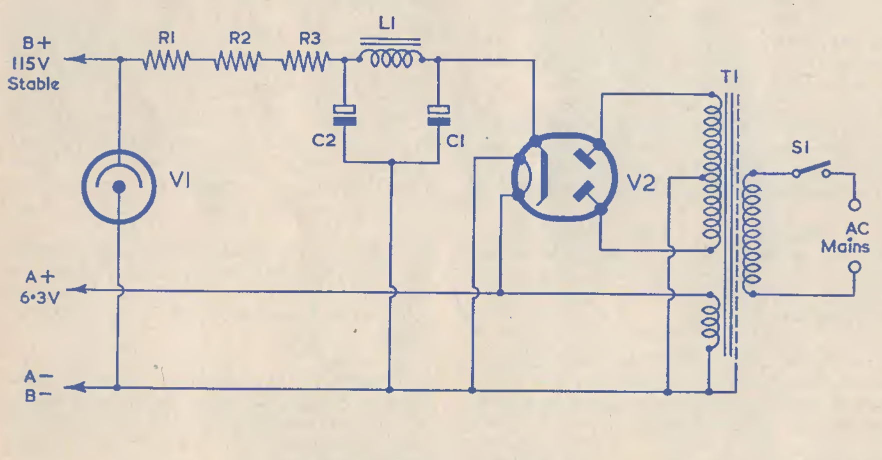


FIG.1. CIRCUIT OF POWER PACK

The circuit is shown in Fig. 1, and is so conventional that it hardly needs detailed description. All the parts used can be obtained cheaply, the valves being ex-Govt. types. The value of the dropping resistor R1–R2–R3 is such that it allows sufficient voltage to appear across the neon regulator to ensure that it will strike with certainty, and on allowing the power unit to run off load it limits the neon current to a value within the tube rating. The h.t. voltage delivered to the BC-221, in the author's case, is stabilized at 115V. Slight differences from this figure may be encountered in other cases, depending on the characteristics of the neon tube actually used, but in any case the h.t. voltage will not reach the 135V maximum normally specified for a BC-221. The life of the components in the power unit should be long, since they are run at voltages and current ratings well within their normal limits.

The unit is made up on a simple chassis of sheet aluminium having a top deck and two sides. Lengths of aluminium angle are bolted to the sides to serve as mounting plates for securing the unit inside the BC-221. Viewed from the rear of the battery compartment, it is fixed to the right-hand side by four bolts passing through the wooden sides of the instrument case, and screwed into tapped holes in the aluminium angles.

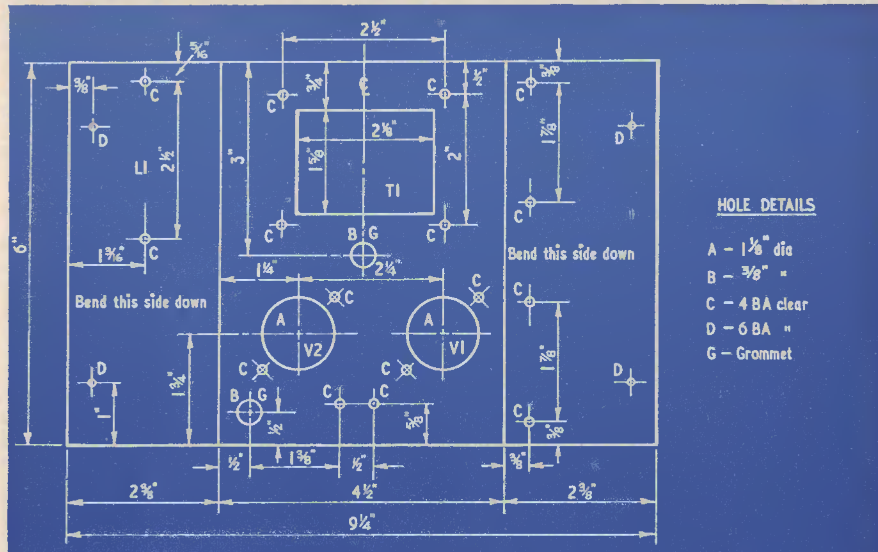


FIG.2. CHASSIS DRILLING DETAILS

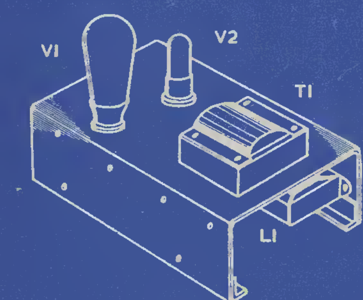


FIG.3. COMPONENT LAYOUT ABOVE CHASSIS

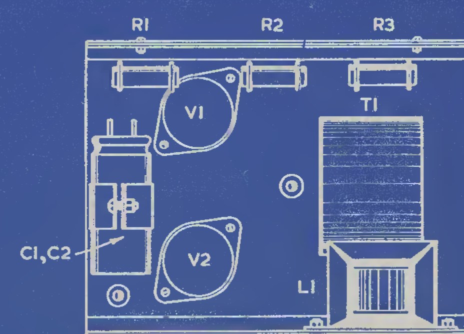


FIG.4. COMPONENT LAYOUT BELOW CHASSIS

The valves should be adjacent to the rear flap of the BC-221 case, and it might be wise to make some ventilation holes in the base and rear flap to carry off the small amount of heat when the unit is in use.

Drilling details for the chassis are given in Fig. 2, while sketches of the top and underside in Figs. 3 and 4 respectively show the disposition of the components. Four 1+1E tag strips on one side of the chassis serve to mount the three resistors R1–R2–R3. A 3+1E tag strip held under one of the securing nuts of the mains transformer provides anchorage for the mains feed and wires to the on-off switch. The electrolytic capacitor unit C1–C2 is mounted on its side by a suitable clip underneath the chassis.

Wiring is simplicity itself, and needs no comment here. Three wires feed h.t. and 6.3V to the three-way terminal strip at the left rear of the BC-221, these wires passing through a grommet in a corner of the chassis near the 6X5 rectifier.

A toggle on-off switch is fitted to the lower front panel of the BC-221. The mains feed also passes through the panel, and when the instrument is not is use the lead can be stowed in this lower compartment.

The mains transformer, smoothing choke, electrolytic capacitor unit and three wire wound resistors were obtained from The Radio Supply Co. of Leeds, but alternative components can be used if the necessary alterations are made in the construction or the chassis to accommodate them. If alternative components are used, the value of the dropping resistor may need adjustment to ensure that the off-load current through the neon tube is not exceeded. As will be seen from the table of results under test conditions given later, in the unit described here the off-load neon current is 20mA, which is just below the 30mA maximum for an S.130 tube, and that the voltage drop across the resistor of 4.5kΩ is 125V for this current. Should the rectified and smoothed h.t. voltage differ from the 240V quoted, the required value of resistor can be calculated from:

$$R = \frac{1{,}000\ (V_{in} - V_n)}{I_n} \text{ ohms}$$

where V_{in} = smoothed h.t. voltage
V_n = running voltage of neon
I_n = max. off-load current in neon

If, due to tube characteristics, this calculated value of resistor results in the maximum current through the tube being exceeded, the resistor should be increased in value until the neon current is below the recommended maximum of 30mA. In any case, and especially where the smoothed h.t. is less than 240V, it should be verified that there is sufficient voltage available initially to strike the neon tube when the BC-221 is drawing load current. This can be calculated from the relation:

$$V_{in} > \frac{V_s\ (R_L + R)}{R_L} \text{ volts}$$

where V_{in} = smoothed h.t.voltage
V_s = striking voltage of neon
R_L = effective load resistance
R = value of series resistance

As the most stringent condition is when the BC-221 draws its greatest load, the calculation should be made at this value. As example, from the table which follows the BC-221 drew 11.21mA at 114.6V with the function switch in the "Operate" position. The effective load R_L is therefore 10.22kΩ. The minimum striking voltage of the S.130 is 160V, and from Fig. 1 the value of R is 4.5kΩ (i.e., R1+R2+R3). Inserting these values in the formula given above shows that

$$V_{in} = \frac{160\ (10{,}220 + 4{,}500)}{10{,}200}$$

$$= 183 \text{ volts, at least.}$$

This is well below the 240V available, so striking of the neon is assured under all load conditions.

To show the effect of too low an h.t. voltage, suppose resistance smoothing was used in place of the choke L_1 and that the smoothed h.t. is 190V. If it is desired to limit the off-load tube current to, say, 25mA, at the running voltage of 130V, the value of the series resistance R must be:

$$R = \frac{1{,}000\ (190 - 130)}{25}$$

$$= 2{,}400\Omega.$$

Applying this value in the previous calculation:

$$V_{in} = \frac{160\ (10{,}220 + 2{,}400)}{10{,}220}$$

$$= 198\text{V minimum.}$$

This is more than the 190V available, and the chances are that the neon would not strike under these conditions. The h.t. voltage would therefore have to be raised by reducing the value of the smoothing resistor, NOT the series resistor R1, R2, R3.

