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Vol. 30 No. 573
JULY, 1954

EDITOR: F. J. CAMM

# PRACTICAL WIRELESS

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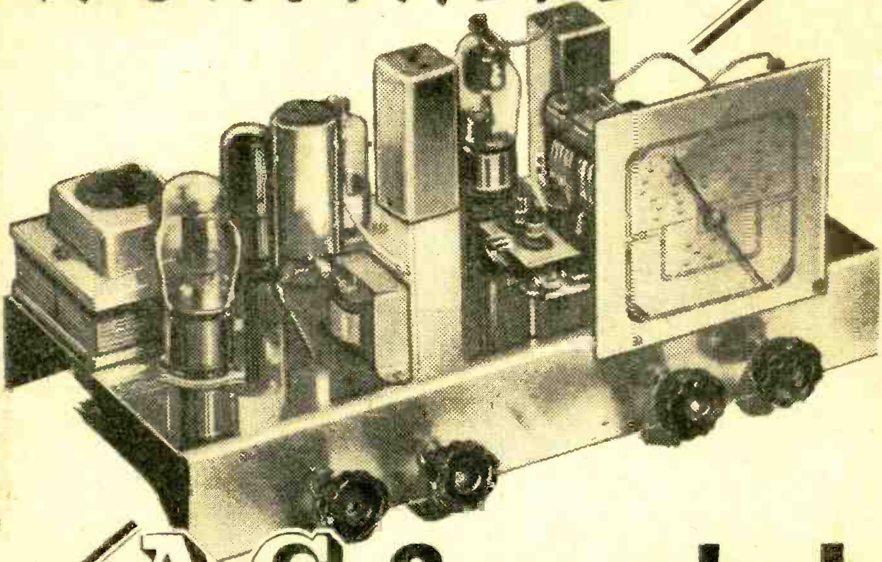

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IN THIS ISSUE:

- AMPLIFIER DESIGN
- DESIGNING OSCILLOSCOPES
- A MODERN REFLEX RECEIVER
- THE P.W. ELECTRONIC ORGAN
- FLASHOVER
- A BEGINNER'S GUIDE TO RADIO

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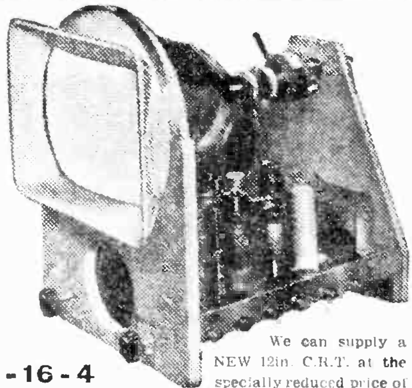

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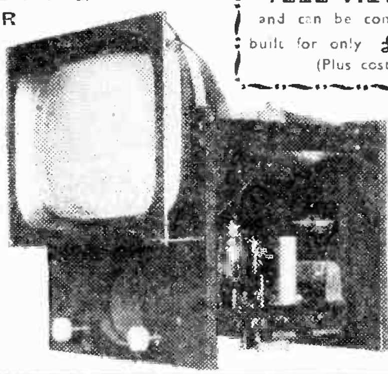

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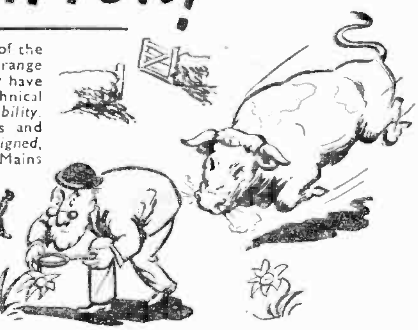

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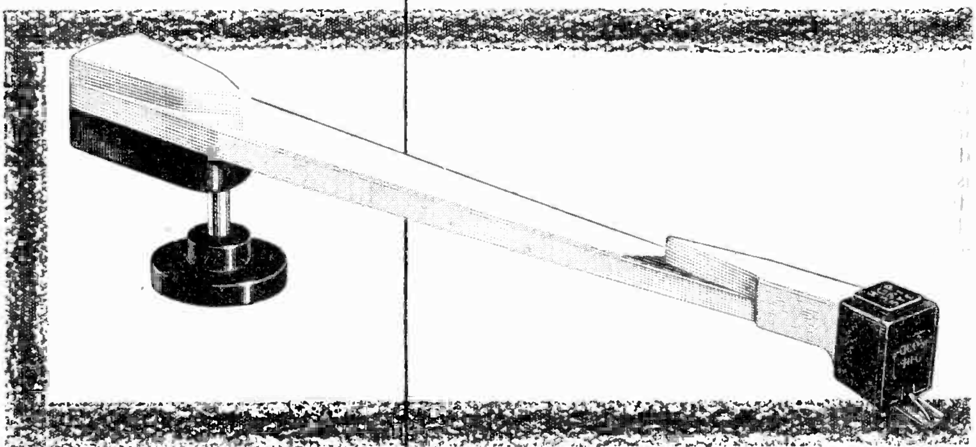
*. . . wrote* **P. WILSON** *in the "Gramophone"*

Now Mr. Wilson is not only a well known technical expert, but he is old enough to have become blasé, and yet here he is, admitting to a new experience—to a realism of record reproduction that has taken him aback. The record that prompted his comments was Decca's version of the Beethoven Fifth. The HGP 39 pick-up (that small but vital link) was one of the **acos** Hi-g series.

**Reproduction like this *is* thrilling, and Cosmocord's big contribution to it costs so little. Only £1.12.0 (plus 10/3 P.T.) for the HGP 39. Amazing—*ask Mr. Wilson!***



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Practical Wireless

EVERY MONTH
VOL. XXX, No. 573, JULY, 1954

Editor: F. J. CAMM

22nd YEAR OF ISSUE

COMMENTS OF THE MONTH

By THE EDITOR

# Fewer Listeners?

According to the review issued by the BBC, the number of listeners to BBC sound radio programmes is dropping. A year ago, out of every 100 licence holders 71 were listening and 29 viewing. This year viewers have increased to 41, and listeners have dropped to 59. This is surprising in view of the number of TV licences compared with the number of listening licences.

Of course, these figures are open to question, for it is almost impossible to devise any system of checking viewing and listening times, and the BBC method can only provide a snapshot of the viewing and listening public at a particular moment. A check can only be made during those hours when both radio and TV programmes are on the air, and the number of hours devoted to TV programmes each day is much less than for sound broadcasting.

It is all the more surprising that whilst, according to the BBC, the number of listeners is declining, the number of amateurs building radio receivers is increasing. There is an ever-increasing interest in short-wave receivers, and demand for blueprints continues to grow. It is also a matter for surprise that the percentage drop in listeners does not correspond with the drop in radio licences. Most viewers, of course, also possess a radio receiver.

There is much less listening to continental programmes than hitherto.

### The Radio Show

The Radio Show takes place at Earl's Court from August 25th to September 4th, and our stand number is 51, on the ground floor, the nearest main entrance being the Warwick Road entrance. It will be an even more representative exhibition this year than last. It is hoped, however, that greater effort will be made to provide for the comfort of visitors, particularly in the matter of seating accommodation and in the catering arrangements. There is plenty of room for improvement in both these connections.

### "Practical TV Circuits"

So many of our readers are interested in both sides of broadcasting, that we may draw their attention herein to a new handbook entitled *Practical Television Circuits*. In its 288 pages, illustrated with 155 diagrams and photographs, are described a number of very successful receivers, some of which have been described in our companion journal *Practical Television*, extending from a cheap receiver designed around the well-known VCR97, which may be built for about £9, to more elaborate receivers designed for quality rather than for low price. It is the companion volume to our *Practical Wireless Circuits*, and costs 15s., or 15s. 6d. by post. The following is a full list of contents: The "Argus"; A £9 Television Receiver; a 3-inch Midget Televisor; A Compact Televisor; An A.C.-D.C. Television Receiver; A Combined Television and Broadcast Receiver; The "Argus" Pre-amplifier; Low Noise Factor Pre-amplifier; Two-valve Pre-amplifier; A "Spot-wobbler"; A Black Spotter; A Variable E.H.T. Generator; A Portable E.H.T. Generator; An Alignment Aid; The Grid-dip Meter and Bar Generator; The Pattern Generator; The Telesquare; The *Practical Television* "Lynx"; The *Practical Television* "Super-visor"; Aerial Data.

### Rental Schemes—P.T. Changes

Changes have been made in the method of levying purchase tax as it relates to certain branches of Radio. The Financial Secretary of the Treasury, giving his reasons, said: "Under the present law a firm or a person making chargeable goods, either for sale or for sale and hire, is liable to be registered and so to pay the tax if his sales and/or hirings exceed the normal £500 limit. But under the present law, if he makes goods only for the purpose of hiring out and for no other purpose, he is not liable to registration and for that reason escapes liability to tax, however large his output may be.

"That loophole has been discovered by certain firms in the radio and television trade who manufacture solely for the purpose of renting sets out. The clause, therefore, provides that they shall be placed in the same position as those who manufacture for sale or for sale and hire; that is to say, shall be registrable and subject to tax if their total output exceeds the £500 limit."—F. J. C.

# ROUND the WORLD of WIRELESS

## Broadcast Receiving Licences

THE following statement shows the approximate number of sound receiving licences issued during the year ended March, 1954. The grand total of sound and television licences was 13,436,793.

| Region | Number |
|---|---|
| London Postal ... | 1,631,961 |
| Home Counties ... | 1,441,738 |
| Midland ... ... | 1,250,965 |
| North Eastern ... | 1,630,413 |
| North Western ... | 1,268,830 |
| South Western ... | 1,012,807 |
| Wales and Border Counties ... ... | 632,119 |
| Total England and Wales ... ... | 8,868,833 |
| Scotland ... ... | 1,096,079 |
| Northern Ireland ... | 222,989 |
| Grand Total ... ... | 10,187,901 |

## Twenty-five Years' Service

ON March 26th Mr. F. E. Debenham, deputy manager of the Mullard Valve Service Department, Waddon, Surrey, completed his twenty-fifth year of service with the Mullard Company. To mark the occasion Mr. A. W. Welton, financial controller of Mullard, Ltd., acting on behalf of the management, presented Mr. F. E. Debenham with a cheque and an inscribed silver salver at a luncheon party given by the company at Kettner's Restaurant, London.

## Dame Sybil Thorndike

REHEARSALS are proceeding for the special performance of Clemence Dane's version of *King Henry VIII*, to be broadcast in the Home Service on June 14th in honour of the fiftieth stage anniversary of Dame Sybil Thorndike.

The all-star cast will include Dame Sybil herself as Queen Katherine, Sir John Gielgud, Sir Ralph Richardson, Sir Laurence Olivier, Vivien Leigh, Robert Donat, Richard Burton, Athene Seyler, Paul Schofield, Russell Thorndike, Ralph Truman and other distinguished artists. Most of the music used in the broadcast was written by Henry VIII himself and copied from manuscripts in the British Museum. The artists will present their fees to charities to be selected by Dame Sybil.

*Seen rehearsing "King Henry VIII" in preparation for Dame Sybil Thorndike's fiftieth anniversary broadcast on June 14th are (left to right) Ralph Truman as Henry VIII, Dame Sybil Thorndike as Queen Katherine, Russell Thorndike, and Sir Ralph Richardson as Wolsey.*

## Tyre and Road Noise

MORRIS MOTORS, LTD., are undertaking some interesting research into the types of road noise coming from various tyre treads and suspensions and their possible insinuation into vehicle bodies.

In order to make on the spot recordings of the noises arising from various points the E.M.I. magnetic tape recording gear is being carried on the Nuffield Research tender, which houses the car under test. With this it is possible for the microphone to be sited near the wheels or inside the vehicle so that both the noises and their effects inside the vehicle can be studied.

## Retirement of Mr. V. A. Bagnall

ON Friday, April 9th, the Edison Swan Electric Co., Ltd., officially said goodbye to Mr. V. A. Bagnall on his retirement from the position of representative in the Birmingham District Office area.

Mr. Bagnall had been with Ediswan since November, 1929, and had been very popular with all the customers in his territory, as was proved by the numerous letters of appreciation which he received from buyers and engineers of many companies on his retirement. The presentation of a desk set was made to him by Mr. A. H. Adey, manager of Ediswan Birmingham district office, on behalf of the staff.

## Home Service Coverage

THE BBC has installed a new low-power transmitter at its station at Ramsgate, Kent, which came into operation on Sunday, May 9th, and took over the service from the temporary transmitter which radiated the London Home Service on International Common Wavelength of 202 metres (1,484 kc/s).

It will have a power of 2 kW, four times that of the previous transmitter, and it is expected that it will extend the area of improved reception to include Deal, Sandwich and Margate. Listeners in these areas who may not be getting satisfactory reception from the London transmitter on 330 metres are recommended to tune to the new Ramsgate transmitter on 202 metres.

### Wireless Operators' Memorial

ON May 12th, the anniversary of its original dedication in 1915, a monument to wireless operators and radio officers who gave their lives in the performance of their duty was rededicated in Battery Park, New York.

In its original form the monument carried small plaques commemorating individual operators who had lost their lives in carrying out their duty. When the memorial was rededicated it bore, in addition, a new bronze plaque with these words: "In Grateful Memory Of Those Wireless Operators Who Made The Supreme Sacrifice At The Call Of Duty—World War I 1914-1918, World War II 1939-1945—They, Dying So, Live."

### Carmen Called by Radio

BRITISH ROAD SERVICES recently carried out an experiment in Leicester with the object of improving the collection of urgent traffic from traders' premises. Three parcel vans operating in the city were fitted with radio sets to enable the carmen to keep in constant touch with the depot traffic office.

Messages and instructions coming into this office from traders wanting urgent collections were relayed to the carman best suited to carry out these instructions, thus speeding up collection and avoiding the necessity of sending a vehicle specially from the depot. In the reverse direction the carmen can contact the depot at any time without going to a public telephone.

### New Marconi Appointment

A NEW appointment, that of chief engineer to their Communications Division, has been announced by Marconi's Wireless Telegraph Co. Ltd. This post is to be held by Mr. C. Gillam, who will be working in close conjunction with Mr. A. W. Cole, the manager of the division.

Mr. Gillam first joined the company in 1930 and after some years with the Transmitter Test Section he spent four years in Turkey installing and maintaining high power broadcasting transmitters. His work for Marconi's has taken him to many European countries, to Egypt and to South Africa. Mr. A. W, Cole first joined the Marconi Company in 1924 and has had a lifelong experience in the communication field.