When the power unit was first constructed, the following measurements were taken. It is suggested that constructors take similar measurements on making up a unit, since the figures obtained form a valuable reference for comparison when checks are made at a later date. After a year's working, the figures quoted have not changed in any way. The meter used in the author's measurements was a Taylor 85A multi-range instrument, 20,000Ω/V.

Parts List

V1	Cossor S.130 (CV1731)
V2	Brimar 6X5GT (CV574)
C1–C2	8+16μF 450V wkg electrolytic
R1–R2–R3	1.5kΩ wire wound 5-watt
L1	10H 60mA choke
T1	Mains transformer, 220/240V input, screened primary, 250/250V 60mA, 6.3V 2.5A secondaries.
S1	On-off toggle
1	International octal valveholder
1	British 4-pin valveholder

Test Conditions

BC-221 set as follows:
Gain—minimum signal.
Dial reading—3026.0 (200 kc/s).
Range—Low.
Corrector—Zero beat on check point.
Air temperature—64 F.
Mains voltage—210V 50c/s.

Test 1. Taken 1 minute after the neon struck. Power unit ON. BC-221 function switch at OFF.

Smoothed H.T.	240V d.c.
Regulated H.T.	115V d.c.
Neon Current	20mA.
L.T. line	6.23V a.c.

Test 2. Taken 10 minutes after conclusion of Test 1.

Switch position	*Volts*	*mA*
Operate	114.6	11.21
Check	114.6	9.19
Crystal	114.7	7.9
Off	114.9	0

L.T. line: 6.2V a.c.

CLUB NEWS

Details for insertion in this section should reach us not later than 7th of the month before publication.

CLIFTON AMATEUR RADIO SOCIETY

A transmitting field day contest is being held on Sunday 24th July, near Farnborough, Kent. Other July events are: 8th, Junk Sale; 15th, Constructional Evening and Ragchew.

Meetings are held every Friday at 7.30 p.m. at 225 New Cross Road, S.E.15. New members are welcomed. Hon. Sec.: C. H. Bullivant, G3DIC, 25 St. Fillans Road, S.E.6.

MITCHAM AND DISTRICT RADIO SOCIETY

Meetings are held on alternate Fridays at "The Canons," Madeira Road, Mitcham. On 15th July there will be a talk on V.H.F. Technique given by G2FKZ; on the 29th July there will be an End-of-Term Discussion. There will be no meetings during August; the first meeting in the new season will be on the 2nd September. Visitors are welcome at all meetings. Hon. Sec.: D. Tilcock, G3JYV, 16 Taffey's How, Mitcham, Surrey.

ROMFORD AND DISTRICT AMATEUR RADIO SOCIETY

A workshop is now available for the use of Club Members. Meetings are held at RAFA House, Carlton Road, Romford, every Tuesday at 8.15 p.m., and all visitors are welcome. Hon. Sec.: N. Miller, 55 Kingston Road, Romford.

THE MIDLAND AMATEUR RADIO SOCIETY

General meetings of the Society are held on the 3rd Tuesday of the month at the Birmingham & Midland Institute, Paradise Street. The annual Field Week-End is being held on 2nd–3rd July at Barr Beacon, Staffs. A talk on "Transistors" will be given by J. Missen (G.E.C. Research Laboratory) on the 19th July. Hon. Sec.: D. Hall, 144 Hill Village Road, Sutton Coldfield.

AMATEUR RADIO CLUB OF NOTTINGHAM

Meetings are held every Monday evening at 7.30 p.m. in the clubroom at Woodthorpe House, Sherwood, Nottingham. Hon. Sec.: N. D. Littlewood, 129 Standhill Road, Nottingham, or care of the Sherwood Community Association at Woodthorpe House, Sherwood, Nottingham.

QRP SOCIETY

Several U.S. amateurs have recently joined the Society, and a healthy interest is bing shown out there in the Society's Portable Amateur Radio Equipment Contest, details of which were announced in the May issue of *The Radio Constructor*.

Two members, GC2CNC and GC2FMV, operated from the Island of Sark during mid-June, putting this hitherto unrepresented island on the radio map.

The Society magazine, *QRP*, has just reached its 67th issue and is currently carrying an interesting series of articles on reporting, for the SWL. Hon. Sec.: J. Whitehead, 92 Rydens Avenue, Walton-on-Thames, Surrey.

R.A.F. ASSOCIATION, N. KENSINGTON

This Association is endeavouring to form a radio section, especially from ex-servicemen resident in the neighbourhood. A Clubroom will be available on Tuesdays, after 8 p.m. Anyone interested should contact Mr. A. J. Boyle, c/o R.A.F. Association, 54 Kensington Park Road, Notting Hill, London, W.11.

NOTES ON RADIO CONTROL

9: *Accumulators, Relays & Suppression*

by QUENCH COIL

Venner Accumulators

One of the most useful items of equipment for the radio control enthusiast are the small light-weight silver zinc accumulators made by Venner Accumulators Ltd. of New Malden, Surrey. These are becoming very popular and it was thought, therefore, that some information about these accumulators, acquired by the writer from personal experience, might prove valuable to readers of these notes.

The usual requirements as to cleanliness should be strictly adhered to. The terminals and bus-bars should be lightly greased with white vaseline. Keep the case clean and dry, and the vents clear of dust, etc.

A grey or white deposit in the cell is characteristic of the silver zinc type of accumulator and is in no way an indication of trouble. Sufficient electrolyte for normal working is absorbed into the plate system. Any free electrolyte present serves only as an indication of sufficiency. The cell should be a quarter to a half full, the level being noted when the accumulator is in the discharged condition. Top up with distilled water only. This should be done when the level of the free electrolyte drops to below a quarter full. Under no circumstances should utensils that have been contaminated with acid be used for holding the topping-up water. It is interesting to note that even an acid-contaminated cloth can be the cause of damage to this type of accumulator. For this reason the writer prefers to charge his own accumulators at home, when one can then be sure that they will be properly treated.

The best rate of charging is the twenty-hour one, charging being completed when the voltage, whilst still on charge, reaches 2.1 volts per cell. Higher rates of charge are permissible providing the voltage limitation above is observed and the cell temperature does not rise above 60°C. Do not charge at high rates continually. It is best to keep to the normal charging rate. Also do not leave cells in a partially discharged condition for more than a few days only. For long storage, discharge at normal load and then short out each cell individually until the voltage is down to zero. Remove the short circuit before putting the cells into store. To facilitate the charging of these batteries, the writer has built a control panel along the lines of that shown in Fig. 1, which gives sufficient detail to be self-explanatory.

Finally a note or two on the treatment of new cells. They are despatched in the filled but unformed condition. When required for use, they should be charged at the 20 hour rate until the voltage on charge reaches 2.1 volts. Under no circumstances, even if the cell appears dry, should any electrolyte or distilled water be added before formation. On the first discharge the battery can be discharged at rates up to but not exceeding the 5 hour rate. The complete discharge characteristics and the capacity of the cell will be fully realised by the third cycle of charging.

The writer uses these Venner accumulators for both electric motor and relay operation in all his models, and has found them ideal. The type H.105 of 1.5 ampere-hour capacity is particularly suitable for model work.

Electrical Interference Suppression

It is most important to suppress all possible sources of electrical interference in the model. It is, unfortunately, quite common practice to operate radio control equipment without an adequate spark suppressor fitted to the relay. The writer has proved to his own satisfaction that such a procedure is wrong. When operating an inductive load such as a solenoid operated escapement for example, minute sparks have been shown to cause the relay to stick, and in some cases its contacts soon became badly pitted. Electric motors should be suppressed by connecting a 0.1μF condenser from each brush to the frame of the motor. Also, do not forget to earth all components to an earth plate on the hull. During bench tests many a receiver has worked perfectly, only to become completely erratic when fitted into the model and placed on the water. It is worth remarking, too, that this question of interference varies from model to model. It may occur in one and not in another. Each model seems to have its own type of problem.