### Radar for Clan Line

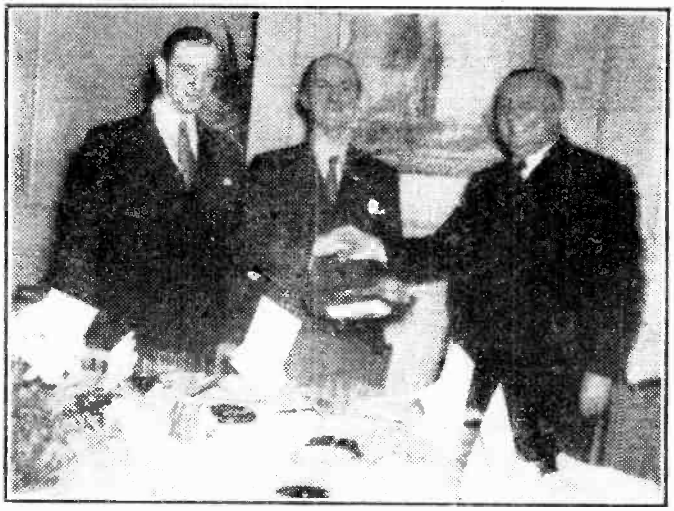
THE Clan Line Steamers, Ltd., have placed an order with the Marconi International Marine Communication Co., Ltd., for twenty-four Marconi Marine radar installations for vessels of their fleet.

The installation work will be carried out by various Marconi Marine depots as occasion arises when the twenty-four Clan Line ships are in convenient U.K. ports. It is anticipated that most will be fitted in Glasgow, Liverpool and London.

### Road Safety "Loudspeaker" Warning

A NEW idea in road safety precautions is being tested at the Great King Street, Hockley, Birmingham factory of the Joseph Lucas Organisation. Every day workers rush from the factory into the roadway to board waiting buses. A gramophone record amplified over loudspeakers is played to them as they leave the factory. Two loud motor horn blasts come "over the air," followed by a number of safety-first slogans which have been selected in consultation with the Birmingham Accident Prevention Council.

A Lucas official said: "It is our contribution to Birmingham Road Safety. All we are endeavouring to do is to encourage people to be more careful when leaving the factory. It is purely for their own good."



*Mr. A. W. Welton, Financial Controller, Mullard, Ltd., acting on behalf of the management, presents Mr. F. E. Debenham, with a cheque and an inscribed silver salver on the occasion of Mr. Debenham's twenty-fifth anniversary.*

### Radio-controlled Models Contests

THE International Radio-controlled Models Society announces that its Annual International Contests for Radio-controlled Models will be held in Birmingham on July 10th and 11th, 1954.

The contests for radio-controlled model boats will be held on Saturday, July 10th, and contests for radio-controlled model aircraft on Sunday, July 11th. The aircraft sections of these contests, comprising a contest for power-driven aircraft and a contest for gliders, are held in accordance with the F.A.I. regulations for international contests.

It is hoped that a large number of competitors, both from Great Britain and from overseas, will take part in these contests. The Hon. Contest Publicity Secretary is Mr. H. Croucher, 27, St. John's Road, Sparkhill, Birmingham, 11.

# AMPLIFIER DESIGN

## 4.—UNTUNED AMPLIFIERS—CONTINUED

By R. Hindle

(*Continued from page 344 June issue*)

*A Short Series of Articles Dealing with the Theoretical Considerations of Amplifier Design, and Containing at a Later Stage Constructional Features of Various Types of Amplifier.*

THESE are, of course, the points plotted to produce the curve in Fig. 17. Now the practical problem will probably be to design an amplifying stage for a given maximum drop in gain at a specified frequency; say the results required are for the gain at 50 c/s to be no less than 0.9 of that at middle frequency. Then

$$2fo = 50 \text{ c/s}$$

so

$$fo = 25 \text{ c/s}$$

therefore Co must have a reactance at 25 c/s equal to Rg, which may be 1 MΩ, thus making Co, referring to a reactance chart, about 0.007μF, or say .01μF as the nearest larger available size. One would always make the capacitance rather larger than the absolute value as calculated because this will give a safety margin and, of course, in practice one has to remember the normal tolerance of component sizes of 20 per cent. so that a component nominally 0.01μF could possibly be no bigger than 0.008μF.

The size of Cc may have worked out much smaller than the experienced reader who has not given much theoretical consideration to the problem expected and, in fact, there is another factor that enters into the choice of Cc. Besides causing a reduction in gain this capacitor also causes a phase shift. Broadly speaking, the human ear cannot detect a phase shift, but in actual fact the effect of phase shifting the component parts of a complex sound such as is being dealt with in an audio amplifier is noticeable as a deterioration in transient reproduction. A feedback amplifier also, as will be seen later, is very sensitive to phase shift. Now the capacitor that causes no more than a 10 per cent. decrease in gain causes something like a 25 deg. phase shift and this may be serious. In fact, for really high quality work, the following combinations of Cc and Rg have been recommended.

| Rg | Cc |
|---|---|
| 10 KΩ | 2.5μF |
| 50 KΩ | 0.5μF |
| 100 KΩ | 0.25μF |
| 250 KΩ | 0.1μF |
| 1 MΩ | 0.025μF |

It will be noticed that Rg×Cc is always the same for a given degree of fidelity and the above table could be specified simply as 25 KΩ/μF.

### Stray Capacitances

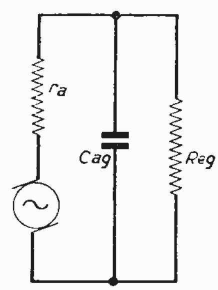
At the high-frequency end of the response curve only the stray capacitances have effect and Cc can be ignored so that the equivalent circuit diagram becomes as Fig. 16(b), but the resultant of RL and Rg in parallel can be worked out, and so can the resultant of Cak and Cgk in parallel so that the equivalent circuit further simplifies to Fig. 18, where Ceq and Rek are the equivalents. Now, the effect of Ceq in parallel with the resistive load is to reduce the load and the higher the frequency the smaller will be the reactance of Ceq, so the smaller will be the resultant load and therefore the amplification will be less. If the reactance of Ceq (i.e., the sum of the stray capacitances) is equal to Req (i.e., RL and Rg in parallel) the effective load is reduced to 0.7Req. Call the frequency at which this equality occurs fp and a table, as under, can be set up to give the equivalent load at other frequencies.

| Frequency | Effective Load × Req |
|---|---|
| 0.2fp | 0.98 |
| ½fp | 0.9 |
| fp | 0.7 |
| 2fp | 0.45 |
| 5fp | 0.2 |
| 10fp | 0.1 |

It will be noticed that the same numerical values occur as were found for the series case for Cc at the lower end of the range and of course this is to be expected because both are derived by combining by vectors a resistance and a reactance. The figures in the table are plotted to produce the right-hand part of Fig. 17, and so the fall of the characteristic is always the same general shape both at the lower frequency end and the higher frequency end, the latter being simply reversed to fall off with increase in frequency. The size of Ceq and of req, however, determines the frequency at which the falling off commences and the steepness of the fall.

### Tone Compensation

The reader will no doubt have realised that whilst this discussion has dealt with stray and accidental capacitances, the same principles would apply in cases where a falling off of the characteristic was deliberately sought after, such as when tone control and compensation arrangements are required, and the method described for using the tables of fo at the lower end and fp for the upper end of the range



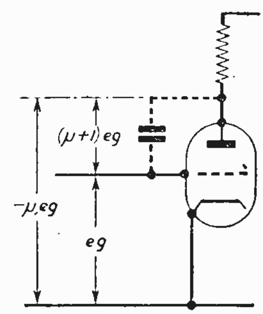




*Fig. 18 (left).—Simplified equivalent circuit. Fig. 19 (right).—The Miller effect.*

can be used to determine the actual size of capacitance and resistance for tone compensation.

The table of fp values gives the equivalent load and not the ratio of amplification at different frequencies. In order to find the actual reduction in amplification ra has to be brought into the picture in accordance with the formula (3) developed in an earlier article, but if the load is small compared with ra the gain is actually in proportion to the figures given in the table of fp values. This will be so for the higher frequencies where Ceq has the greatest effect.

Cc is a component the size of which the designer is free to choose, but Cak and Cgk are present purely by accident. Part of these are due to the valves themselves, and so are out of the control of the designer ; these valve strays form the irreducible minimum. Added to them, however, are the capacitances to earth of the valveholder sockets, the wiring and the components associated with the anode and grid circuits. The process of design is, therefore, to determine the permissible falling off in the upper frequency response, i.e., the frequency at which the load may be allowed to drop to 0.7 of the value for mid-frequency response. The total stray capacitances are then estimated and the reactance of the strays at the frequency determined for the reduction of load to 0.7 is calculated from the standard formula

$$Xc=\frac{1}{2\pi fC}$$

(or more conveniently read from tables or an abac). The value of Rg is then made as high as permissible for the valve to be used in the following position and the maximum Rl calculated, being the resistance that, in parallel with the chosen Rg will equal the value of the reactance of the stray capacitances as calculated above. The value so determined may be found higher than is permissible on D.C. grounds to avoid too great a reduction in the H.T. at the anode of the valve and so would prevent adequate gain being obtained. If so the value of Rl can be made less than the value as previously calculated, knowing that a reduction in value will actually improve the frequency characteristic. If the specified characteristic used for the calculation of Rl was, in fact, particularly desired and was not a stipulation of minimum requirements, of course, extra capacitance could be added across the load resistance which, along with the inevitable strays would make a capacitance with a reactance at the frequency determined for reduction in load to 0.7 equal to the effective resistive load, i.e., Rl and Rg in parallel. This situation could arise, for instance, in designing an amplifier with feedback when it is desirable to limit gain at frequencies higher than those actually required because of the possible phase-shifts introducing the possibility of instability.

### Layout Considerations

Generally the proposition is to retain the upper frequency response and the designer must keep to a minimum the strays. This he does by

1. Careful layout so that interconnecting wires are kept to a minimum in length.
2. Running the necessary connections carrying the signal by the most direct route and keeping them away from the chassis, from earthed metallic objects such as smoothing capacitors and from other wires such as heater leads that are at earth potential.
3. Careful choice and placing of components, for instance, using valve holders made of material with suitably low dielectric constant and of low-loss construction and also using coupling components of small physical size which can be mounted well away from the chassis. The coupling capacitor (Cc) is a case in point. Its minimum capacitance is determined as previously discussed and it must be capable of withstanding the maximum H.T. voltage likely to be applied to the previous valve. The temptation to use a good, big component well over the minimum capacitance and of more than adequate rated voltage must be resisted unless the upper frequency characteristic required is sufficiently limited to permit the increased stray capacitance that the larger component will cause. The small miniature modern components are obviously the best, because of the stray capacitances to chassis of the metal plates of the capacitor itself.

### Miller Effect

The input capacitance of a valve is of quite some importance. A part arises from the proximity of grid to cathode, these two electrodes forming the two plates of a capacitor. At first glance the capacitance between grid and anode would seem to have little to do with input capacitance, but it makes, in actual fact, the most important contribution. A capacitance is measured by the quantity of electricity that flows into it when a given voltage is applied. Now, so far as the grid can see the voltage applied to the capacitor is the grid input signal only, Eg, but at the anode, assuming a resistive load, is a voltage equal to $-\mu$Eg, i.e., the grid signal multiplied by the amplification factor, the minus sign indicating the phase reversal taking place across the valve. The voltage across Cga, the inter-electrode capacitance in question, is actually $Eg+\mu Eg=(\mu+1).Eg$ as seen from Fig. 19, and the quantity of electricity actually flowing into the capacitance is that caused by this larger voltage. But the grid says that this flow is caused by a voltage of Eg only, and so it accounts for it by seeing a capacitance to earth of $(\mu+1)$ times Cga in addition to Cgk. Thus the total input capacitance is $Cgk+(\mu+1).Cga$. The larger the amplification factor (and modern valves tend to have larger and larger amplification factors), the worse is the effect and it is aggravated by the fact that modern valves can generally be worked with larger anode load resistors so that the effect of stray capacitances is greater. This effect of feeding back from anode to grid an amplified capacitance is called the Miller Effect. It occurs, of course, whether Cga is the valve inter-electrode capacitance or an added component and this feature can be used when a large input capacitance is deliberately required, as, for instance, in the case of a time-base saw tooth generator, by adding the appropriate capacitance between grid and anode.

### Pentode

Miller effect sets a serious limit to the upper frequency response of a resistance coupled amplifier and so naturally the designer looks for a valve with a minimum grid to anode capacitance. Triodes have been considered up to now, but these have notoriously high grid/anode capacitances and it was for this reason, though with R.F. amplification in mind, that the screen grid was added to give the tetrode and later the pentode. Unless, therefore, a comparatively small gain and a not too wide frequency response is required the designer turns to the pentode rather than the triode. Many are still loyal to the triode as amplifier and, indeed, it is wise to do so provided that the required amplification can be obtained over a sufficiently wide frequency range and so long as the phase shift resulting therefrom is no more than can be tolerated for the purpose in question.

The use of a pentode in no way changes the basic principles of amplification already discussed and both facts and formulae still apply. The difference is merely one of magnitude. The pentode has a larger amplification factor ($\mu$) and a larger A.C. resistance (ra) than the triode and a very much smaller input capacitance (Cgk + Miller fed back capacitance). These factors permit a much larger amplification and also the extension of a useful degree of amplification to a much higher frequency than could be obtained from a triode. Another useful feature from the point of view of design work is the simpler mathematics involved in determining gain. A triode would normally have an anode load equal to at least three times its ra. Because the ra of a pentode is so much higher, it is not generally practicable to make the anode load bigger than, or even as big as, ra because of the resulting drop in H.T. voltage at the anode of the valve that would result. The formula for gain is the same as for a triode, i.e.

$$\text{Gain (A)} = \mu \frac{\text{Req}}{\text{Req} + \text{ra}}$$

but as Req is comparatively low compared with ra it will have little effect on the denominator and the formula simplifies approximately to

$$A = \frac{\mu.\text{Req}}{\text{ra}}$$

but

$$\frac{u}{\text{ra}} = \text{gm}$$

so

$$A = \text{gm.Req}$$

i.e. gain equals the load multiplied by the mutual conductance. It will be seen, therefore, that the table of effective loads for different frequencies produced before, can now be looked upon as a table of relative gains without resorting to a further arithmetical process.