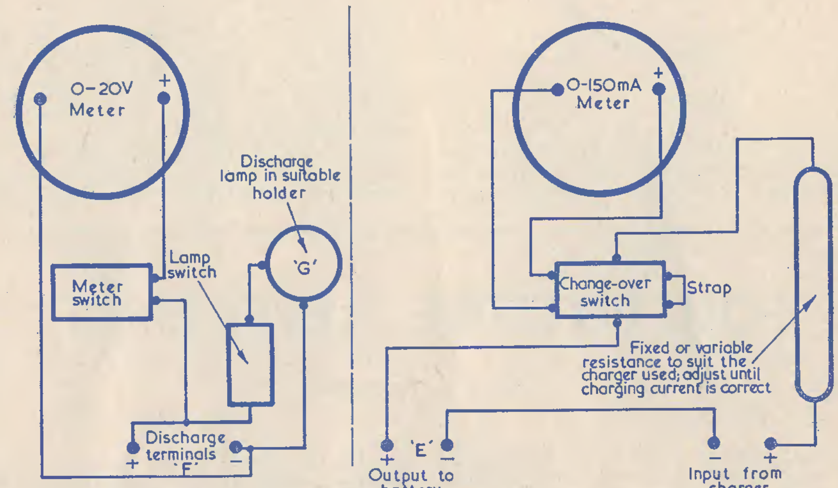


Fig.1

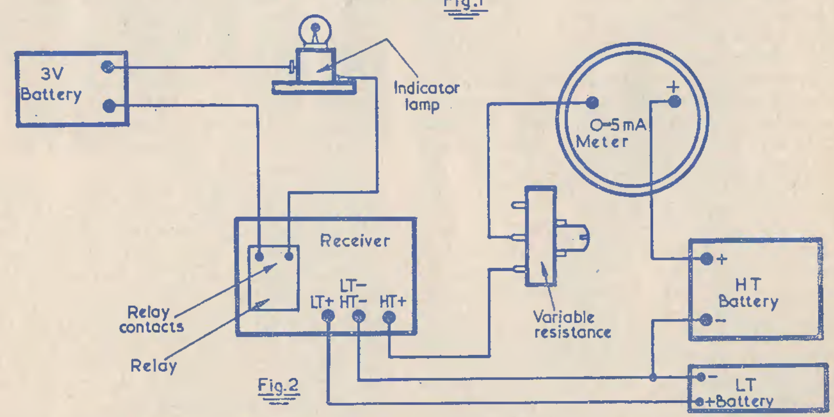


Fig.2

E174

Simple charging panel (Fig.1)
To charge connect battery to 'E', check voltage by means of leads from 'F'.
To discharge connect battery to 'F', check voltage by switching meter.
When checking for correct voltage, switch off lamp 'G'

Polarised Relays

This type of relay is by far the best so far tried by the writer. It is most rigid and is totally unaffected by vibration and similar shocks. It should be fitted with spark suppression like any other relay. The adjustment is somewhat critical, but this is not difficult if the following procedure is adopted. Connect up as shown in Fig. 2. Tune and check the receiver as for normal operation, using a full length aerial on both receiver and transmitter. Check the receiver for current change when the transmitter is keyed and note the meter reading (A in

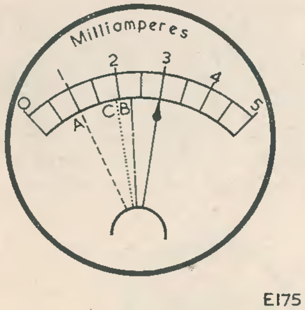


Fig. 3.

Fig. 3). Switch off the transmitter and slowly adjust the resistance to reduce the current to a point when the indicator lamp comes on. Note the meter reading (B in Fig. 3). Continue to reduce the meter reading until the reading is as at A. Slowly turn the resistance in the opposite direction until the indicator lamp goes out. Note the meter reading (C). The meter readings B and C show the make and break or operating points of the relay. By careful adjustment of the contact screws, the relay can be adjusted to a very fine limit over the range used for the receiver. When long range operation is required, it is advisable to adjust the relay operating points (B and C) close to the standing current, at the same time taking care not to adjust too close, or the relay may not pull in when the transmitter signal is keyed off.

The value of the variable resistance will vary with the h.t. voltage. In the writer's case it was 50,000 ohms, with 67½ volts h.t.

FOR FUTURE REFERENCE

by G. H. SAWYER

There must be many radio enthusiasts who, having taken their hobby seriously for a number of years, probably since pre-war days, find that an ever-increasing volume of space is taken up by old periodicals and other oddments in the way of radio literature. Although they may take up a matter of cubic feet of space the owners are usually most reluctant to have a "turn-out"; and this is not without good reason, for they contain many useful articles, the subject matter of which may still hold good from pre-war days.

At the same time it may not be fully realised that perhaps well over half of this valuable shelf-space is being occupied by out of date and useless advertisements. This is particularly so where a stock of back-numbers of the last five or six years is kept, as some such publications contain quite three times as many advertising pages as those of useful text and illustrations.

According to one's particular requirements, the books may be reduced in size either by "slicing" or "sifting." The first method, the easier and quicker, consists of cutting out the whole section of advertisements and retaining only the text with its index or list of contents. The second method requires more time, and probably more patience, but well justifies the extra trouble. This entails scanning each book as quickly as possible and extracting all articles of interest to the reader. This is mostly possible merely by glancing at the titles, and indeed it is essential not to start sampling the text unless it is unavoidable, for everyone knows the fatal result of searching for some particular article, and in the process thereof stumbling across another which one had intended to read long ago. The job in hand is held up while a period of high-pressure study is indulged in on the nea est seat!

Where it is decided to select individual articles, it will be found better to extract whole pages than to take out cuttings of various shapes and sizes, as the former are much more easily handled and filed in a suitable folder. This may contain stiff sheets for dividing the contents into alphabetical sections, each sheet holding an index for the section; or if preferred, one main alphabetical index may be made on the inside cover of the file itself.

The scheme as a whole may be very conveniently worked out in two separate operations; first, slicing out the advertisement sections, and later, as time allows, sifting through the remainder for wanted material.

Even if the system offers no great advantage in some cases, as a space-saver, there is no doubt that it is a real time-saver in that it provides a well-ordered home reference library.

LOUDSPEAKER MATCHING

by F. H. ALLUM, *Grad. I.P.R.E.*

When constructing a receiver or amplifier, the output transformer must be carefully selected. The output transformer is required to transfer the greatest amount of power from the output valve or valves to the speech coil of the loudspeaker. To ensure this, the anode load impedance must be twice the anode resistance.

The formula for calculating the output transformer ratio is:

$$\sqrt{\frac{\text{Optimum Load of Valve}}{\text{Speaker Impedance}}}.$$

Example: If the optimum load of the valve is 3,200 ohms and the impedance of the speaker is 2 ohms, the ratio is:

$$\sqrt{\frac{3{,}200}{2}}=\sqrt{1{,}600}=40{:}1.$$

To ensure an adequate low frequency response, the primary inductance (in henrys) of an output transformer should be approximately the impedance divided by 150.

Example: If the optimum load of the valve is 3,200 ohms, the inductance should be:

$$\frac{3{,}200}{150}=21.3 \text{ henrys}.$$

If the output stage consists of a pair of valves in push-pull, the total optimum load across the full primary will be double that of a single valve, but the ratio will not be doubled.

Example: If the optimum load of each valve is 3,200 ohms and the impedance of the speaker is 2 ohms, the ratio is:

$$\sqrt{\frac{2\times 3{,}200}{2}}=56.6{:}1.$$

If it is required to connect, say, three loudspeakers to an amplifier, each having a different speech coil impedance and different output, the following method of calculation is used.

Let the voltage applied to the anode be 400 volts, the optimum load 4,000 ohms, and the output 40 watts; and suppose the loudspeakers have characteristics of:— 25 watts and a 15 ohm speech coil; 12 watts and a 12 ohm speech coil; and 3 watts with a 7 ohm speech coil.

No. 1 speaker dissipates 25 watts, so that the voltage across the speaker coil will be: $\sqrt{W\times R}=\sqrt{25\times 15}=19.36$ volts, the voltage ratio is 400:19.36 or 20.65:1; this will also be the turns ratio. Now we require the ratio of the primary impedance to the secondary impedance, given by $Z_p/Z_s=(E_p/E_s)^2 = (20.65)^2 = 426.8{:}1$. We already know the required load is 4,000 ohms, so that the impedance of the secondary will be $Z_p/Z_s = 4{,}000 \div 426.8 = 9.4$ ohms, which is the impedance of the secondary winding for No. 1 speaker when loaded by the speech coil.

Similar reasoning applies to No. 2 speaker. The voltage across the speaker coil $=\sqrt{12\times 12} = 12$ volts; the voltage ratio is 400:12 = 33.3:1. The ratio $Z_p/Z_s = (33.3)^2 = 1{,}111{:}1$. The impedance of the secondary will be $4{,}000 \div 1{,}111 = 3.6$ ohms.

Likewise with No. 3 speaker, the voltage across the speaker coil $= \sqrt{3\times 7} = 4.6$ volts, the voltage ratio is 400:4.6 = 87.3:1. The ratio $Z_p/Z_s = (87.3)^2 = 7{,}621{:}1$. The impedance of the secondary will be $4{,}000 \div 7{,}621 = 0.525$ ohms.

The next step is to check that the three speakers will reflect back into the primary winding the correct load of 4,000 ohms.

The reflected load to the primary due to No. 1 speaker:

$$=15\times\left(\frac{400}{19.36}\right)^2$$

$$=6{,}404 \text{ ohms}.$$

No 2 speaker has a 12 ohms speech coil, and the reflected load:

$$=12\times\left(\frac{400}{12}\right)^2=13{,}340 \text{ ohms}.$$

No. 3 speaker has a 7 ohms speech coil, and the reflected load:

$$= 7\times\left(\frac{40}{4.6}\right)^2=52{,}930 \text{ ohms}.$$

The formula for the collective loads:

$$=\frac{Z1\times Z2\times Z3}{(Z1\times Z2)+(Z2\times Z3)+(Z3\times Z1)}$$

$$=4{,}000 \text{ ohms}.$$

The VERSATILE BUZZER

by W. SCHROEDER

The uses to which an ordinary buzzer can be put are as surprising as they are numerous. Connected in a circuit instead of a fuse, a buzzer will make a very sensitive safety device which has quite a few advantages. Fuses for currents of 50mA or less are not easily obtainable, and it is in such places that the buzzer will effectively safeguard any sensitive equipment, and, at the same time, it will give an audible signal should a short-circuit or an over-load occur.