The formula A = gm.Req is worth remembering, giving an easy way of assessing the gain of a stage of amplification. Two points must be stressed. Firstly, gm is measured in mA/V whereas the formula requires the use of amps and volts, so the answer must be divided by 1,000. Thus, a pentode with gm = 2 mA/V works into a load of 100,000 ohms. The gain will be

$$\frac{2 \times 100{,}000}{1{,}000} = 200$$

The second point is that the figure for gm used, must be that for the practical working conditions and not necessarily that published in abbreviated valve data charts. It will be remembered that gm is the ratio of change in anode current to a small change in grid voltage causing it. The figure usually quoted is for static conditions without anode load. The load resistance under working conditions tends to regulate the anode current, i.e. to reduce the extent of the variation of anode current and so the working (called the dynamic) gm is lower than the static figure quoted.

**Pentode or Triode**

It will be as well now to state clearly the conditions determining a choice between a triode and a pentode for resistance coupled amplification. The circumstances are overwhelmingly in favour of the pentode with its higher gain, extended frequency response and superior phase-shift characteristic ; the pentode can be looked upon as the standard amplifier valve, to be ousted by the triode only in special circumstances. Against the pentode is its greater tendency to produce noise due to the increased number of electrodes which would, however, be of importance only if extremely minute signals (of the order of microvolts) were to be amplified. The second and more important limitation, is set by the greater degree of distortion resulting from the use of a pentode on large input signals. Some distortion is inevitable with any valve, due to the curvature of the characteristics, but the pentode case is much worse for a given grid voltage variation than the triode. Let it be well noted, however, that the superior gain of the pentode results in at least equal output for a given degree of distortion from a pentode as from a triode and it is output that really matters. The input can generally be designed to suit the valve.

A triode would generally be used, then, only in the following circumstances.

1. Where only a comparatively small amount of amplification is required and the effects of the input capacitance are tolerable.
2. Where the signal is so excessively small that there is difficulty in producing a satisfactory signal/noise ratio. Or :
3. Where the input signal has to be so large as to cause more distortion than is tolerable in the case of a pentode.

Case 3 is the one that often justifies the use of a triode in an audio amplifier ; case 1 precludes the use of a triode as video amplifier for television and such purposes.

**3. Resistance Coupled Amplifier Design.**

It has already been pointed out that the larger the anode load the larger, generally, will be the amplification obtained from a valve, subject to the limitation set by the resulting reduction in H.T. at the valve anode, and the effect of a load varying with frequency due to reactive components has also been discussed, but the time has come to consider in further detail the effect of the size of the load. The easiest course is by means of load lines.

**Load Lines**

The characteristic of resistance is that a voltage is dropped across it which is in direct proportion to the amount of current flowing ; double the current flowing and the voltage across the resistance is also doubled. Taking a given resistance, the current flowing for different applied voltages can be measured, or calculated by Ohm's Law, and a graph can be prepared of voltage against current. This graph will be found to be always a straight line and, knowing this, it is necessary only to find two points and to draw a straight line through these on the graph.

Of the various graphs of characteristics of their valves that the valve makers provide the one of immediate interest is that for anode volts plotted against anode current for a given constant grid voltage.

*(To be continued)*

# DESIGNING Oscilloscopes

A SHORT SERIES FOR THE SERVICEMAN AND EXPERIMENTER—PART 1 DEALS WITH THE POWER SUPPLIES

THE oscilloscope consists in the main of three parts, each with its own separate function—the power supply, the amplifiers and the timebase. However, since the C.R.T. is one of the controlling factors in the design of the power unit it will be dealt with as part of the power supply.

The considerations that must be given in the choice of a suitable mains transformer are :

(a) The heater voltages that will be required for the tube, rectifiers and amplifier valves.

(b) The H.T. voltages and currents required by the timebase, amplifier(s) and the tube.

The use of metal rectifiers for the main and E.H.T. rectifiers will avoid heaters being required here, but it must be remembered that it will be at the cost of H.T. and E.H.T. volts—the output from a valve rectifier is usually in the region of 1.3 times the

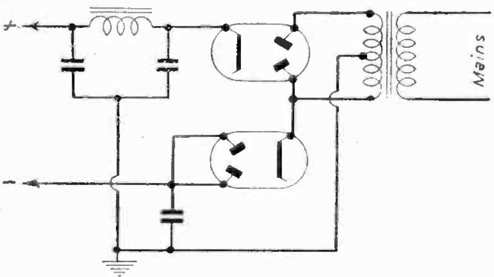



*Fig. 1.—A power pack for approximately* 900 *volts.*

R.M.S. volts of the winding. Why not the recognised 1.4 ? The 0.1 is lost in the drop across the rectifier valve. We get a D.C. voltage equal to the R.M.S. input from a metal rectifier. Using a 350-0-350 transformer as a 700 volt half-wave tapped at 350 we would with a valve expect to get out just over 900 volts and 450, but with a metal rectifier only 700 and 350. It will be seen that if the tube supply is a "negative" one and the timebase and amplifier are "positive" there can be with the tube between the two H.T. lines a voltage of nearly 1,500 volts. On the other hand, with the use of metal rectifiers just over 1,000 could be expected.

The voltage requirement of various tubes varies a very large amount. For example, the Mullard DG7-5 requires only some 700-1,000 volts, and will work very well with 900 volts. The circuit in Fig. 1 will, with a 350-0-350 transformer, supply ample power for the DG7-5. The valves can be of the EZ40, EZ41, EZ80 types. The old 6X59 has been found to be quite satisfactory in the Service, but the writer has experienced considerable trouble with some makes of the 7Y4 rectifier, due to heater-cathode failures. This circuit allows the use of a full-wave rectifier for the positive line and half-wave for the negative.

The use of this type of circuit ensures that there are no high voltages in the circuit for E.H.T.—the difference in voltage between the two lines is a good working E.H.T. for the tube, but the maximum peak voltage to chassis is only some 450 volts.

Fig. 2 shows a circuit that is of considerable use for many of the slightly larger tubes—including the well-known VCR97 for scope work. The snag in the circuit is that a separate rectifier winding is required for the E.H.T., and as the normal low-priced transformer has only two heater windings we have an increased cost as a heater transformer will be required. Another snag is that both of the rectifier circuits will be half-wave, with the resulting increased requirements in the smoothing of the positive circuit. If higher voltages are required it is better to obtain one of the specially made E.H.T. transformers. Care should be taken in the choice of this latter, and, remember, a few shillings extra spent here can save a lot in the long run. Moisture can be troublesome here, as a very slight amount of damp can cause a breakdown between the windings or turns. The fully impregnated types, such as those made by Ellison, can usually be relied on to give a first-class service.

**Smoothing**

The smoothing condensers for the E.H.T. circuits require careful choice—except in the circuit of Fig. 1. Paper condensers can be very costly, but for 1,000 to 1,500 volts it is possible to use a combination of electrolytics. Each one must be shunted by a resistor of 100 K$\Omega$ to 1M$\Omega$. The lower value is to be preferred. The circuit is shown in Fig. 3. It is advisable to work the condensers well within their capacity for voltage ; that is, if 500 volt electrolytics are being used, then use four for 1,500 volts. The parallel resistors are not primarily for bleeding, but to maintain a constant voltage across the electrolytics. If a constant voltage is not maintained by the resistance the voltages across the condensers would not be equal. For example, nearly every electrolytic has a leakage current and as these vary from condenser to condenser the one in the chain with the lowest leakage current would develop an excessive voltage and be ruptured ; thus a higher voltage would be thrown on those remaining in the chain,

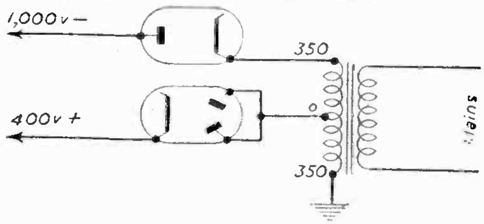



*Fig. 2.—A more elaborate power unit for larger tubes.*

causing the next to rupture. It will be seen, therefore, that the resistance chain in parallel with the condensers will greatly increase the life of the condensers.

If the series chain of electrolytics is used they must all be of the same capacity and type. The working capacity of the chain will be the capacity of one condenser divided by the number of condensers in the chain. For example, if there are four condensers or 16 $\mu$F, the overall capacity will be only 16/4 or 4 $\mu$F. Over 1,500 volts it is better to use paper condensers.

The calculation of the values of the resistors and the potentiometers for the C.R.T. chain is quite simple. The current can be taken as being 10 mA. through the chain—or if the transformer is rated at a lower current at this value it may be only 2 mA. The higher the current the better will be the action of the various controls. With very low currents there is an effect of the picture size varying with the setting of the brilliance control. The ratio of maximum tube cathode current to control chain current should be at least 10 to 1. That is, if the maximum current drawn by the tube is 100 microamperes, then the minimum chain current should be 1 mA. Taking the DG7-5 for typical calculations we find the makers give the following data :

| | |
|---|---|
| Va2 ... ... ... | 800 volts |
| Va1 ... ... ... | 200-300 volts |
| Vg ... ... ... | 0-50 volts |
| Ia1 ... ... ... | 0-500 micro-amps. |

No matter if the Va2 voltage were 700 or 1,000 volts the calculations would be the same. Consider the current through the chain as 10 mA, then the total will be about 80,000 ohms. R1 in Fig. 4 will have to carry 50 volts at 10 mA, and as that amounts to only ½ watt it can be of the carbon type. From Ohm's Law we know that R is voltage divided by the current, i.e., 50,000/10 (milli-volts and milli-amperes) which is 5,000 ohms. The next resistor is a fixed one and has to handle the difference between 50 and 200 volts. Again the calculation is simple, 150,000/10 which is 15,000 ohms, and this should be two watts to give a good wattage margin. The focus control is again a variable, and as it has only 100 volts to drop it can be carbon, the value being 100,000/10 or 10,000 ohms. The final resistor in the chain will take the difference between the 300 and the final 800 volts, i.e., 500 volts. This will then have to be of the 5W wire-wound type, and have a value of 50,000 ohms, but as only the preferred ranges are generally available the constructor will have to be content with either a 47,000 ohm in any tolerance or a 51,000 in close tolerance. It is always better to have the resistors on the large size as regards the wattage rating, as heat may not be dissipated as fast as one would like.

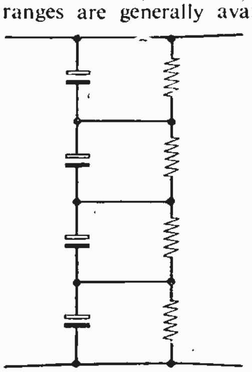


*Fig. 3.—Using a combination of condensers.*

## Smoothing Circuits

The design of the smoothing circuits is quite normal—the L×C of the circuit should give at least 300 for full-wave circuits and 600 for half-wave. That is the values of the two electrolytics added together and multiplied by the inductance of the choke in Henries, for example, two 8 $\mu$F and a 10H choke would give 16×10 or 160; this would tend to give a slight modulation ripple, but if two 16 $\mu$F or a 20H choke were used first-class results could be expected. The E.H.T. smoothing circuit, however, is almost without exception resistance-capacity. Here we have to consider cost and the loss of E.H.T. volts. The cost of the condensers is almost in direct proportion to the capacity, whereas with the resistor it is dependent on the wattage. The larger the amount of spare voltage the better. Also, the lower the current in the network the higher the resistance that can be used. For example, a tube requiring 3kV is to be used and it is decided to use a transformer capable of giving an R.M.S. output of 2.5 kV. The rectified voltage before the smoothing that we can expect will be 3.25kV; we will, therefore, have only 250 volts for smoothing; but if we take the E.H.T. across to the H.T. positive there will be another 350 volts or so to play with. The high-voltage tubes take a smaller current, and a maximum tube current of 100 micro-amperes is average. If the current is too high through the network the cost of the high wattage resistors will be very high, but if a current of 10-20 times the maximum tube current is taken for the calculations the effect on trace size with the change of brilliance will be only small. Perhaps we settle on 2 mA for the particular job; this, with 600 volts to spare, will give a smoothing resistor of 300,000 ohms maximum. The ratio of R and C for smoothing has to be 300 times greater than for L and C. For half-wave, then, we should have a minimum of 300×600, or to be on the safe side 200,000. Take the case in hand, and we have a resistance of 300,000, then if the two smoothing condensers are only 0.5 $\mu$F each there will be ample smoothing.

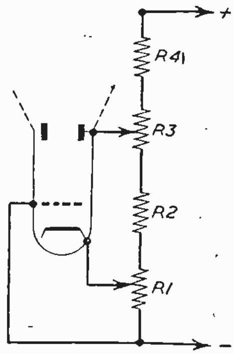



*Fig. 4.—Basic tube control arrangement.*

Heater supplies are a bit of a problem if one is making a low-priced scope, as there are normally only two low voltage windings. In most cases a low voltage type of tube such as the DG7-5 can be used, thus enabling all the valves to be operated with a common 6.3 volt heater chain. The DG7-5 takes 6.3 volts for the heater so that it is advisable to make use of a heater auto transformer—there are many of these on the market and the price is well below that of the mains type of heater transformer.

In the next part we will deal with the types of deflection amplifiers and their various requirements.

*(To be continued)*

# On Your Wavelength

## BY THERMION

### The B.S.R.A. Exhibition

MR. L. LESLIE, of London, N.10, thinks that my arguments against the B.S.R.A. holding a separate exhibition might equally be used against the existence of a separate association to cater for the interests of those concerned with sound recording. The secretary will best be able to say whether the number of members justifies the existence of a separate organisation. Personally, I am not in favour of the formation of new associations when the subject is covered by existing associations. A small association cannot carry much weight, and in matters of Government policy it can only speak with a very weak voice. I have always said that there are far too many associations duplicating one another's work, holding their own exhibitions and thereby weakening the movement. *Reductio ad adsurdum*, we could have associations for the manufacturers of split pins, gummed labels, tin-tacks, valve assemblers, solderers, etc., etc. Many of these associations are no more than clubs, but endeavour to give the impression that they are national institutions by the use of the word "association."

I agree that high-quality sound recording is a highly specialised art, but it certainly is not a cogent reason for holding a separate exhibition. Such exhibitions can never be on a large enough scale to attract either visitors or exhibitors. It must always be a somewhat small industry and therefore attract only a small amount of exhibitors. It follows that there will be a small number of visitors. I still think that it would be best to take advantage of the vast number who visit the National Radio Show, so that the association can preach to the unconverted.

Run as a separate exhibition, it can only appeal to those already converted, and who are therefore unlikely to place orders with exhibitors. A sound recording section of the National Radio Show would be a benefit to all those interested in it, but probably more so to those an association hopes to gather into its fold.

### The BBC Monopoly

IT is somewhat paradoxical that the British Government granted the BBC its monopoly in the first place and now wishes to take it away. I am against monopolies of any kind. They seldom redound to the benefit of the consumer.

### Choosing According to Cabinet Style

A FRIEND of mine informed me with pride that he had recently purchased a new radio set. I was somewhat astonished to learn, knowing him to be a keen musician, that he had purchased a receiver of a certain make which I know would not appeal to a quality fan. The receiver, of course, gives a good average performance. I asked him what had led him to make this choice, and he blandly informed me that it was because he liked the shape and style of cabinet which matched his other furniture! This is a point which some radio manufacturers might bear in mind.

### Letter From an Expert!

ONE of my readers, Mr. F. E. Siggers, who hails from the salubrious district of Ratmalana, Ceylon, crosses swords with me over my comments on the radio expert who advised the listener to repair a leaking cistern with concrete. He says that this repair is often done in cases where the owner of property will not fit a new cistern. He says that the trouble with experts (he is one in Government service) is that they know more and more about less and less until they know everything about nothing.

Well, as Mr. Siggers is an expert, he ought to know. I regard such a method of repair as a botch, like repairing a leaky radiator by putting saw-dust in the water or cracking an egg into it—two methods I have seen recommended in some of the less knowledgeable automobile journals.

### The Radio Show

MAKE a note in your diary to visit Stand 51 on the ground floor of the National Radio Show which takes place at Earls Court from 25th August to 4th September. That is the stand which will house PRACTICAL WIRELESS and our companion journal, *Practical Television*, and our full range of technical books. I shall be there, incognito, of course.

### V.H.F.

THE BBC has placed an order for the construction of 26 V.H.F. frequency-modulated transmitters for sound broadcasting, but delivery will not commence until about a year's time. Twenty-four will be of 4.5 kW. and two of 10 kW. power. The lower-powered transmitters will operate in parallel pairs each handling one programme. Thus, six of these transmitters will be used on each free programme station. The two higher-powered transmitters will be used in parallel at the BBC's existing V.H.F. station at Wrotham.

### What is a Dabbler?

I LIKE the final paragraph of an article in a contemporary: "In this trade of ours which has many restrictive trading practices it behoves us to keep some sense of proportion and not to make the legitimate entry into our trade subject of any conditions save those of ability and honest intentions. Any other course is both unfair and predestined to failure."

The trade was grateful in the early twenties when the industry was founded from that great band of enthusiast "dabblers" then called experimenters, from which financiers drew their personnel, knowing nothing of radio themselves.

# A Simple SIGNAL GENERATOR

## HOME-MADE COILS ARE USED IN THIS USEFUL ACCESSORY

By G. W. Davey

AFTER experimenting with superhet receivers for some time, without any means of aligning them, other than the method of trimming for maximum signal, it became increasingly evident to me that the optimum results were not being obtained and that some form of signal generator was essential. Some thought was given to the form this should take, and it was decided to cover all bands from 10 metres to 2,000 metres if possible, with special fixed points for 465 and 110 kc/s, the latter being necessary for a superhet in use with I.F.s of this frequency. The final result is shown in Fig. 1. All the required bands are covered by means of switched coils in four banks, namely, 110 kc/s, 465 kc/s, broadcast wavebands, i.e., medium and long, short waves in three bands. The original was built out of spares from the spares box, but it will be seen that the design is entirely simple and can be constructed out of any components to hand. The coils are the chief points to consider and are arranged as follows :

**110 kc/s.** If this range is not likely to be required it can easily be omitted. In the original design I used an old I.F. transformer from which the trimmer was removed on one winding. This winding was reduced in size by about half by pulling off approximately half the wire. This winding becomes the "reaction" winding in the oscillator anode circuit.

**465 kc/s.** The simplest method of covering this range is as for 110 kc/s, by adapting an old I.F. transformer as described above. This type of transformer is not usually spare, being a modern component, and as I had not one I wound a suitable coil in accordance with the details in Fig. 2. The spare trimmer from the 110 kc/s transformer was used to tune it, but any suitable trimmer can be used.

**Medium and long waves.** An old dual-range coil was used here tuned by a .0005 $\mu$F condenser. The particular coil used did not have built-in wavechange switching, and an on-off switch was wired in circuit for shorting out the long-wave winding. Nor did the coil have any screening, with the result that the oscillations could be picked up over quite a wide area, but a screened coil would obviate this

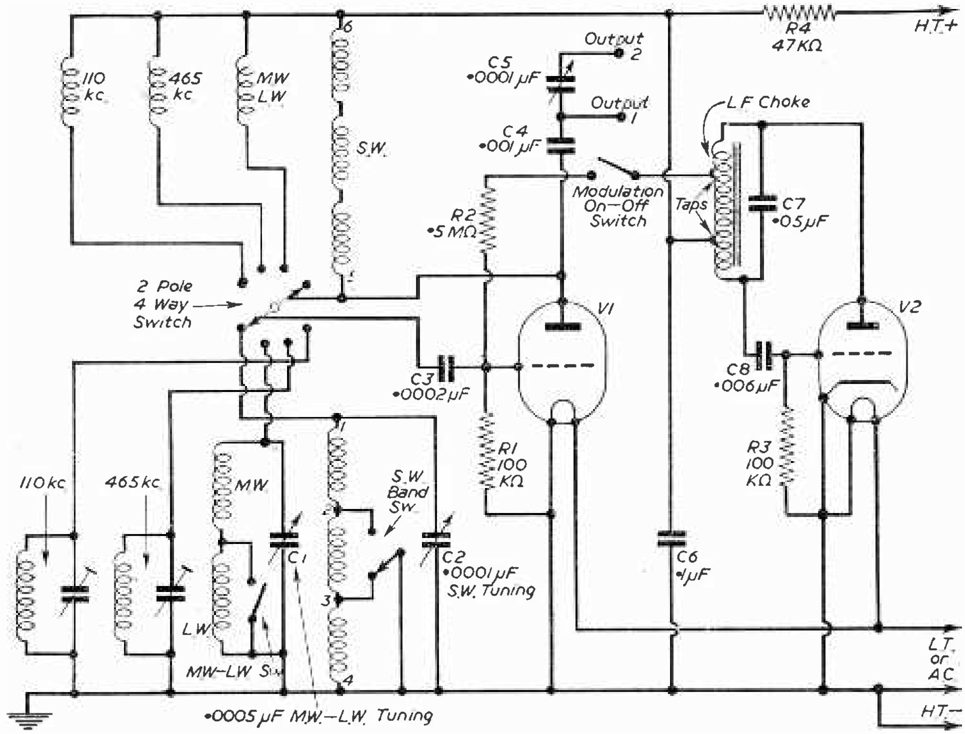



*Fig. 1.—Theoretical circuit.*

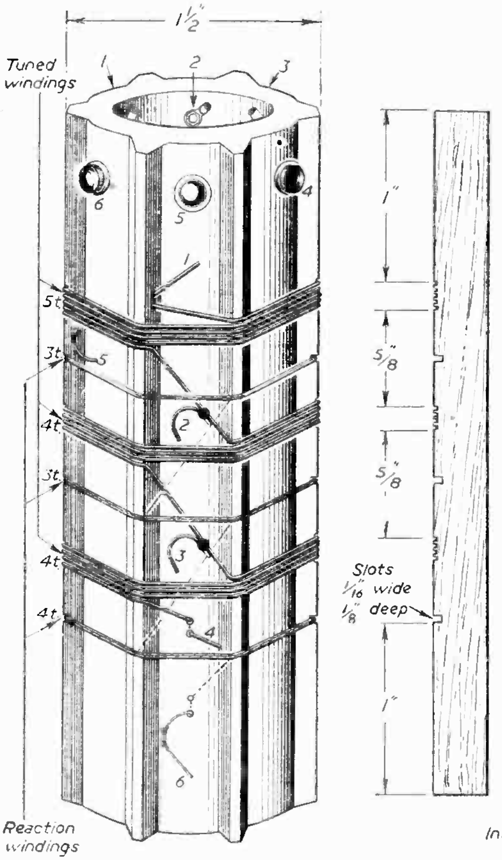



*Fig. 3.—The three-range coil. Tuned winding: 20-gauge enamelled or tinned copper wire. Reaction windings: 30-gauge d.c.c. Tuned winding, spaced one thickness of wire: reaction pile-wound in slots.*

wafer, but plugs and sockets could be used if desired. The theoretical diagram makes the arrangement clear and shows that the switching gives a choice of seven wave ranges.

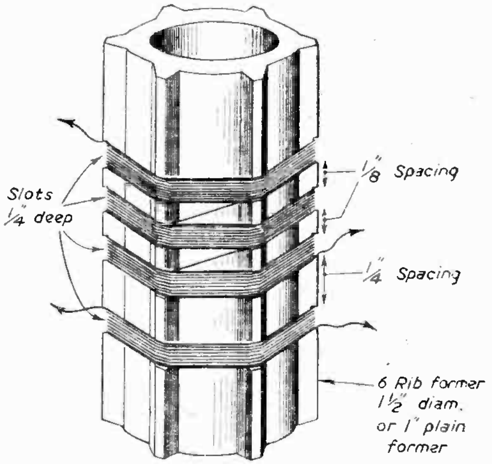



*Fig. 2.—Tuned winding: 120 turns 36 d.s.c. wire, i.e., 40 turns in each slot. Reaction winding: 50 turns 36 d.s.c. wire.*

**Power Supply**

As the question of valves to use is allied to that of power supplies, it is appropriate to discuss these ext. In the original generator I have used raw A.C.

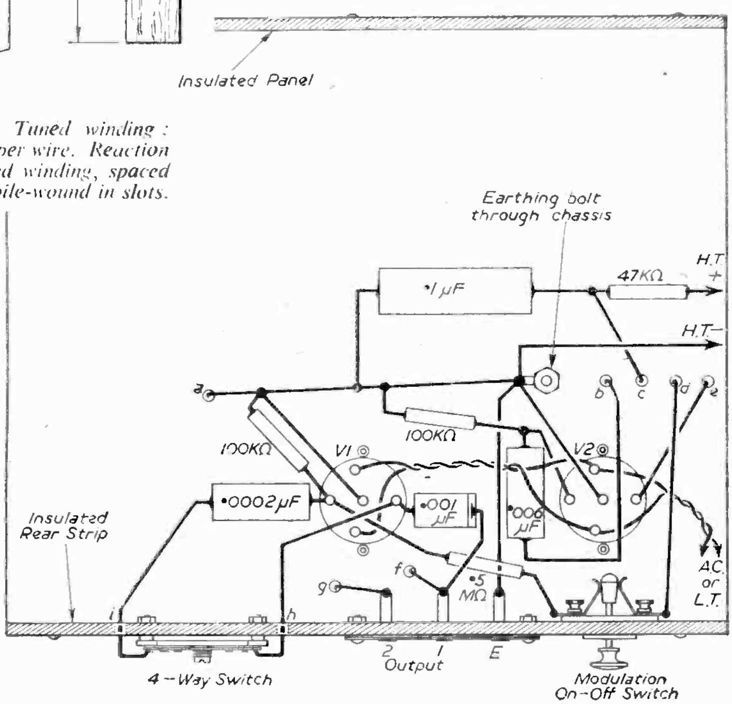



*Fig. 4.—Underchassis wiring.*

and effect an improvement.

**Short waves.** An old triple-range short-wave coil was used in this position, but a home-made coil can easily be made and details of a suitable design which was published in these pages some years ago are given in Fig. 3. This is tuned by a .0001 μF capacitor and a single-pole change-over switch is connected for wavechange purposes. If such a switch is not available two on-off switches can be used.

Each of these four ranges is connected to a two-pole four-way switch in such a way that the tuned winding and complementary reaction winding are connected respectively to the grid and anode. For this purpose I managed to arrange a spare switch at 4 volts for the valve filaments and 250 volts for H.T., these being taken from the workshop mains unit. As the H.T. required is about 100 volts, R4 of 47,000 ohms is included to drop the 250 volt supply, and if battery supplies are to be used this resistor may be omitted, or suitably reduced for a lower voltage supply. If it is decided to make this a battery operated unit the valves to be used will depend on the L.T. supply. Two triodes are required and any spare valves available may be utilised, those with more than three electrodes having grids additional to the control grid strapped to the anode thus forming three working electrodes. Two-volt valves can be run from an accumulator or, as use of the signal generator is only intermittent, from three-volt dry cells with a suitable resistor in circuit. In the original unit I used a directly-heated four-volt power valve which was well past use for its original purpose, but which made a very satisfactory oscillator run from four volts A.C. The modulator valve is an old indirectly-heated triode with the cathode taken direct to chassis.

The low-frequency oscillations are obtained by means of an L.F. choke connected between grid and anode of the valve and tuned by a .05 μF condenser. A suitable type of choke was at one time made by Varley—the three-henry tapped choke. If one of these is not available, or unobtainable, a very suitable substitute can be made from the primary of an output transformer, provided that this has two intermediate tappings. I used this arrangement in the original with complete success. A push-pull intervalve transformer could probably be used in the same way with primary and secondary in series. Modulation is injected into the grid of the oscillator from a tapping on the choke through a ½ megohm resistor. An on-off switch between the resistor and choke provides a means of switching modulation in and out. Two outputs are provided, taken from the anode of the oscillator valve, the more powerful one through a .001 μF condenser, the other via a variable .0001 μF condenser in series with the former one. Ability to vary this condenser provides a useful means of reducing the output of the generator to provide a weaker signal. (*Continued on page* 421)

**COMPONENT LIST**

**Capacitors :**
- C1—.0005 μF variable.
- C2—.0001 μF short-wave tuning.
- C3—.0002 μF fixed mica.
- C4—.001 μF fixed mica.
- C5—.0001 μF solid dielectric.
- C6—.1 μF fixed paper.
- C7—.05 μF fixed paper.
- C8—.006 μF fixed mica.

**Resistors :**
- R1—100 K Ω } ¼ watt type.
- R2—.5 M Ω } ¼ watt type.
- R3—100 K Ω } ¼ watt type.
- R4—47 K Ω. ½ watt (optional: see text).

**Coils :**
- 1 m.w. and l.w. dual range.
- 1 3-range short-wave } See text
- 1 465 kc/s (with trimmer) } See text
- 1 110 kc/s (with trimmer) } See text

**L.F. Choke.** 3 Henry tapped choke.

- 1 on-off single-pole switch.
- 1 on-off single-pole switch.
- 1 s.p.d.t. change-over switch.
- 1 2-pole 4-way switch.
- 2 triode valves and valveholders to suit.
- Chassis, dials, panel, terminals, etc.