Naturally, for such an application the construction, and especially the contacts, of a buzzer must be of the utmost reliability, and it is in this respect that many of the cheaper types of this component fail. Rather than trying to make an unsatisfactory buzzer fit an application, many constructors will prefer to make their own, which will then be really suitable for the use they are intended for, a task which is not at all difficult.

The Construction of a Buzzer

The materials needed are easily obtainable. All that is required are some cardboard and paper, a piece of soft iron for the core of the bobbin, about an ounce or two of enamelled copper wire, the gauge of which can be anything between 20 and 40, depending on the current the completed buzzer is to pass, a piece of brass, a few screws, and two contacts which can be taken from another unsuitable buzzer, from a voltage regulator as they are used in cars, or from a burnt-out vibrator, in which there are usually to be found three or four contacts which are still serviceable or can be rendered so by carefully cleaning and filing them into shape.

Fig. 1 clearly shows the construction of a simple type of buzzer. The core of the bobbin is covered with paper, then the two cardboard cheeks are forced over the core, and the bobbin is wound between them. One side of the core is tapped to take a screw for mounting the coil, which also keeps the armature in place. This consists of a strip of brass, bent as shown in the figure, with a fixing hole drilled at one end, the contact fitted in the centre, and a small, soft iron washer soldered to the other end.

The bobbin with the armature is then screwed on to a strip of insulating material; after one end of the winding on the coil has been scraped clean and wound around the fixing screw. The other end of the winding is taken to a screw terminal, and the other, adjustable, contact is fitted opposite the armature, with the two contacts just touching one another.

This completes the construction of the buzzer, which can now be tested with a battery; about 6 volts should be quite sufficient. A 1,000 Ω potentiometer and a milliammeter should be connected in series. Adjustments to the potentiometer will then reveal the minimum current necessary to operate the buzzer and the maximum current it will pass if used instead of a fuse. An increase in the applied voltage hardly changes the current which is passed, although this can be altered within certain limits by adjusting the pressure of the contacts.

A Simple Tester

The obvious application of the buzzer is, of course, as a continuity tester. One terminal of the buzzer is connected to one end of a battery, and the other terminal of each of the buzzer and the battery, both of which can be housed in a small wooden box, is taken to one of two test prods. This continuity tester will come in handy when testing heater or other circuits where normally fairly high currents flow. An ordinary ohmmeter might still indicate a short-circuit, when, in fact, a bad connection somewhere offers a fairly high resistance which will soon be detected by the buzzer, especially if it is constructed to take a current in the region of 200–300mA.

Miniature Power Supply

With the addition of a few components, the buzzer can be made to deliver enough high tension current to operate a one-valve receiver. Fig. 2 shows the circuit of such a power supply. The operation is as follows: When the contacts of the buzzer interrupt the current, the magnetic field in the core collapses, and a very high voltage is induced in the coil. This is passed through a germanium

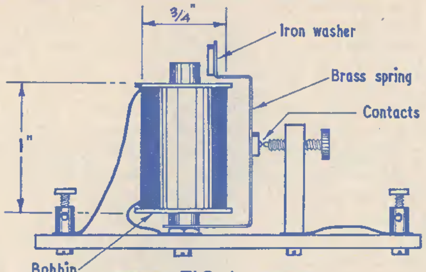


FIG. 1.

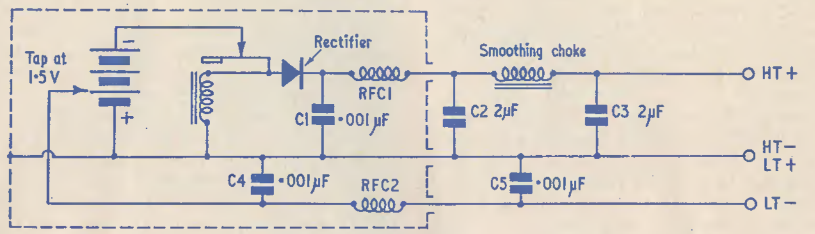


FIG. 2.

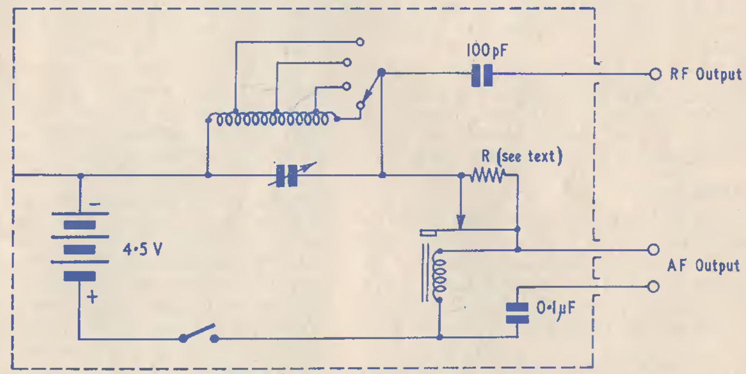


FIG. 3.

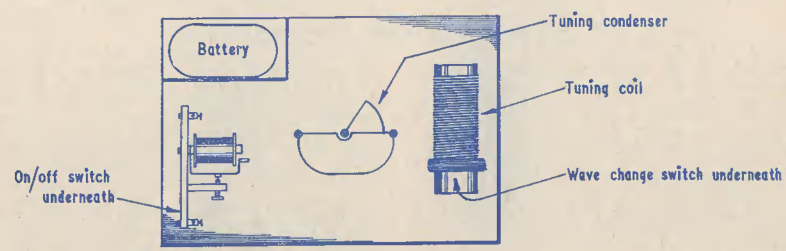


FIG. 4.

G167

diode or a selenium rectifier and charges up the condenser C_2. Another voltage, but of opposite polarity, is induced when the current begins to flow again. This, however, is not as high as the interrupting voltage, and the rectifier prevents it from cancelling the charge on C_2. Care must be taken to connect the rectifier with the correct polarity, or the voltage obtained on C_2 will be very low only, oeing derived from the closing currents. A good buzzer will easily deliver about 80 volts at 1 mA, but as this is very low compared with normal power supplies, it is best to avoid the leakages occurring in electrolytic condensers by using large paper condensers for C_2 and C_3. As the sparks at the contacts of the buzzer are a source of strong broadcast interference, the whole, including the batteries, must be screened, and the negative lead be taken to a good earth.

The efficiency of this h.t. supply is very good; the writer has used one for some time now which consumes 20mA at 4.5 volts, and the output of which is 70 volts at 0.5mA. The efficiency, therefore, is nearly 40%, which compares favourably with many vibrator packs.

The l.t. supply can be taken from the same battery which operates the buzzer, but additional components must be added (C_4, C_5, and R.F.C.2) in order to eliminate interference.

The whole unit can be built into a 2-oz tobacco tin, which also houses the batteries, three miniature 1.5V cells being used; the completed unit is ideally suited for vest-pocket receivers or for a rucksack radio.

Test Oscillator

Perhaps the most ambitious application of the buzzer is that as a test oscillator. The simplicity of the arrangement has much to recommend it, and the tuning can, with a simple circuit trick, be made sharp enough to satisfy all normal requirements of the radio amateur.

The circuit of the test oscillator is shown in Fig. 3. All that has been added to the buzzer is a tuning circuit which can be switched to cover the different bands. The whole unit is housed in an aluminium screening box of suitable dimensions. Fig. 4 shows the general layout. The buzzer and the battery are mounted on one side of the box, the tuning condenser in the centre and the coil and wavechange switch at the other end. The coil is best wound in four sections to cover the short, medium, i.f. and long wavebands. Practically any coil can be used here, as no coupling coils are necessary, but the most convenient form would be the tapped single-layer coil wound on a 1 or 1½ in former, with a pile-wound section for the long waves. The r.f. output is taken from the "upper end" of the coil via a 100pF condenser. To avoid stray radiation, this should be a co-axial socket, and an obvious refinement would be the addition of an output attenuator which must be screened separately.

When first using this test oscillator it will be found that the tuning is very broad. To increase the sharpness of the tuning, a resistor should be connected across the contacts of the buzzer, the value of which must be found by trial and error. Any value between 50 and 1,000 ohms might be suitable. The value of this resistor should be as high as possible to cut down current consumption and to maintain a sufficiently large r.f. output, but it also should be suitably low to make the tuning sharp enough.

For the testing of amplifiers and for operating R–C bridges, this oscillator will also deliver an audio tone. This a.f. is taken from the two ends of the buzzer-coil, one of which is connected directly to one of the a.f. output terminals, the other via a 0.1 μF condenser. Again, an output attenuator can be incorporated, which, in this case, needs no special screening.

The appearance of the test oscillator can be greatly enhanced by the use of Panel-Signs, and as it is completely self-contained, it should prove a very useful piece of equipment. Simple as such an oscillator is to construct, it will hardly ever prove insufficient for testing receivers or even for the alignment of superhets.