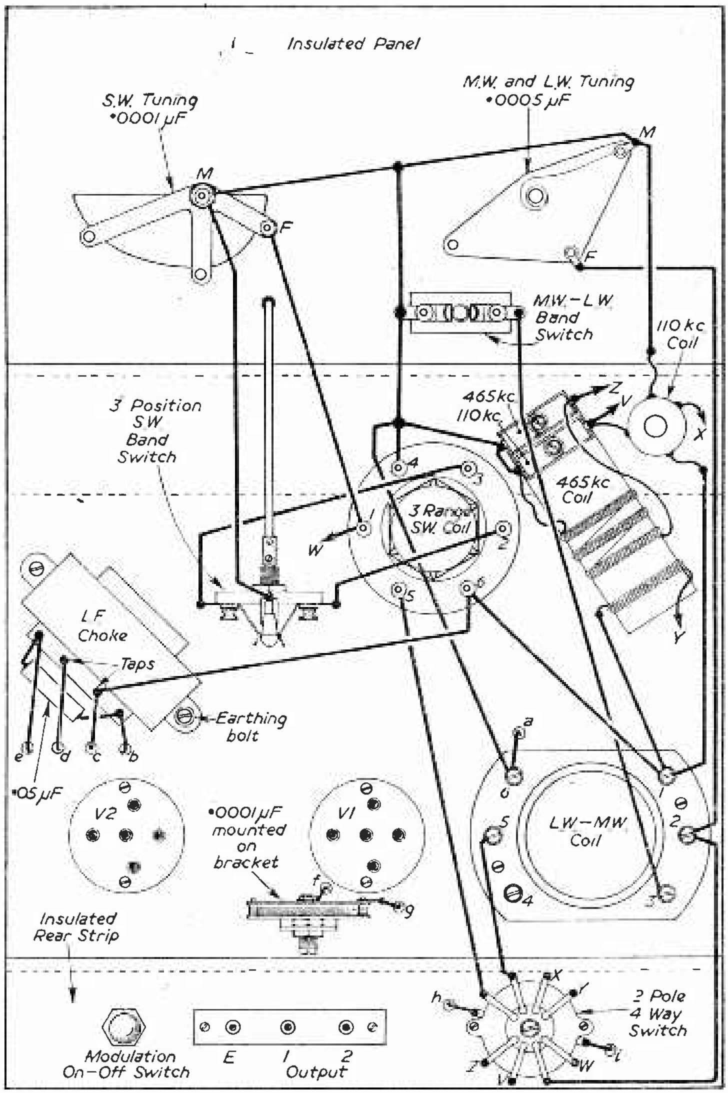



*Fig. 5.—Part wiring diagram. The underchassis wiring is given in Fig. 4.*

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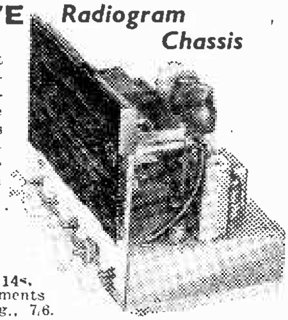

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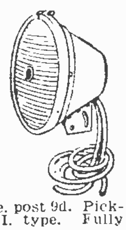

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# TRANSMITTING TOPICS

## FLASHOVER: ITS CAUSE AND PREVENTION

By O. J. Russell, B.Sc.(Hons.), G3BHJ

WHILE the results of a flashover may be momentarily brilliant and spectacular the amateur, as well as the professional transmitter constructor, is well advised to prevent its occurrence.

Most disastrous of all a flashover inside a valuable V.H.F. double tetrode may entail a replacement bill of several pounds. Even the ubiquitous 807 is not plentiful enough to be carelessly expended. Furthermore, of course, a flashover on a transmitting condenser, apart from causing ugly arc craters on the plates, may burn out expensive high voltage rectifiers, create shorted turns in power transformers, or even a smoothing choke burnout. Those privileged to see a really spectacular flashover on high power equipment will also appreciate that there is also a considerable element of danger.

In fact, all flashovers are preventable, providing that due account is taken of the maximum peak voltages that may exist in a P.A. stage. Flashover results from ignoring the voltage rating of components and it is necessary to use components capable of safely withstanding the full peak voltages. A side issue is the case of a condenser meant to pass R.F. voltages, but intended to block off lethal D.C. supply potentials. If not rated for the full peak voltage such a condenser may fail and no indication be given that a short circuit exists, although killing H.T. potentials may be superimposed on an R.F. feed line. The amateur is not likely to repeat the hair-raising experience of the writer when a nominally "R.F. only" feed line was found to be also at 7,000 volts D.C. potential. However, with the Pi tank circuits now popular the full H.T. voltage may appear on a nominally safe earthy coaxial socket centre pin, and this may well be 1,000 volts or so in a QRO amateur rig. As in many important matters the motto is that it is much better to be safe than sorry.

Recent correspondence has elicited the fact that some confusion may exist as to the actual peak voltages present on various components in a P.A. stage. To save trouble consider Fig. 1, which shows the peak potentials from anode to earth in a typical PA stage. Superimposed on the steady D.C. potential of the supply is an R.F. voltage of peak value ideally equal to the H.T. supply potential. Accordingly, the instantaneous potential swings from zero to twice the value of the H.T. potential. In practice the actual peak R.F. swing is a little less than the actual D.C. potential, but as a safety factor is necessary the actual working peak potential is safely taken as twice the anode D.C. supply voltage. This applies for C.W. operation and also for efficiency modulation operation. However, under anode modulation the peak voltages are doubled at the peaks of 100 per cent. modulation. This is because at the 100 per cent. modulation positive peaks the effective H.T. value has been doubled. Accordingly, the peak anode potentials are also doubled. This is obvious enough if one considers modulation by a square wave, but it also applies to sine wave modulation at the tips of

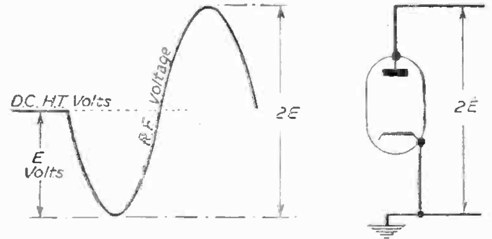



*Fig. 1.—Showing the peak voltages existing at the anode of a Class C R.F. stage.*

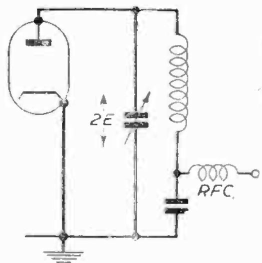



*Fig. 2.—In this circuit the tank condenser has to withstand both the D.C. anode potential and the R.F. potential. Under C.W. conditions this amounts to twice the H.T. supply voltage. This voltage is doubled under 100 per cent. anode modulation.*

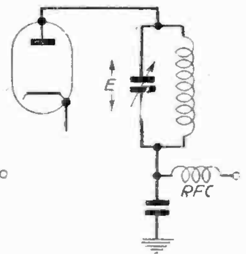



*Fig. 3.—By rearranging the circuit of Fig. 2, the tank condenser now has only to withstand the R.F. voltage. Under C.W. conditions this equals (ideally) the H.T. potential. In all cases anode modulation doubles these peak figures at 100 per cent. modulation.*

the modulating waveform. Hence, the potentials across the P.A. stage reach a peak of four times the applied D.C. supply potential. Thus an 807 at 600 volts under C.W. conditions has a peak voltage of 1,200 volts, and under 100 per cent. anode modulation this is doubled to 2,400 volts.

**P.A. Stage Arrangements**

Considering several P.A. stage arrangements, the circuit of Fig. 2, in which the tuning condenser is shunted from anode to earth, has to withstand the H.T. when anode modulated phone is used. This gives a safe margin over the expected peak maximum of 2,400 volts that may occur on anode modulation peaks. It is not often appreciated that with anode modulation under conditions of over modulation the peak voltages quoted may be exceeded. Hence the need for an adequate safety margin.

A few further points are in order. The Pi tank networks use a fixed condenser of high grade low-loss mica or ceramic types to block off the D.C.-H.T. potentials from the Pi network (Fig. 6). In

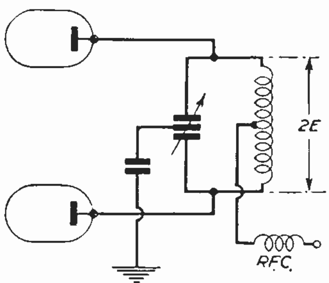



*Fig. 4.—Peak voltages in split stator circuit when H.T. is blocked off by a by-pass condenser. Each half under C.W. conditions has to withstand E volts peak.*

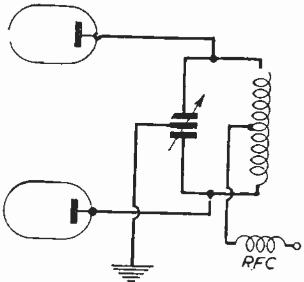



*Fig. 5.—If the centre rotor of the split stator is grounded, each half has also to withstand the D.C. supply potential. The peak voltage across each half is thus 2E under C.W. conditions.*

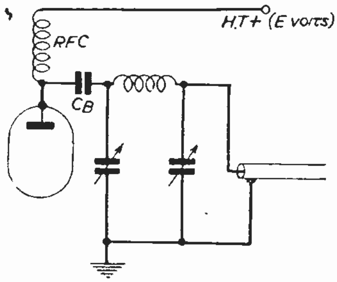



*Fig. 6.—In a Pi network tank, the blocking condenser CB, has only the supply voltage to withstand for C.W. operation, or twice this value for anode modulation conditions. However it must be a high quality low-loss condenser.*

same peak voltage as the valve—that is D.C. supply volts plus peak R.F. volts. In the circuit of Fig. 3 the condenser has to withstand only the R.F. peak volts. Calling the supply potential E, in Fig. 2 the tank condenser has to withstand 2E volts but only E volts in the circuit of Fig. 3.

The push-pull or split anode neutralising type circuits also provide some pitfalls. Actually the peak R.F. voltage across the tank coil is 2E volts. Hence the circuit of Fig. 4, in which the tank condenser has no D.C. voltage but only R.F. voltage to withstand, has to be capable of withstanding 2E peak volts. In the split stator arrangement of Fig. 5, in which H.T. is blocked off by a fixed condenser, each half of the split stator condenser has to withstand only E volts. However, in the circuit of Fig. 5, where the D.C. supply voltage is also across each half of the split-stator condenser, then each half must be capable of standing 2E volts. Also the fixed by-pass capacities must stand E volts of D.C. supply potential. All this only applies to C.W. or efficiency modulated P.A. stages. Under anode modulation conditions all these voltages must be doubled. Preferably a safety factor should also be included. Thus fixed by-pass condensers of say 3,000 volts working should be used to by-pass the H.T. line to an 807 P.A. with 600 volts

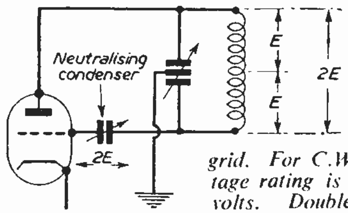



*Fig. 7.—The neutralised amplifier is especially vulnerable to flashover which may put the full H.T. on to the grid. For C.W. the peak voltage rating is twice the supply volts. Double this for anode modulation service.*

this case, for C.W. operation the condenser must be rated to withstand at least the full D.C. potential. Under anode modulation conditions the rating must be at least twice the applied anode D.C. potential. A further problem is encountered in a neutralised amplifier. Here the results of a flashover are most disastrous

(*Concluded on page* 442)

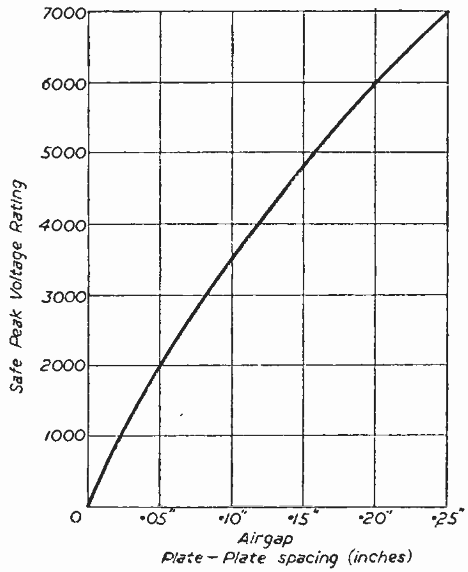



*Fig. 8.—Safe working peak rating of air spaced condensers.*

# Some Aspects of Valve Testing

DETAILS OF SOME OF THE MORE IMPORTANT CHARACTERISTICS

By J. S. Kendall

WITH a radio valve what is it that we are trying to measure? Is it the total emission, or to ascertain that it will work under certain conditions? In many of the older and simplest types of tester an attempt was made to measure the total emission. Whilst this was quite a reasonable idea, it was very easy to ruin the valve in so doing; and as the wires in the grids of the more modern valves have got finer and finer, and the total possible emission increased, it is possible to overheat the grid wires and get secondary emission from them, thus giving a reading that is too high. The standard method used to-day is the checking of the valve under a set of working conditions. Some just apply the voltages to the anode and screen, earth the grid, and see that the correct bias voltage is developed across a resistor in the cathode circuit. This is probably one of the simplest types of tester. It does not, however, test to see if the emission is such that the valve will pass sufficient current on a positive signal peak. Again, other testers apply the correct anode, screen, and grid voltage, and then reduce the grid voltage by one volt and note the change of current through the anode of the valve. These tests all have disadvantages unless the power supplies are all stabilised, and this can make an accurate instrument costly. One way of overcoming the power supply difficulty is to use A.C. for the anode supplies. This may sound a little strange, but look for a moment at Fig. 1. Here, the voltage appearing at the cathode of the valve will be D.C. and can be used to charge the condenser CK, thus applying a steady voltage to the voltmeter—A.C. superimposed to too great an extent will soon ruin the pivots of the meter—so the time constant of the RK and CK should be one-fifth of a second with the lowest value of RK used. If this time constant is larger it is of no matter.

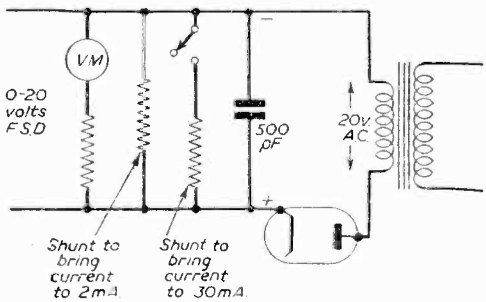
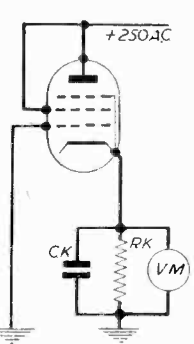



*Fig. 3.—Measuring a rectifier characteristic.*

### Transformer Tappings

Working on this circuit, we will require a mains transformer that will give a wide range of H.T. voltages—90, 120, 150, 200, 250—at currents of up to 50 to 80 mA, and also heater voltages will be required for the various types of valves to be tested—1.4, 2.0, 2.5, 3.0, 4.0, 5.0, 6.3, 12.6, and so on up to 117 for certain U.S.A. types. Usually, the constructor can use a little ingenuity in the choice of transformer, and by the use of series connections of various spare secondaries get near enough to the required voltages. For example, a transformer with 0-4-6.3 and 0-4-5 volts for heaters, such as is found in many of the universal replacement types, can be connected to give also 1.3 v. (6.3-5), 1 v. (5-4) and 2.3 v. (6.3-4), and if a 4-volt to 6.3 auto transformer is added, then two 6.3's will give 12.6. Universal heaters can be used on a universal basis, but the writer does not care for this type of supply and care should be taken to see that the chassis of the tester is at neutral potential.