Publications Received

Modern Solders. An interesting 22-page booklet, the third and completely revised edition, available to engineers and technicians on application. More than 35 illustrations include pictures of soldering processes in various parts of the world. Five tables give particulars of melting points, feet per pound, tensile and shear strength, specific gravities and electrical conductivity of eleven different Ersin solders. Descriptions are given of other Multicore products such as the Bib Wire Stripper, the Bib Recording Tape Splicer, Multicore Tape Solder, etc. From Multicore Solders, Ltd., Maylands Avenue, Hemel Hempstead, Herts.

Mail Order Catalogue No. 12. Well produced and printed, and lavishly illustrated, is this latest catalogue from Arthur Sallis, Radio Control Ltd. There are 427 items, mostly ex-W.D. equipment, listed. These range from Rolls Royce Coolant Pumps to resistors and condensers, and include a number of items of interest to the radio control fan. Other radio constructors, and model engineers will also find plenty of useful apparatus in its pages. Obtainable, prize 1s. 6d. post free, from Arthur Sallis, Radio Control Ltd., 93 North Road, Brighton, Sussex.

Book Catalogue, Cleaver-Hume Press Ltd. A 48-page reference list of books published or distributed under the Cleaver-Hume imprint, including the well-known books and journals from the Philips Technical Library, which are often reviewed in these pages. From Cleaver Hume Press Ltd., Publishing Division, 31 Wright's Lane, Kensington, London, W.8.

Let's Get Started 25:

FREQUENCY MODULATION

by **A. P. BLACKBURN**

THERE HAS BEEN A GOOD DEAL OF INTEREST —not to say excitement—in the high frequency field about the B.B.C.'s recent announcement that they are now putting their v.h.f. service to work. And the thing we hear most about is something called frequency modulation; it certainly appears to have received an undue amount of publicity. Why, is rather obscure, if you don't know much about f.m.

It looks as though the first idea of using this system started in America—which isn't surprising, because in their large, crowded cities it was becoming virtually impossible to receive broadcast stations, due to the interference from innumerable electrical gadgets. Something had to be done to overcome this obstacle.

In 1936, or thereabouts, an American—Major Armstrong—suggested f.m. might be the answer to their problem, and since then considerable strides have been made in its development. However, in this country most f.m. networks have been applied only for special communications purposes.

Principles

Oddly enough, it wasn't the basic principle of f.m. that stumped the experts—that is so simple that you would need to be little short of a genius to miss it. No, it was in applying it that they encountered their first difficulty. So although the existence of f.m. was known well before Major Armstrong began his work on it, it was never considered a practical proposition.

A refresher course in amplitude modulation would perhaps give us a better understanding of this subject. You will remember that in amplitude modulation the audio modulation varies the amplitude of the carrier by an amount corresponding to the intensity (or loudness) of the modulation. The rate at which this is done depends upon the frequency of the modulating audio. Fig. 1a, no doubt very familiar by now, illustrates this.

Frequency modulation, however, is rather different. Here the varying amplitude of the modulating signal varies the frequency of the carrier at a rate depending upon the frequency of the modulating signal. This is shown in Fig. 1b for the same modulating wave as in the a.m. case in Fig. 1a. You will notice that the amplitude of the carrier is constant in the f.m. case. The action is rather like turning the tuning knob of the transmitter in time with the modulating waveform, and giving it an extra turn in either direction if the modulation amplitude increases. This variation of frequency with intensity is called the *deviation*.

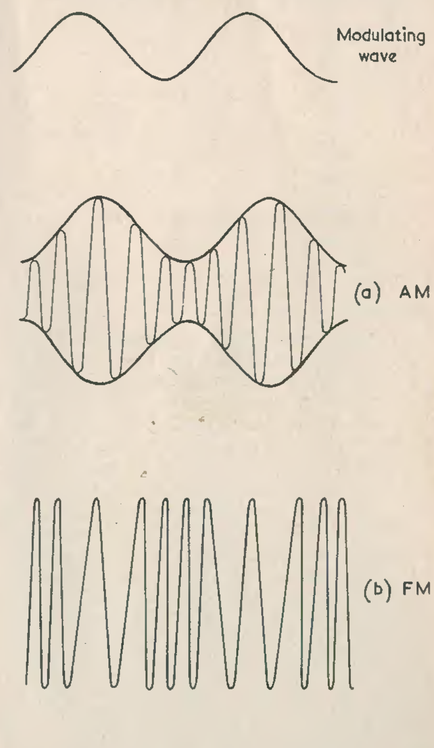


FIG. 1.

Normal deviation for broadcast work is ±75kc/s. At first sight it would seem that this was the bandwidth of the signal; for example, a carrier at 100Mc/s when modulated fully by ±75kc/s. Deviation would seem to occupy a bandwidth of 75kc/s either side of 100Mc/s. This, of course, is not true. In fact, this assumption has led some would-be inventors astray before now. These luckless experimenters unfortunately believed that if they held the intensity variations of the signal to a very low level, a very narrow frequency deviation could be achieved, and, therefore, on the above assumption, a very narrow bandwidth would result.

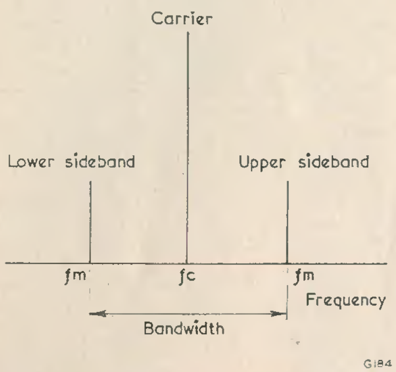


FIG. 2.

Sidebands

The assumption they made was that if an a.m. carrier, modulated at 100c/s, has sidebands at either side of the carrier of 100c/s, an f.m. carrier modulated to ±100c/s deviation would have the same sidebands. Remember that in the f.m. case, the ±100c/s deviation is produced by the *intensity* of the modulation. On a basis of intuition—or common sense if you find that less feminine—sidebands of ±100c/s would seem obvious. Experimental evidence, however, contradicted this theory; and the reasons why, were not understood until a complete mathematical analysis was published. We are, happily, going to spare ourselves the analysis, but briefly this showed that sidebands of a very high order could exist, even for a low deviation. Just to refresh our memories, Fig. 2 shows the sidebands of an a.m. transmission, sitting either side of the carrier. The carrier is represented by fc, and the sidebands are spaced fm (the audio frequency) either side of it.

Now in f.m. the sidebands are produced by the frequency deviation and the modulating frequency. In other words, if we were to produce f.m. by waggling the tuning knob of the transmitter, the sidebands which would be produced would be dependent upon how far we waggled the knob and how quickly.

The ratio of frequency deviation to modulating frequency is called the modulation index and is usually denoted by the letter M. The bandwidth in the a.m. case (from Fig. 2) is twice the modulating frequency. In the f.m. case it can never be less than for a.m., and is normally much greater. If M is made very small, the bandwidth is twice the modulating frequency, as for a.m., but as M increases the bandwidth increases.

The reasons for the final choice of ±75kc/s for the frequency deviation are many and varied, and will not be discussed here. However, one may well ask, in view of the increased bandwith required for f.m., why use it at all?

Advantages

In answering this question one risks falling foul of the many authors who have discussed f.m. at considerable length over the past fifteen years. However, it is probably safe to summarise some of the advantages of the system.

As I mentioned at the beginning of the article, the greatest advantage claimed for f.m. is its improved performance in conditions of noise. This question of noise may be rather confusing. Briefly, there are two major types of noise. One is generated in the receiver itself, and usually sounds like a steady hiss. This is produced in a valve (or even in a plain resistor). The first valve in the set, i.e. the stage immediately after the aerial, usually contributes most of this type of noise, because more amplification follows that valve than any other. F.M. does not help us against this type of noise. The other type is external to the receiver; for example, ignition interference from cars. Most television owners will be familiar with this sort. Now, impulsive interference is essentially amplitude modulated. It usually takes the form of short pulses of energy. If we could design our receiver so that it did not respond to a.m. interference would be suppressed. We shall see later that such a receiver can be designed.

This may seem to have solved the interference problem. Unfortunately, it can be demonstrated that some of the interference will still pass through the receiver. Briefly, what happens is that the noise when mixed with the f.m. signal will cause some phase modulation of the signal. Phase modulation is a rather similar sort of animal to frequency modulation, and the receiver will respond to the interference as a result. However, a considerable reduction in noise does result.

Admittedly, a.m. receivers can be designed which can suppress interference, but they are usually relatively complex. Another advantage of f.m. is that the transmitter only has to

be designed to cope with a constant amplitude signal. When using a.m. the transmitter must be able to cope linearly with relatively high modulation depths, which means that power considerably higher than the average power must be handled. An f.m. transmitter may therefore be smaller for a given power than an a.m. transmitter.

The method of modulating the transmitter may be simpler in the f.m. case than in a.m. It has been found that amplitude modulation must be applied to the carrier at high power, that is, somewhere around the transmitter output stage. This means that a high power stage is required for the modulator. For frequency modulating a carrier a relatively low power may be used, as we shall see presently. To leave some space for the circuitry, we will leave the principles of f.m. at this point.