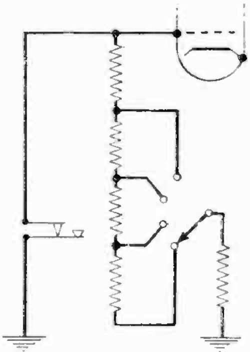



*Fig. 1 (left).—Measuring bias voltage.*
*Fig. 2 (right).—A variable grid leak.*

Having found an idea of how to obtain the various supplies, then the choice of the meter and the cathode resistor are the next problem. The cathode resistor should consist of a chain of resistors in series around the bank of a wafer switch so as to provide 90-2,000 ohms in about 10 or 11 steps, and get as near to the usual cathode bias value as possible. The voltmeter should have a full-scale reading of about 10 per cent. higher than the reading for a good valve. The voltage for full deflection can be changed by the use of a range of series resistors again on the bank of a Yaxley-type switch. The voltmeter should then be calibrated in 50 per cent. of scale "RED," 20 per cent. "?" and the remainder between 70 and 100 per cent. of deflection "GOOD." Thus a small allowance is made for the valve being just a little too good as it were.

### Softness

The writer has often had valves that have been soft, and it is often an advantage to be able to test for this condition. It is a simple addition to the tester, for, instead of the voltage or, should we say, earth on the grid being direct, it is fed through a high resistor. The value of this resistor varies from valve to valve and the writer has found that the following formula is suitable: $20/G^2$ megohms, where G is the mutual conductance of the valve under test conditions. The circuit for testing "softness" is shown in Fig. 2. The extra components are added to the circuit in Fig. 1. The key is pressed, thus allowing the high resistor to be put in series with the grid of the valve. Any current through the grid of the valve resulting from gas will develop a voltage across the resistance, so that the grid is taken positive and increases the current through the valve. Thus, with a reading of 90 per cent. for the

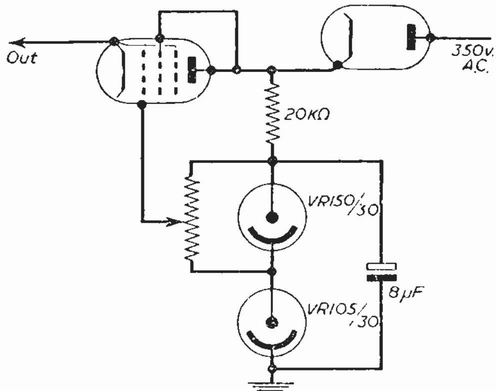



*Fig. 4.—A stabilised H.T. supply.*

normal test on the valve, with gas present the voltage would rise to well over 100 per cent. in a bad case; normally, a few per cent. rise can be expected.

So far we have considered an A.C. method of testing amplifier valves, but what is the position regarding rectifier valves? What could be simpler than just applying 20 volts and measuring the current rectified—this is quite simple and reasonably effective. Fig 3 gives a typical circuit. Here, 20 volts is applied to the circuit in the form of A.C., and the valve used as a rectifier to charge the 500 pF electrolytic condenser. A switch is included so that a current drain of either 2 mA. max. for testing diodes or 30 mA. for testing rectifier valves can be obtained. The operation of the circuit is simple; the correct heater voltage is applied to the valve under test and the value of rectified voltage appearing at the cathode measured under certain conditions. The calibration of the meter for the amplifier valve will still hold good. Two or three questions will spring to the mind of the reader; why only use 30 volts and not the full working voltage? At low voltages we actually get a better idea of the condition of the valve. The second question is why use a 500 pF condenser, when the makers state the maximum reservoir condenser at perhaps only a 20th of this? The reason is that as the voltage is only very low the surge current is not liable to cause the slightest damage to the valve.

**Scope**

The testing of the amplifier valves with direct current gives a far greater scope, but, of course, as these supplies have to be stabilised the cost is higher. A simple stabiliser circuit for the anode supplies is shown in Fig. 4. The rectifier valve can be either full or half-wave, and, of course, a suitable condenser should be placed at the cathode for smoothing. The two stabiliser valves can well be the VR105/30 and the VR150/30, which can be obtained readily on the surplus market. The Series stabiliser valve should be one of the heavy current pentodes of which the Mullard EL37 is undoubtedly the best. The potentiometer for feeding the correct voltage to the grid of the pentode can be almost any value between 50 KΩ and 1MΩ. This latter is calibrated in voltage, and there will be only a few volts difference between the voltage applied to the grid and that at the cathode of the EL37. The feed of voltage to the screen can be arranged by series resistors.

The method of testing the valve is almost the same as that described for A.C. testing, but as the conditions on the anode and screen are held steady an improved circuit can be used where the valve is actually tested under full drive conditions. A basic circuit is shown in Fig. 5. Here the emission of the valve under static conditions can be taken, and then a voltage fed to the grid circuit. This latter should not be such that the valve is overloaded, but should be of normal working value, for example, a valve such as the EL33 would, with 250 anode and screen, and a 150Ω cathode resistor develop 6 volts across the bias resistor. If 2.5 volts were applied to the grid of the valve, the entire swing would be on the straight portion of the valve characteristics, so that although the current through the valve fluctuates the average would be unaltered, but if the emission of the valve was failing, whilst it would appear only a little low with the A.C. test or the D.C. static test, as soon as the A.C. voltage was applied to the grid the average emission of the valve would fall, causing a fall in the voltage at the cathode of the valve. This type of dynamic test would be far better than the A.C. or static test.

Having dealt roughly with the testing of the valves there come several snags that have to be overcome. For instance, there is nothing more common and

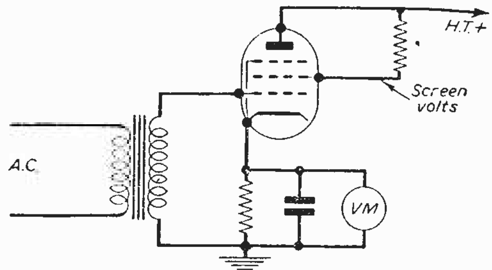



*Fig. 5.—Circuit for testing a valve under full drive conditions.*

misleading in the low-priced testers than parasitic oscillations. These can cause either a rise or fall of anode current. The simplest method of overcoming the trouble is the use of stopper resistors on grids, screens and suppressors. Whilst for the grid 10,000Ω is required, 10Ω can be used on the anode and 100 on the screen and the suppressor; these resistors can cause errors, but the errors are constant and due allowance can be made for them.

Switching arrangements for the various valves and valve-holders will be left to the reader's own ingenuity and requirements. The arrangement of a suitable code and set of charts for the tester when designed and made will be required. This will have to be compiled from manufacturer's data and then results proved and verified by trial and error, using good new valves. It is no use trying out the tester in the first instance on valves that are of unknown quantity.

Whilst the foregoing is not intended to be a complete constructional article of a valve tester, it should provide the reader with a few useful ideas.

# A Modern Reflex Receiver

A NOVEL CIRCUIT BUILT ROUND THE MULLARD ECL80 VALVE

By C. M. Stewart

THIS receiver was designed to discover the possibilities of combining an old idea with the latest ideas in valve design. The circuit shown is the outcome of several experiments in this direction, and shows how the maximum performance can be obtained from a minimum of components.

The basic idea of "reflexing" is not new, it was devised in the early days of radio when the valve was to the amateur constructor very much as the transistor is now. The valves available were therefore utilised to their fullest extent, and this was accomplished by making one valve do the job of two.

Reflex operation means that the R.F. amplifying valve in the receiver is also used to amplify the audio signal from the detector. If the output valve in the normal T.R.F. receiver consisting of R.F. amplifier, detector and output stages can be made to perform the duties of the R.F. amplifier as well as its own, the number of valves in the receiver can be reduced by one. Further, if the functions of amplification and detection can be combined in the one valve envelope, the number of valves can again be reduced. This is made possible by the use of a "double" valve, and a valve of this type has recently come on the market and was used in this circuit.

The trouble with reflexing in the early days was that the arrangement was often unstable and this has earned the idea a bad name. This can be overcome by modern valves and techniques, and in practice a reflex receiver need be no more unstable than the usual T.R.F. set.

The instability was caused by the unsuitability of the valve types then available. A valve which is designed as an audio amplifier may not be a very good R.F. amplifier, due to its larger interelectrode capacitances and electrode structure. The large interelectrode capacitances caused positive feedback due to the Miller Effect with consequent instability.

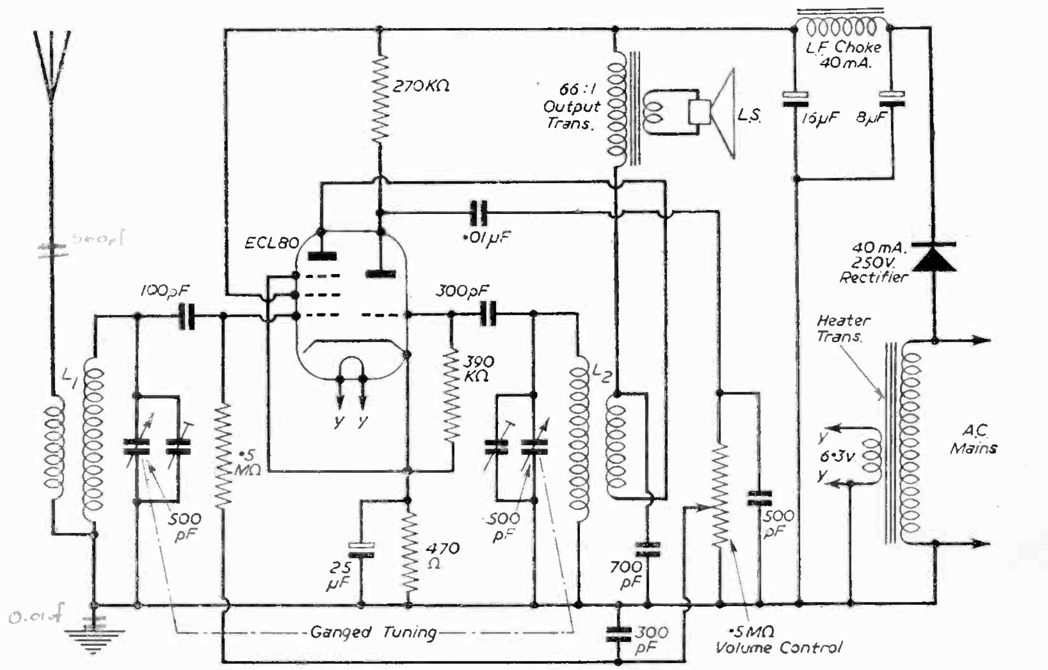
### The Circuit

This receiver has shown no particular instability, but it should be emphasised that wide deviations from the component values stated are not recommended.

The ECL80 is a modern valve of the miniature all glass type, and by the use of midget components a very compact set can be built. Constructing the receiver should present no particular difficulties, but the aerial and detector circuits should be kept as far apart as possible to prevent stray coupling.

The pentode section of the valve has proved to be excellent in its dual role of output and R.F. amplifier. The detector is of the conventional triode grid-leak type and the audio signal from this stage is passed via the ½ MΩ grid resistor to the grid of the pentode for reamplification.

There are some points to watch when choosing




*The final circuit of the receiver.*

components for this circuit. Air-cored coils have been specified because the midget iron-cored type used in the first version of the prototype were found to have rather tight coupling between the two windings. Thus if the acrial was changed for any reason it was found that the alignment of the set had been affected ; also some instability occurred at the extreme end of the tuning scale. Air-cored coils were substituted and these defects disappeared, but readers can experiment on this point for themselves. The value of the grid-leak resistor is lower than usual for the same reason.

It will be noticed that the H.F. transformer primary carries the anode current of the output valve, which is greater than that of the normal R.F. valve, but the winding seems able to carry the current quite comfortably, especially as the anode current of the pentode section of the ECL80 is about half that of output valves like the 6V6.

**COMPONENT LIST**

- ECL80 valve.
- One B9A noval valve holder.
- One 500 pF two-gang tuning condenser with trimmers.
- One 500 pF mica condenser.
- One 700 pF mica condenser.
- Two 300 pF mica condensers.
- One .01 μF 350 v.w. condenser.
- One 25 μF 25 v.w. electrolytic condenser.
- One 8+16 μF 350 v.w. electrolytic condenser.
- One ½ MΩ carbon volume control.
- One 270 KΩ ½ w. resistor.
- One 390 KΩ ¼ w. resistor.
- One ½ MΩ ¼ w. resistor.
- One 470 Ω ½ w. resistor.
- One 40 m.A. smoothing choke.
- One 6.3 v. heater transformer.
- One 40 m.A. 250 v. metal rectifier.
- One output transformer, ratio 66 : 1.
- One 3 Ω speaker.
- Coils L1—Wearite PA2. L2—Wearite PHF2.

The 500 pF and 300 pF condensers across the volume control are for the purpose of removing any R.F. component of the signal left after the detector stage which if passed to the pentode section would cause the valve to oscillate or cause instability.

The 700 pF condenser from the H.F. coil to earth is to provide an easy path to earth for the R.F. and should be mounted on the coil itself as the leads to the speaker transformer may be fairly long.

The electrolytic bypass condenser is used to earth both R.F. and audio and in some cases it may be found necessary to place a mica condenser of about 1,000 pF in parallel with it, as electrolytics sometimes have a high impedance to R.F. currents. This was not found to be necessary in the original receiver.

The type of power supply shown means that the chassis will be "live," but this was chosen because of the small size and low price of a heater transformer as compared with a standard mains transformer. A midget transformer with a separate H.T. winding is on the market, however, and may be substituted for the heater transformer, thereby isolating the chassis from the mains.

### Performance

The receiver was found to give more than adequate output with a 10ft. piece of plastic-covered wire thrown on the floor. The quality is excellent and overall performance is as good, if not better, than the standard T.R.F. set. Alignment is easily made by adjusting the trimmer condensers on the tuning condenser for maximum output. It is not necessary to make the receiver unduly small if it is not required, for tests were made with a 6½in. speaker and the speaker could be fully loaded without affecting quality. The station-getting abilities are surprising, especially in the evening when plenty of continental stations come through as well as the local BBC broadcasts.

This circuit has one other advantage over most other types of one-valve receiver, which is that no reaction is used. Anyone can, therefore, operate the receiver without a great deal of fiddling, which can be appreciated by all who have had experience on this point.

This circuit is by no means the end of the possibilities of the reflex principle, but is merely a pointer to further developments. For example, if the tuning coils and condensers are replaced by I.F. transformers and a frequency changer used before them, a very compact and efficient superhet receiver would result.

# Radio Road Service

A SCHEME to direct and control A.A. Patrols and night breakdown vehicles by means of a greatly extended radio network, covering nearly 15,000 square miles, is announced by the Automobile Association. It involves erecting transmitters within the next few months in the vicinity of Manchester, Sheffield, Newcastle, Nottingham, Bristol and Cambridge, with the local A.A. office as the control station. They will supplement the A.A. transmitters already in use in London, Guildford, Birmingham, Leeds and Glasgow. The aim is to speed up assistance for motorists living in and passing through these areas at any hour of the day or night.

To begin with, by the early summer A.A. Radio Patrols will start duty in the Birmingham and Leeds areas. In both cities they will be controlled by the 24-hour emergency services which already operate the Association's breakdown vehicles at night and at week-ends. By mid-summer, Manchester, Bristol, Nottingham and Newcastle will be brought into the radio network. In each of these areas the A.A.'s headquarters will remain open throughout the 24 hours to direct Radio Patrols during the day and A.A. radio-controlled breakdown vehicles at night and at week-ends. Finally, Radio Patrols will cover roads in a wide area of the Eastern Midlands and the Eastern Counties. These Patrols will be directed through an A.A. transmitter near Cambridge.

These developments will give a radio coverage of some 15,000 square miles from 11 A.A. offices. Thus, the Association's declared policy of providing a national radio network to ensure that help is quickly forthcoming during the whole of the 24 hours will have been largely carried out.

In addition, during the summer many more A.A. Patrols attending important events will be equipped with "walkie-talkie" apparatus, enabling them to keep in constant touch with A.A. Mobile Headquarters on the spot. The immense advantages of a direct radio link in dealing with abnormal traffic and car parking arrangements have been proved again and again by experiments carried out.

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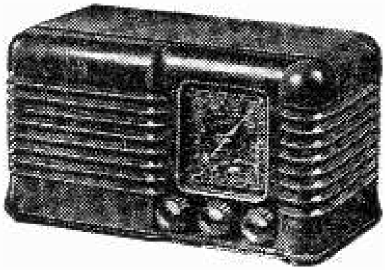

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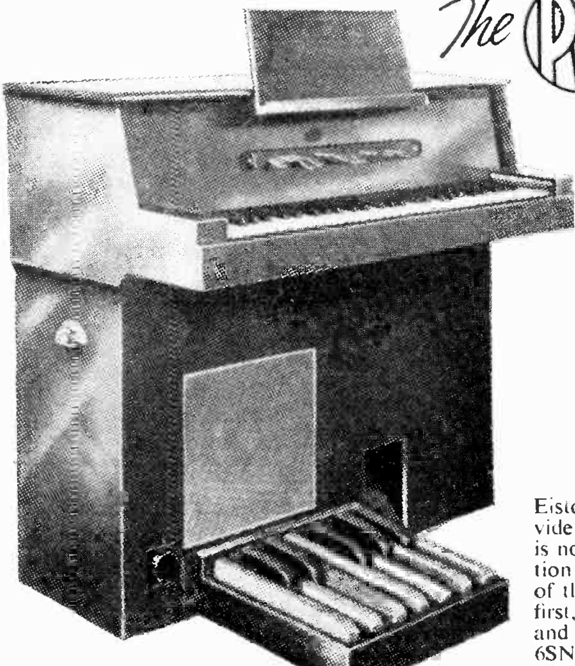

# The PW FULL-COMPASS Electronic ORGAN

SOME QUERIES ANSWERED, AND SOME MODIFICATIONS

By W. J. Delaney

THERE are two or three queries which have been raised concerning this instrument, and as they are of general interest to others who may be building the organ they are dealt with in the following notes. First, the design of the amplifier. The small unit which is mounted on the keyboard, carries a pre-amplifier stage, in addition to the vibrato and tone-control stage. The output from this pre-amplifier is passed to the main amplifier without any other modification—all tone-control and similar effects being introduced prior to the pre-amp. stage. Therefore, as the output is straightforward audio, *any* design of amplifier may be used. The only requirement is that there should be a minimum of hum. As the output from the organ ranges from 32 cycles up to 1,976 cycles the design should be such that a fairly good response at the bass is provided, and although negative feed-back is not essential, it does assist in keeping down the hum and levelling up the response. The constructor can, therefore, include any preferred design of amplifier, even, if necessary, including that used for his normal broadcast receiver, switching over to the organ as required. The speaker, for the same reasons, should be chosen with care, but there are several makes which may be used. The original was a Goodman's Axiom, but any 12in. may be used, the W.B. "Stentorian" Duplex, for instance, giving a very wide response and producing a brilliant top. A 10in. would probably be damaged on loud volumes by heavy movement of the cone, although this would depend upon the output stage which was used. The original amplifier has since been changed to incorporate a pair of 6L6s in the output stage which in turn has called for a larger mains transformer. The Elstone MT/A150 has been fitted and found to provide all that is required in this position. The layout is not critical and may be followed from the illustration given on page 225 of the April issue. The order of the valves, reading from the left of the picture, is first, rectifier; the next two are the output valves, and the next the two input stages, consisting of the 6SN7 and 6SL7. The two clear glass bulbs between the output transformer and the input stages are the stabilisers, which incidentally are VR/150/30s, not S130s. All other details of the amplifier remain as given in Fig. 27.

### Vibrato

As shown in Fig. 13 the vibrato may not function—much depends upon the run of the leads and the actual resistance of the lead to the switch. A good plan is to mount a 1 MΩ variable resistor across the actual switch contacts as shown in Fig. 1, and to adjust this to the desired speed of vibrato. It may then be measured and a fixed resistor of that value inserted, or left so that if desired, a variable speed vibrato may be obtained. It will be remembered that the adjustable control R34 varies the *intensity* and not the speed of the vibrato.

### Pedal Board

Many constructors wish to fit a full pedal board, and this has now been done. Very little additional

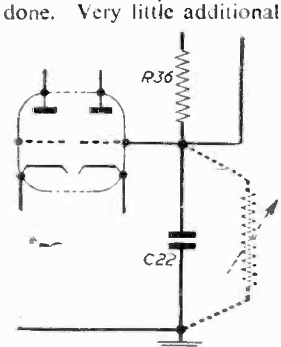


*Fig. 1.—The addition of a variable resistor, as shown here, will enable the speed of the vibrato to be adjusted.*

work is called for in adding this, and if a standard pedal board is not purchased it may be easily constructed from hard wood, making the "white" notes from strips 2in. by ¾in. and fitting shaped blocks as given in Fig. 2 to strips as required for the "black" notes, making these strips only 1 in. deep so that they will not be depressed when the "white" notes are pressed down. The contact mechanism may be exactly as described in the previous article, or may be mounted on the top of the end of each note and contact a horizontal strip running from end to end of the pedal manual. It would be preferable to make the contacting mechanism inside a small plinth upon which the main organ body may be placed, and the pedals may then be taken away as required, and simply inserted into position, their weight being relied upon for the actual positioning, if the instrument is to be kept portable. A permanent installation could, of course, have the pedals screwed into position. The electrical side would be a continuation of the existing pedal arrangement with a slight difference in the linking. It is reproduced in Fig. 3. Up to the B above the low C the arrangement as described and illustrated in the March issue will hold good. If this has already been made, an additional strip of paxolin would be needed, but if work has not yet progressed so far, the strip of paxolin should be of such a size that it will accommodate the network already described plus those for the remainder of the notes. The pedals usually consist of 32 notes and therefore there will be 32 chains of resistors consisting of a 10 MΩ in series with a 2.2 MΩ. These are passed through central and upper and lower holes and the centre point is made firm and taken to each pedal contact. The 2.2 MΩ resistors are all joined at the bottom and this is the pedal bus-bar, taken to the main keyboard input as already shown. The top of each 10MΩ resistor is then taken to each note, working from the bottom C upwards in turn for the desired 32 notes. Any number of pedals may, of course, be used and it is not essential to use 32. As already described the first 11 notes are produced by making harmonic beats, coupling the bottom C to the G above through a 20 MΩ resistor. C is coupled to A through a 20 MΩ resistor and so on for the first 11 notes. At the second C on the pedal keyboard, however, the coupling changes. The 20 MΩ resistor is still employed, but is taken down to C on the main distribution strip, so that a beat is obtained by mixing the two Cs, and this process is continued for the remainder of the pedals. To accommodate the new strip it may be mounted on the rear of the screening

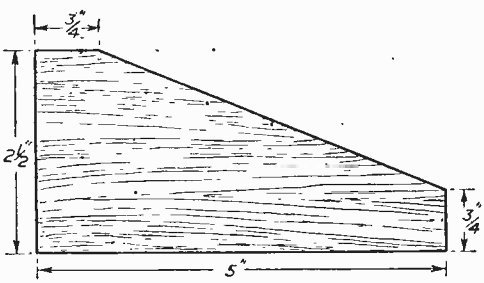


*Fig. 2.—Constructional details of the "flats" for the pedals.*

box, or placed slightly in front of the main distribution strip, and the box made sufficiently large to cover it. The wiring is best carried out in screened cable, and as there is a noticeable shortage of 32-point plugs and sockets, it is necessary to use two or three different

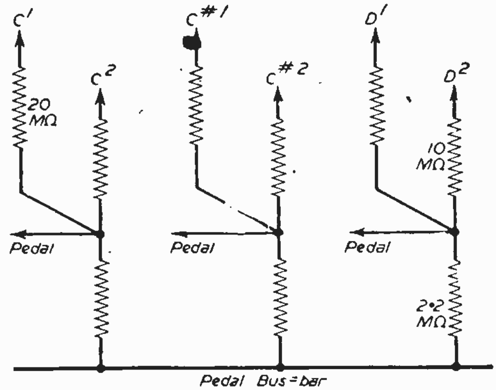


*Fig. 3.—Part circuit of the pedal manual.*

plugs to accommodate the leads. I used Belling-Lee 10-way plugs and sockets, but the various ex-service Jones plugs may be pressed into use. Alternatively, if the instrument is not to be portable, the wiring may be soldered into position without any plugs and sockets.

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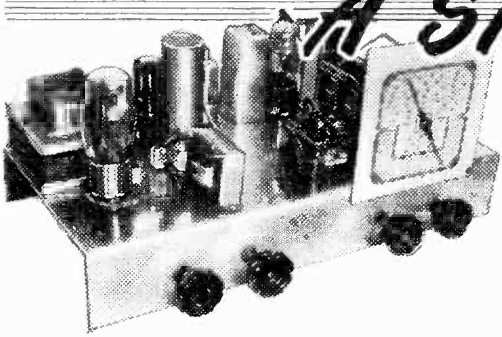
# M.R.U.A. Victory

THE Mobile Radio Users' Association has won its first major triumph: the reduction of the land mobile radio licence fee from five pounds per annum to three pounds. The association has consistently pointed out that mobile radio users receive no service in return for this fee and that no similar fee is levied in the United States of America. They will continue to press for further reductions in fees payable and for the removal of anomalies.

The announcement of reduced fees is published in a Statutory Instrument (No. 439) which, in conjunction with another Instrument (No. 438), has been laid before Parliament by the Postmaster-General. It is of interest to note that the right of the Postmaster-General to levy any fees has been challenged by the Colchester engineering firm of Davey, Paxman & Co., Ltd., who issued a writ against the Post Office some time ago.

The Chairman of the Mobile Radio Users' Association, Capt. L. P. S. Orr, M.P., who has been a tireless advocate of the rights of mobile radio users, both in and out of Parliament, has tabled a Prayer to annul these Instruments. His object in doing so is to ensure full parliamentary discussion of the issues raised and to present the views of users of mobile radio. One anomaly which he hopes to raise concerns the difference in fees as between Police and Fire services, who are to pay two pounds per annum irrespective of the number of stations involved, and Ambulance services, who will pay at the rate of three pounds per station, as will other land mobile users.

# A SIX-VALVE AC Superhet



AN EASILY-BUILT RECEIVER UTILISING A COMMERCIAL COIL PACK

THIS design is intended for the constructor who requires a rather higher level of sensitivity and selectivity than is provided by the simpler superhet circuits. It can be relied upon to give very good results, with high sensitivity, selectivity adequate for all ordinary purposes, and ample volume with good tonal quality of reproduction. Excellent loudspeaker reception of many stations which are not normally well received with the smaller type of set can be anticipated, even with a poor aerial.

The circuit is illustrated in Fig. 1, the coil pack being omitted since wiring in this unit is already completed in the specified pack. A radio-frequency amplifier is used before the frequency-changer, which increases selectivity and sensitivity, and also greatly reduces second-channel interference and whistles which can arise when no such stage is present. The coil pack provides bottom-end coupling on both long and medium waves, with separate primaries for coupling on short waves, and a high level of efficiency is maintained over all frequencies tuned. The necessary coupling condensers and oscillator padders are already incorporated in the coil pack, which is in two sections, permitting separation of aerial and F.C. circuits. As a result, no difficulty arises in maintaining complete stability.

Common screen grid or cathode circuits have not been used for any of the stages, as is sometimes done in the interest of economy. This avoids any stray and undesirable back coupling. Additional smoothing for the early stages is obtained from the 5 K$\Omega$ resistor and 8 $\mu$F condenser, and residual hum is of a very low level.

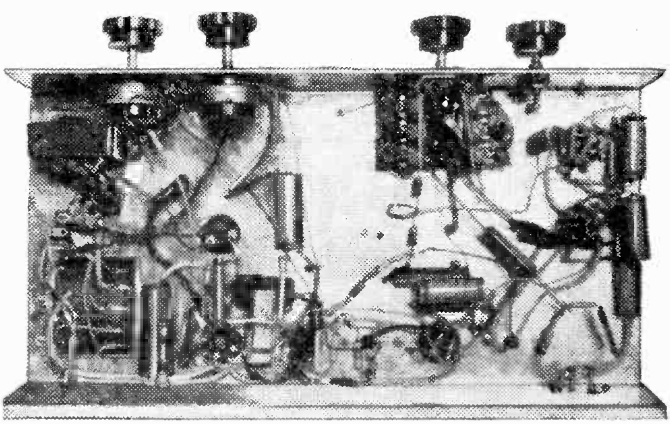
A degree of negative feed-back is obtained from the 1 megohm potentiometer, which also acts as a variable control permitting adjustable feed-back of higher frequencies via the .0005 $\mu$F condenser. This arrangement was found to act as an efficient tone-control, while also amply reducing any tendency towards undue emphasis of higher frequencies which may arise with a single output valve of this kind.