Modulators

There are many approaches to the problem of producing a frequency modulated wave. We will examine first a type that was used for many years in experimental work, the circuit of which is shown in Fig. 3.

This circuit is generally called a "reactance valve modulator." Its purpose is to present an artificial capacity or inductance to the tuned circuit L_1C_1 and to vary this capacity (say) according to the modulation conditions.

Briefly the action is as follows. First, imagine that the tuned circuit L_1C_1 has a carrier frequency voltage impressed across it by virtue of its being connected into an oscillator circuit. Note that V_1 is *not* the oscillator; its purpose is quite separate. This carrier frequency voltage appears across the circuit C_2R_1 at A and B, therefore. The values of C_2R_1 are chosen to give a 90° phase shift to the voltage at between A and B.

The grid voltage will be shifted 90° with respect to A and B. Now the anode voltage of the valve will be 180° out of phase with the grid voltage by virtue of normal valve action. (Remember that as the grid becomes more positive the anode will become more negative and vice versa. Anode and grid are therefore 180° out of phase.) The total phase shift at the anode with respect to A and B may be 180+90 or 180−90 depending upon whether the phase at the grid was leading or lagging A or B. In Fig. 3 the grid voltage is lagging on A and B. Therefore the signal current which will flow from the anode of the valve into the tuned circuit will be of such a phase that, from the tuned circuit's point of view, an inductance has been connected across it.

Now, it can be shown that the value of this apparent inductance may be varied by variation of the mutual conductance, gm, of the valve. If, therefore, an audio signal is injected at the point marked "modulation" in Fig. 3 and the valve is of the variable-μ type, the gm of the valve will waggle up and down as the amplitude of the audio varies. The "inductance" shunted across L_1C_1 will also vary and the resonant frequency of L_1C_1 will be varied also. Remembering that L_1C_1 is connected to an oscillator, the oscillator frequency will vary also.

What this circuit has done, therefore, is to convert an amplitude-varying signal into a frequency-varying one. Now this has been achieved at the oscillator, which is, of course, low power. The oscillator output may be amplified and eventually arrive at the power stage of the transmitter. The only modulating power required is that to drive the grid of the reactance valve, V_1.

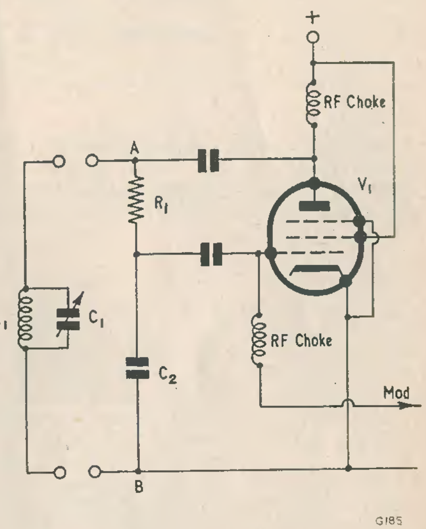


FIG. 3.

This circuit suffers from the disadvantage of non-linearity. This means that equal increments of amplitude in the audio signal will not produce equal increments of frequency change in the oscillator. Another difficulty is that complex circuits have to be used to hold the oscillator to its correct *centre* frequency, otherwise the transmission would drift from its stated frequency.

In passing, it is worth mentioning that a system recently developed uses a crystal as master oscillator at quite a low frequency. The crystal resonant frequency is varied by means similar to those described above, and the resultant low frequency f.m. signal frequency multiplied to the v.h.f. range. The interesting thing about this system is that the frequency deviation is multiplied by the same amount as the frequency. If the master oscillator crystal had a resonant frequency of 1 Mc/s, deviated ±750c/s by the modulation, and then the frequency was multiplied one hundred times, the deviation would become ±75000c/s, i.e. ±75kc/s.

Receivers

Basically, an f.m. receiver differs from an a.m. receiver in one major respect—the detector. Whereas for a.m. a diode "selects" the audio from the carrier by changing the

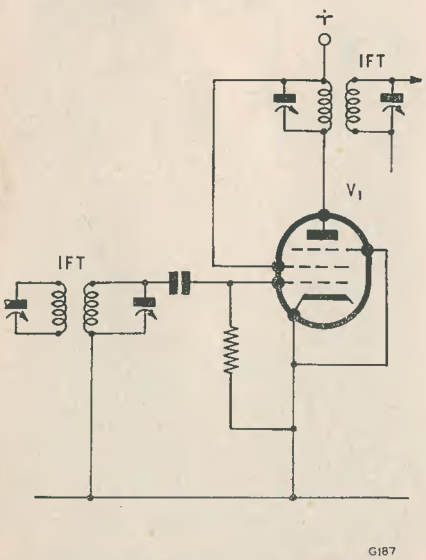


FIG. 5.

amplitude-varying carrier into plain amplitude variations, for f.m. reception the detector has to change frequency-variation into amplitude variations.

Another item invariably found in f.m. receivers is a limiter. The object of this is to remove amplitude modulated noise peaks from the signal. Such circuits can be used in a.m. receivers, but they are considerably more complex as they have to discriminate between a.m. noise and a.m. signal.

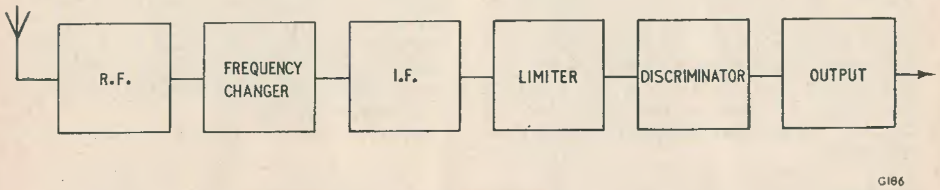
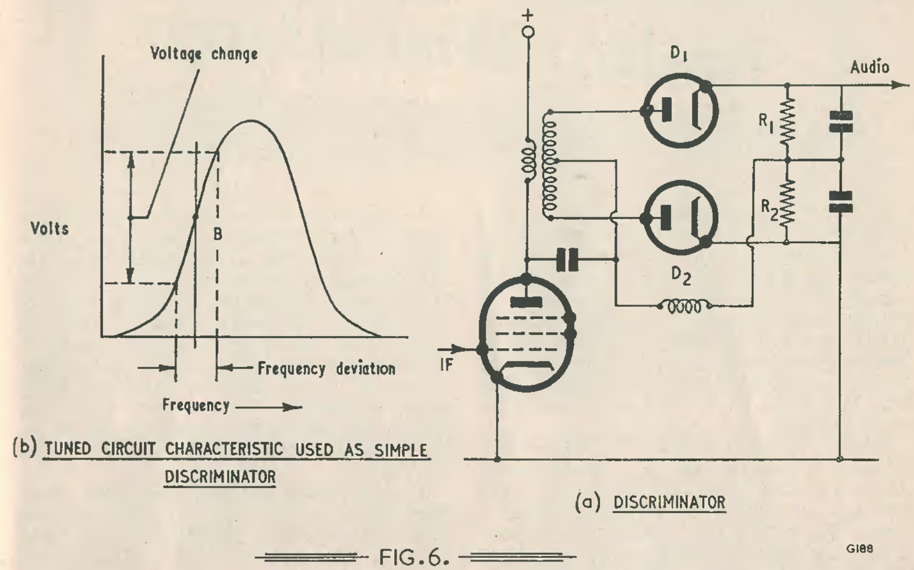


FIG. 4.

A block diagram of an f.m. receiver is shown in Fig. 4. Up to the limiter, the circuit is similar to an a.m. receiver. The limiter may be regarded as doing just the opposite of a grid leak detector, which removes the carrier and leaves the audio. What we want is to remove noise peaks and leave the carrier. V_1 in the circuit of Fig. 5 achieves this with the reservations regarding phase modulation by noise mentioned earlier. All that is done is to deliberately overload the grid. If the signal from the i.f. transformer is too large for the grid base of the valve, positive peaks of the carrier will be chopped off by the valve grid acting as a diode, and negative peaks will be clipped by the valve going into cut-off. Noise peaks exceeding the peak voltage of the carrier will therefore not appear in the output. The grid leak and capacitor should have a short time constant.

The detector in f.m. receivers is called the discriminator. A circuit is shown in Fig. 6 but, it should be pointed out, there are other types. Before plunging into this circuit, consider Fig. 6b. This is the response graph of a normal tuned circuit. Let us imagine that one of the i.f. stages of a normal a.m. receiver were deliberately detuned to point B, and an f.m. signal tuned in. The frequency variation would swing about B, as shown by the arrows. It can be seen that amplitude variations would result. This is the simplest discriminator. Its disadvantage is the non-linearity that occurs at the bottom (and top) of the curve. At these points large variations of frequency produce far smaller variations of amplitude, than in the middle of the curve.

Fig. 6a overcomes this disadvantage to a considerable extent. A detailed explanation would be rather lengthy, and space is running short. Briefly what happens is that, when two equal signals are applied to the two diodes, the signals will be cancelled in the resistors



(b) TUNED CIRCUIT CHARACTERISTIC USED AS SIMPLE DISCRIMINATOR

(a) DISCRIMINATOR

FIG. 6.

R_1R_2 because the diode currents are flowing in opposite directions. This is the condition when an unmodulated carrier is applied. When modulation occurs, the frequency of the carrier will change. The action of the circuit is now to discriminate between changes of frequency above or below the centre frequency. We will assume that a rise in frequency causes the diode D_1 to conduct. The upper end of R_1 will therefore become positive. If the frequency changes in the other direction D_2 will conduct heavily and produce a positive voltage at the lower end of R_2. This is equivalent to the junction of R_1 and R_2 becoming negative. D_1 will, however, only be conducting gently, due to the phase relationships in the circuit. The total voltage across both R_1 and R_2 will be a large negative voltage across R_2 plus a small positive voltage across R_1. The result is that the upper end of R_1 becomes negative. The change in polarity of these points is dependent upon the change of carrier frequency. Once again, then, amplitude variation has been achieved from frequency variations.

As mentioned before, there are many variants of the techniques described in this article. It seems as though f.m. has at last come to stay, and it should provide a new and fruitful field for experiment.

FREQUENCY-MODULATION DEMONSTRATION AT THE SCIENCE MUSEUM

The new service of broadcasting by the BBC using the frequency-modulation system on very high frequency waves, which was officially inaugurated on the 2nd May, has brought the benefits of high-quality interference-free listening to many in the south-eastern counties whose reception of the BBC sound programmes has been badly marred in recent years by interference from continental stations.

In order to explain the benefits of the new system to the listening public, the reasons for its introduction, and the circumstances in which it is of the greatest value, a special demonstration has been arranged at the Science Museum and will remain open for about three months. Comparative recordings will be demonstrated and the operation of a modern commercial FM broadcast receiver explained.

The Science Museum is open on weekdays from 10 a.m. to 6 p.m., and on Sundays from 2.30 to 6 p.m. Admission is free.

Radio Miscellany

AN INTERESTING LETTER COMES FROM Mr. R. G. Young of Peacehaven, on the question of t.v. aerials. He is situated in a real "fringe" area—from the Isle of Wight on Channel 3. Peacehaven, like most coastal regions, is exposed to high winds for several months of the year and he has many moments of anxiety in case the roof takes off, let alone the t.v. aerial. The only safe place, he decided, was in the attic of his bungalow.

Keen viewers in his locality with multi-element arrays on specially strengthened masts can be sure of reasonably good reception on only two or three evenings a week. The rest of the time there is "snow" in varying degrees and frequently no picture conditions. In general, not a very encouraging situation in which to expect much in the way of reception from an indoor aerial. To make matters worse, the attic did not lend itself to allow full lengths for the elements. The ends of these had to be bent back at an angle to get them in at all. Consequently a good deal of trial-and-error experiment had to be made.

Finally a three-element aerial, plus one reflector, all of $\frac{3}{8}''$ copper tube spaced an eighth-wavelength apart, was found to give results equal to those of tall and well-sited commercial arrays.

To relate no more than this of the story might make it sound a rather boastful claim. Obviously an indoor aerial cannot possibly give equal results to much taller outside aerials. Height is an all-important factor. When the 222-ft transmitting aerial was erected on top of the 1,250-ft Empire State Building in New York the range jumped from some 40 miles to 70 miles.

Mr. Young's secret, of course, lies in the fact that the indoor aerial was orientated to optimum *signal* during reception. When it comes to the fringe areas this point becomes more and more critical. This is a very different matter to merely pointing the aerial in the supposed direction of the transmitter. The latter is what frequently happens in the case of dealer installations.

I recall some time ago a case of a dealer who did not take any interest at all in the aerial installation. He simply gave the aerial and the address to a local builder who sent a couple of his men round to put it up. As a matter of interest I made a point of asking the men how they determined the direction the aerial was to face. I had supposed, of course, that they might do it by compass bearing. Not on your life! They simply pointed in the same way as all the other aerials in the neighbourhood were pointing.

Luckily there was a fairly good signal strength in the locality—it was on high ground about thirty miles from A.P. That, however, is hardly the point. Even if the signal strength is ample, the picture-to-interference ratio is greatly improved by judicious rotation.

Flying High

The notice in last month's issue by the British Interplanetary Society reminds me that many of our readers have evinced more than a passing interest in their work. High altitude rockets electronically equipped, radio controlled missiles and the ionosphere are, after all, closely allied to our own hobby and quicken our interest in the Society's work.

Oddly enough, the day of publication brought a gentle rebuke from a reader about my recent "scornful" remarks on Scientific Fiction. He points out that I fail to distinguish between "good literature" and "trashy stuff written for morons."

To be quite frank, the only books I have read coming under the former heading were by H. G. Wells and Jules Verne. Undoubtedly there are others. These are, of course, not only well written but are reasonably accurate within the scientific knowledge of their period as far as the travel part is concerned.

I suppose most thinking people have pondered over the question of other populated worlds since the birth of modern astronomy. Now that Space Travel is becoming an exciting possibility—perhaps an achievement for the early part of next century—the idea gains colour. Probably there are other "Worlds" in the outer cosmos, but certainly not in the planets of our Solar System. Although some day we might be able to get to the moon in a few days, to reach the nearest planets would take many months. Radio waves would take hundreds of years to travel to the regions where possible populated worlds might exist. V.H.F. waves do actually penetrate into space. Normal short-wave and broadcast transmissions, of course, are bounced back to earth by the ionized layers which surround us. They are reflected up and down until they become so attenuated as to be undetectable.

Perhaps the transmitting amateurs of the next century may judge Dx in terms of the number of space-ships worked and QSL'd! By that time we shall probably have moved appreciably toward the radio transmission of power. Any technique we can visualise to-day would be shockingly wasteful and inefficient.

In these enlightened times even "scientific" fiction ought to be consistent with our scientific knowledge. Anyway, I will certainly concede that not all Space Fiction is rubbish—only most of it!

Radiations

On occasion I have found myself greatly attracted to attempt a serious study of the problems of outer space, but it is discouraging to find oneself running against so many conjectures. A few experts seem inclined to think that cosmic radiations may be relatively harmless to human life. Others are certain they would be fatal without special protection. Even radio beginners soon get to know about the Sun bombarding us with electrical particles which become more intense during sun-spot activity. Those who have been in northern latitudes will have had visual evidence of them in auroral manifestations. The effects are both beautiful and awe-inspiring. Many readers will remember that in 1938 there was a display of great brilliancy and changing vivid hues, visible in the south of England—even in southern Europe.

CENTRE TAP *talks about* TV AERIALS, SPACE FICTION, PLUGGING HOLES

Bat-Men

My "scorn" of the trashy type of Scientific Fiction was precisely because it is the exact opposite of its name. It is not only unscientific, but illogical. By some curious convention it is supposed that the inhabitants of the planets take on the legendary characteristics of their planet-names, or the gods after whom they were called. Thus Mars is supposed to be peopled with bloodthirsty conquerors. The people of Mercury are red-skinned types, with crustaceous lobster-like limbs. Saturn is populated with evil creatures having small bodies, big staring eyes and spidery legs. They belong to the shadowy realms of nightmares—not planets. Despite the impossibility of life as we know it existing in the air-less void of our little circle of planets, it would be more reasonable, if they assumed them to be inhabited, that the people there would of necessity be wise and united in their common struggle to survive under such inhospitable conditions.

They certainly would not be winged bat-men whose favourite pastime is scorching up would-be rescuers with death-ray guns as a preliminary to carrying off all the beautiful, half-dressed maidens.

This was during a period of intense sun-spot activity which played all sorts of tricks with radio communication. High altitude aurora are commonplace near the magnetic poles—again following the pattern of magnetism and electricity. Indeed, the universe and radio are so closely linked that we have already reached the stage when we shall have to know more of the former to fully develop the latter.

Wholly Satisfactory

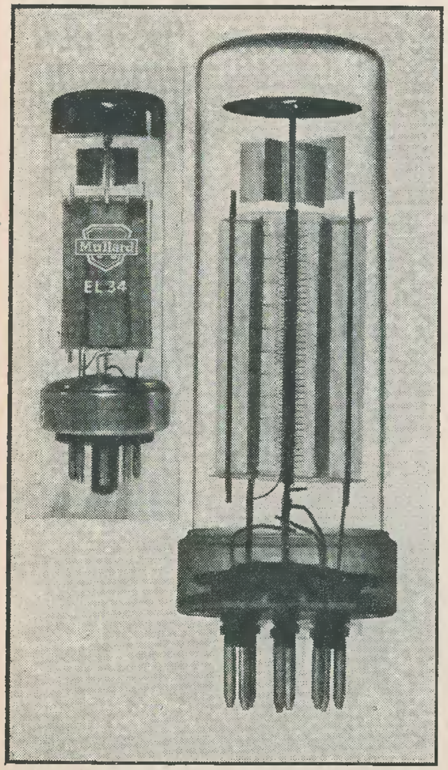
Harking back to my remarks regarding the filling of unwanted panel and chassis holes, I am reminded that this can be satisfactorily done on steel. Indeed, I have seen almost invisible repairs after the filling of holes of up to $\frac{1}{2}''$ diameter. The idea could probably be readily adapted to aluminium if solder of the "plastic" type was used in place of the normal lead-tin variety.

The hole is first plugged with steel wool—or a tangled disc of fine copper wire would serve equally as well. Then molten solder is worked into it until it becomes solid. By careful finishing with fine emery cloth a perfect surface is obtainable—invisible, at least, when enamelled over.

TRADE NEWS

NEW MULLARD OUTPUT PENTODE FOR MEDIUM POWER AUDIO AMPLIFIERS

The Mullard EL34 is an outstanding new audio output pentode with a rated anode dissipation of 25 watts. In view of its high sensitivity, high power output, low distortion and modern construction, it should find wide application in all classes of audio work. It can be used in amplifiers with output powers ranging from 11 watts (single valve) to 100 watts (push-pull) and is equally suitable for domestic amplifiers and public address equipment.



External and X-ray views of the new Mullard EL34

Performance

The EL34 has a mutual conductance of 11 mA/V, which gives it high sensitivity. It is a compact octal-based valve of cylindrical shape (seated height 98 mm, diameter 38 mm). It has a heater rating of 6.3V, 1.5A. The high maximum anode voltage of 800V permits operation in push-pull fixed-bias circuits with an output power of 100 watts at 5 per cent total harmonic distortion. For domestic amplifiers, a pair of triode-connected EL34's in push-pull give an output of 14 watts at less than 1 per cent distortion with an H.T. of 430V, or 16 watts at 3 per cent distortion with an H.T. of 400V.

For P.A. purposes, two EL34's connected as pentodes with cathode bias give 35 watts output with a line voltage of 375V.

Special Construction

The EL34 is of single-ended construction. In order to enable high anode voltages to be used without flashover, a special manufacturing technique is employed. The valve envelope is completely of glass, with a pressed-glass foot, clamped into a metal ring which unites the glass and the plastic material of the octal base. Stiff wire leads projecting from the pressed glass foot line up exactly with the pins in the octal base, without crossing over. This reduces the risk of flashover, and provided that the valveholder itself can withstand the high tension, anode voltages up to 800V can be used.

* * *

THE LATEST LEAK DYNAMIC PICKUP

The Dynamic Pickup is the result of five years of continuous development since the production of the first "Dynamic" prototype five years ago. The first "edition" proved to be too expensive for the pocket of the average high fidelity enthusiast. There was also room for certain marked improvements when the first edition experienced considerable ordinary usage. These and other improvements are incorporated in what should now, for all intents and purposes, be regarded as the Leak Dynamic Pickup. It has been designed specially to enable the manufacture of a hand-made quality pickup to be possible on a mass production scale. For this reason, the firm claims that it is the cheapest coil pickup with a diamond stylus in the world.

The Dynamic Pickup is also the only truly *coil* pickup freely available throughout Great Britain, and, indeed, the world.

The pickup's downward pressure is light—2 to 3 grammes for Long Playing Records and 5 to 6 grammes for the 78 r.p.m. The wear on the record itself and on the stylus is greatly reduced by such a light pressure.

The diamond stylus has a playing life of at least one hundred times that of sapphire, because it is the hardest known material. It will take a higher, smoother polish, also. The diamond stylii incorporated by H. J. Leak & Co. Ltd., in the Dynamic Pickup is guaranteed unconditionally not to break or chip.

The playing arm is designed to have a very low inertia and it is carried on a single pivot bearing so that it will track warped or out-of-centre records without introducing sound reproduction distortions. The arm is counter-weighted and has provision for plug-in interchangeable heads. An arm-rest is provided for it.

In order that the pickup may be accurately located on the turntable mounting board, a template of original design is supplied to the customer. Only one fixing-hole is required. The stem, which fixes into this, contains a miniature socket, which accepts the plug leading to the transformer.

Technical Details

Generating System. Dynamic, which is moving-coil. The coil impedance is approximately 6 ohms at 1,000 cycles per second.

Stylus. Diamond. L.P. 0.001 in. tip radius plus or minus 0.0001 in., 78 r.p.m., 0.0025 in. radius plus or minus 0.0001 in.

Frequency Response. Total variation plus or minus 1 decibel from 20,000 c.p.s. to 40 c.p.s. with long playing head including transformer, the recorded velocity being 1.2 cms per sec. root mean square above turnover. The low frequency resonance is 20 c.p.s. plus or minus 5 c.p.s. with the Leak lightweight arm. The damped high frequency resonance when using the long-playing (L.P.) stylus on Vinyl record material is 21,000 c.p.s. plus or minus 2,000 c.p.s. With 78 r.p.m. stylus on shellac records it is above 27,000 c.p.s. The frequency response does not change with temperature.

This means that the frequency response is exceptionally smooth with no artificial accentuation of any group of notes in the audible sound spectrum.

The Transformer. The step-up ratio is 1 to 80. It is heavily shielded in mu-metal. The primary lead is terminated in a plug and a shielded secondary lead is supplied. The output delivered is 8mV for each cm. per second root mean square recorded velocity. This means that an amplifier with a sensitivity of 40mV at 1,000 c.p.s. will be easily loaded by the pickup from commercial records.

The height of the pickup is adjustable, thus enabling it to be used with any make of turntable.

Prices

The Arm: £2 15s. retail, plus 19s. 3d. purchase tax in Great Britain.

Long Arm for 16-inch records: £3 5s. retail, plus £1 2s. 9d. purchase tax in Great Britain.

Head for Long Playing Records with Diamond Stylus: £5 15s. retail, plus £2 0s. 3d. purchase tax in Great Britain.

Head for 78 r.p.m. Records with Diamond Stylus: £5 15s. retail, plus £2 0s. 3d. purchase tax in Great Britain.

Mu-metal-cased Transformer: £1 15s. retail. No purchase tax in Great Britain.

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SPECIAL VALVE OFFER: TZ40 35/–; 6L6G, **10/6**; 829/3E29, **60/–**; 100TH, **90/–**; 866A, **17/6**, or **30/–** per pair; 807, **10/–** each, or **17/6** per pair; 931A, **45/–**; 813, **70/–**.

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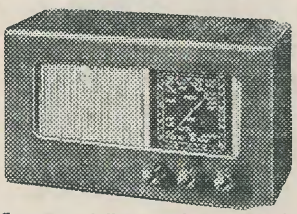

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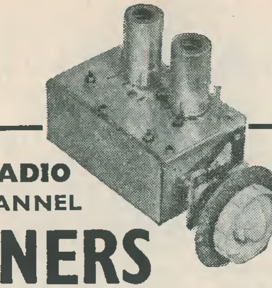

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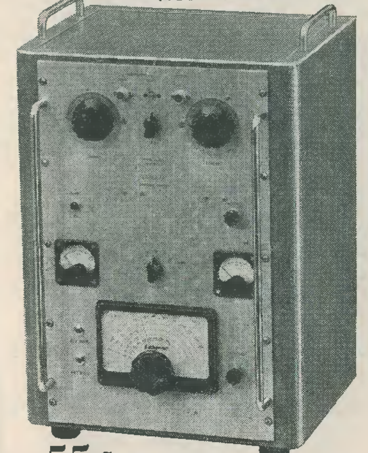

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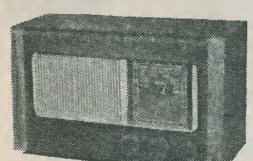

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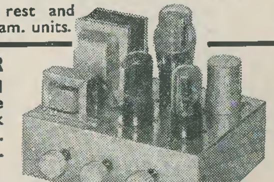

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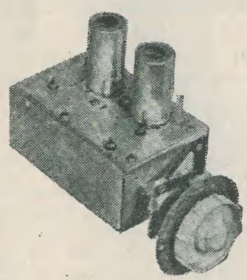

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[continued on page 767

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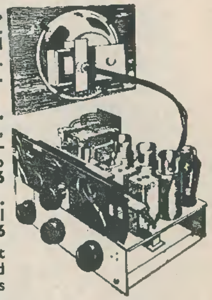

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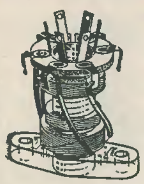

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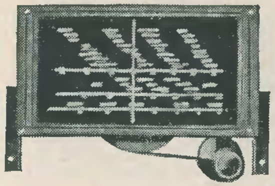

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continued from page 765]

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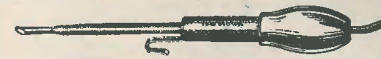

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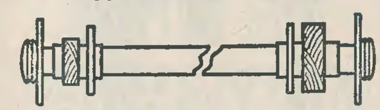

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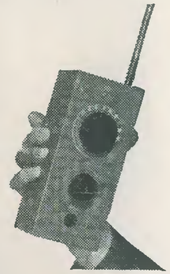

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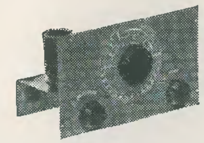

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