The usual AVC circuit is provided, and a manual volume control integral with the on/off switch. The circuit makes use of robust and easily obtainable octal base valves of popular type which can be purchased either new or as ex-government surplus. These types should continue to be available for a long period and no difficulty should be encountered in obtaining replacements at some future date if necessary.

The receiver is not built upon "economy" lines, the standard of performance having been considered more important in the present instance. Nor has any attempt been made to keep dimensions down, especially as this usually makes construction more difficult.

### Chassis Details

The chassis is of 16-gauge aluminium, 8in. by 16½in. by 2½in. deep. The general layout is shown in Fig. 2, and the positions of the valveholders may conveniently be marked out first. The three rear holders have their centres 1¼in. from the back of the chassis. Measuring from the right-hand edge of the chassis, the I.F. stage (6K7) is 5in. to the left. A further 3½in. is measured to the D.D.T. stage (6Q7) holder centre, followed by 2¼in. to the output (6V6) holder centre. The rectifier (5Z4G) is situated with its centre 3in. from the chassis front and 2in. from the left edge; while the centres of R.F. (6K7) and F.C. (6K8) holders are 1½in. from the right edge, respectively 1½in. and 3¾in. from the front. When these holders have been correctly positioned, the other components may readily be set out from Fig. 2.



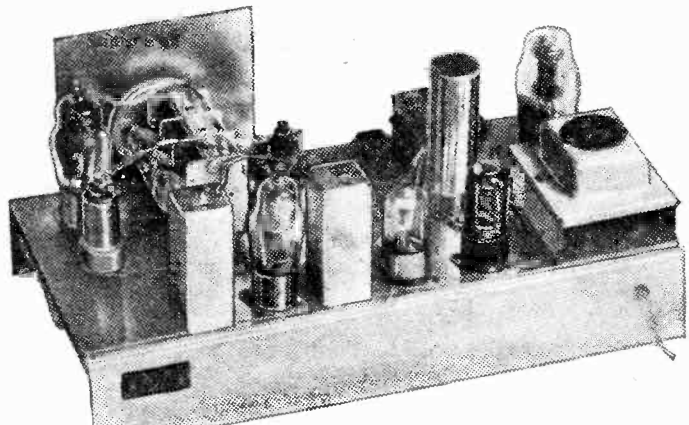
*View of the underside of chassis showing wiring.*

The mains transformer is of drop-through type, requiring a rectangular cut-out. Two bolts secure it to the chassis. A hole is also necessary so that the tags of the 8 plus 16 $\mu$F condenser may project, the can and fixing clip of this component being negative. Other holes are required under the I.F. transformer cans, under the tuning condenser, and for leads to pass through as shown in Fig. 2.

The tuning condenser may be mounted, but the dial should be left off until the receiver is completed. The chassis can then be placed upside-down without difficulty, so that under-chassis wiring can be undertaken.

**Notes on Wiring**

Components and connections under the chassis will become apparent from Fig. 3, and wiring may



*Three-quarter rear view of the receiver.*

best be undertaken stage by stage. An examination of Fig. 3 will show that most of the components associated with one stage are separate from those of other stages, and beginners may find it helpful to remember this.

When the R.F. stage is wired, one lead is taken through the chassis, under the gang condenser, and to tag 7 of the small coil pack. The grid (top cap) of the R.F. valve is wired to the top tag of the front section of the gang condenser, the lead being screened as in Fig. 2. A connection passes from the lower tag of this section of the condenser to tag 3 of the coil pack.

The cap of the F.C. valve is similarly wired to the rear section of the gang condenser, as shown in Fig. 2. A lead from this section passes down through the chassis to the tag of the switch illustrated in Fig. 4. This connection is screened, as will be seen from Fig. 3.

The primary of the first I.F. transformer is taken to F.C. valve anode and H.T. line. The

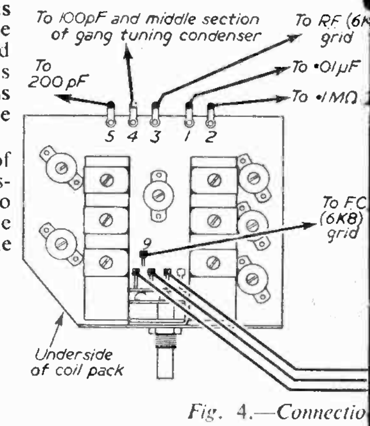



*Fig. 4.—Connectio*

secondary of this component goes to I.F. grid and A.V.C. line, the former connection being screened and emerging from the top of the transformer screening can.

The primary of the second I.F. transformer is wired to I.F. valve anode and H.T. line, the secondary going to diode and 100 pF condenser.

Other leads which pass through the chassis will be seen from the diagrams. Where leads are screened, proper braiding should be used. The braiding is cut

**COMPONENT LIST**

3-gang .0005 $\mu$F condenser, dial assembly and drive (Osmor).

3-Band RF Superhet coil pack, complete (Osmor).

Fixed Condensers: 4 of 100pF, 200pF; 2 of 500pF; 2 of .002 $\mu$F; 3 of .01 $\mu$F; 8 of .1 $\mu$F, 8 $\mu$F 350V., 8 plus 16 $\mu$F 250V., 25 $\mu$F 25V., 50 $\mu$F 50V.

Resistors: 240 ohm, 1 watt. 2 of 250 ohm, 300 ohm; 2 of 5K $\Omega$, 6.8K $\Omega$, 10K $\Omega$; 2 of 47K $\Omega$; 4 of 50K $\Omega$; 2 of .1 megohm; 2 of .25 megohm; 2 of .5 megohm; 2 of 1 megohm.

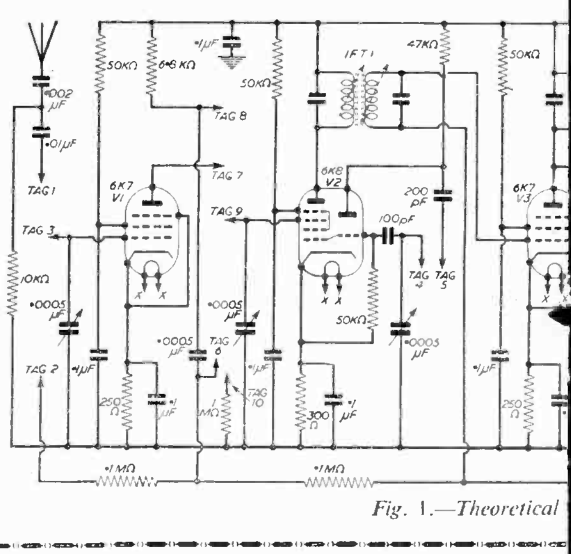
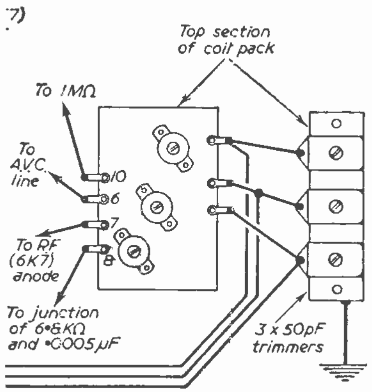



*Fig. 1.—Theoretical*

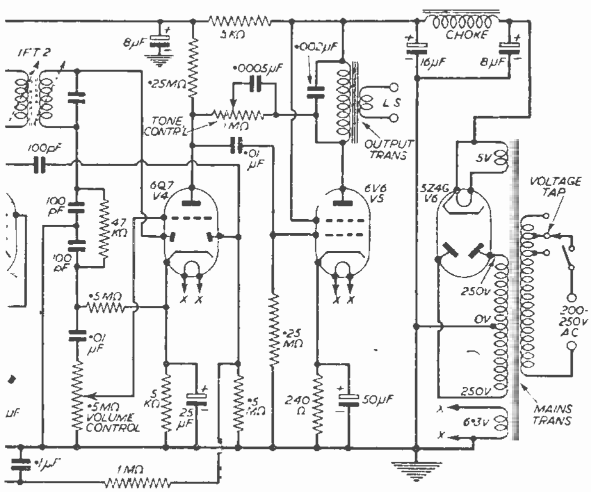
back, lightly bound with connection wire, and the joint soldered. The lead joined to the braiding is then returned to the chassis, and this earthing connection should on no account be omitted. If it is, severe crackling may arise, due to intermittent contact between braiding and chassis, or no screening effect at all may be obtained.

The condensers of larger capacity have polarity indicated, and this must be followed. The small condensers may be wired in either way, though where the




ns for the coil units.

.1 μF condensers have a band, or the letters "OF" (denoting Outside Foil) this end of the condenser should preferably be earthed to the chassis. In the diagrams, connections to the chassis are marked "MC." These are best made by soldering the connections to tags secured under convenient bolts. To avoid hum, no other connections should be taken to those chassis connections which are used to complete the heater circuit. This is a most important point.

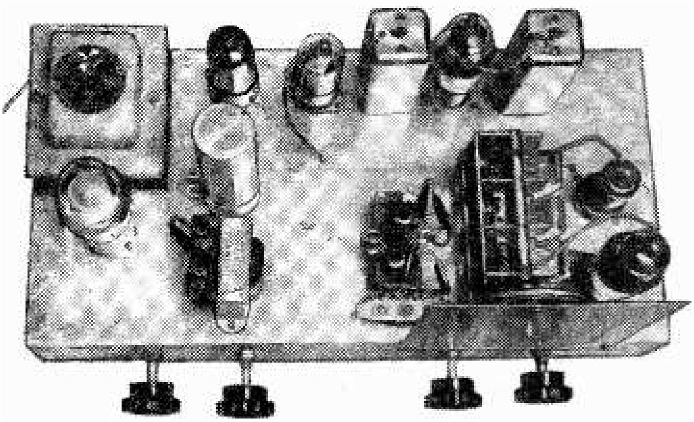



circuit of the 6-valver.

### The Coils

The nine tuning coils, together with padders, are ready wired. The smaller section of the pack is mounted above the chassis, a small bracket being cut for this purpose. This section, with its three coils, will be seen in Fig. 4. The three associated trimmers are not connected, and must therefore be wired to the tags as shown. The 3-bank trimmer is mounted on long bolts or pillars, this providing the earthing connection to chassis. Three leads pass down through the chassis to the spare tags left on the switch and care should be taken to connect these in the correct manner so that S.W., M.W. or L.W. coils are appropriately selected.

In the case of the sub-chassis pack, the trimmers are ready wired in and it is only necessary to take connections from the rear tags as illustrated in



*Plan view of the receiver.*

Fig. 4. The pack chassis should make good contact with the front runner of the receiver chassis, the fixing nut being tightened securely.

It should be noted that Fig. 4 is a schematic diagram showing connections, and does not illustrate the actual layout of the components. It can, however, be followed when wiring up.

### Speaker, Etc.

An output transformer is incorporated on the chassis, leads to this passing through the chassis. With the usual 2-3 ohm transformer, a 2-3 ohm

**COMPONENT LIST**

- .5 megohm potentiometer with switch. 1 megohm potentiometer.
- 6 octal valveholders.
- 2 465 kc/s IF transformers.
- Smoothing Choke (Osmor).
- 5,000 ohm 50mA output transformer (45:1 for 2-3 ohm speaker).
- 4 knobs.
- Elstone 6.3V., 250/0/250V. 100mA, 5V. mains transformer.
- Chassis, screened braiding, wire, etc.
- Valves : 2 of 6K7, 6K8, 6Q7, 6V6 and 5Z4G.

speaker able to handle 3 to 5 watts is required, and it should be mounted on a baffle, or enclosed in a cabinet, for best results. With no cabinet or baffle, reproduction will be poor.

The adjusting plug of the mains transformer should be placed in an appropriate socket, the next-highest socket being selected if the exact mains voltage is not available. The receiver must never be plugged into D.C. mains.

The tuning drive cord is passed round the driving spindle and taken down through the slot in the tuning

(*Continued on page* 421)

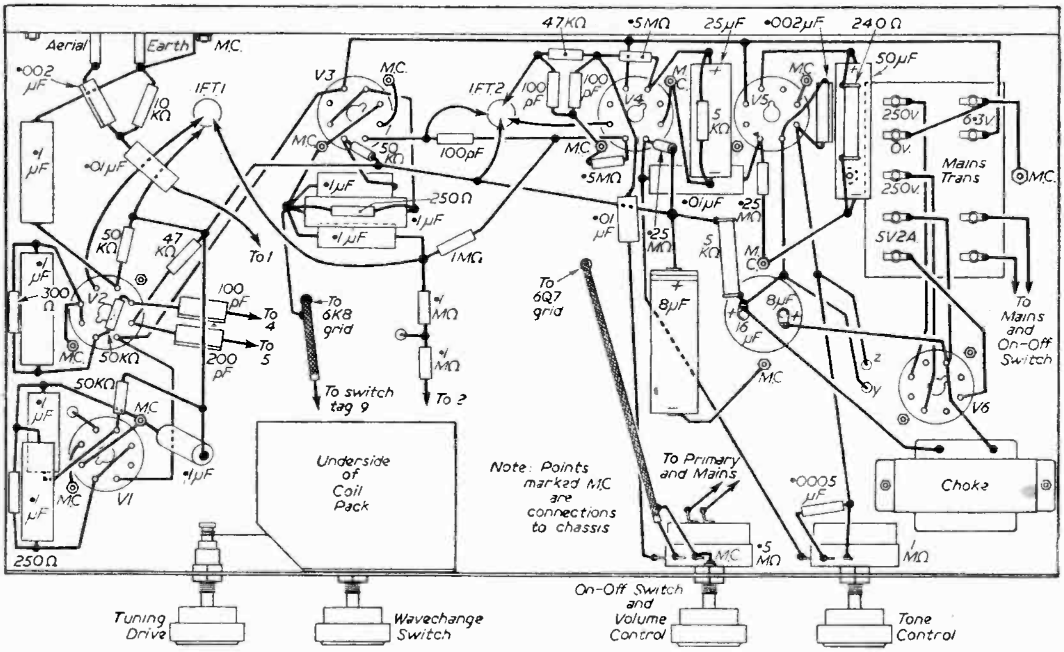
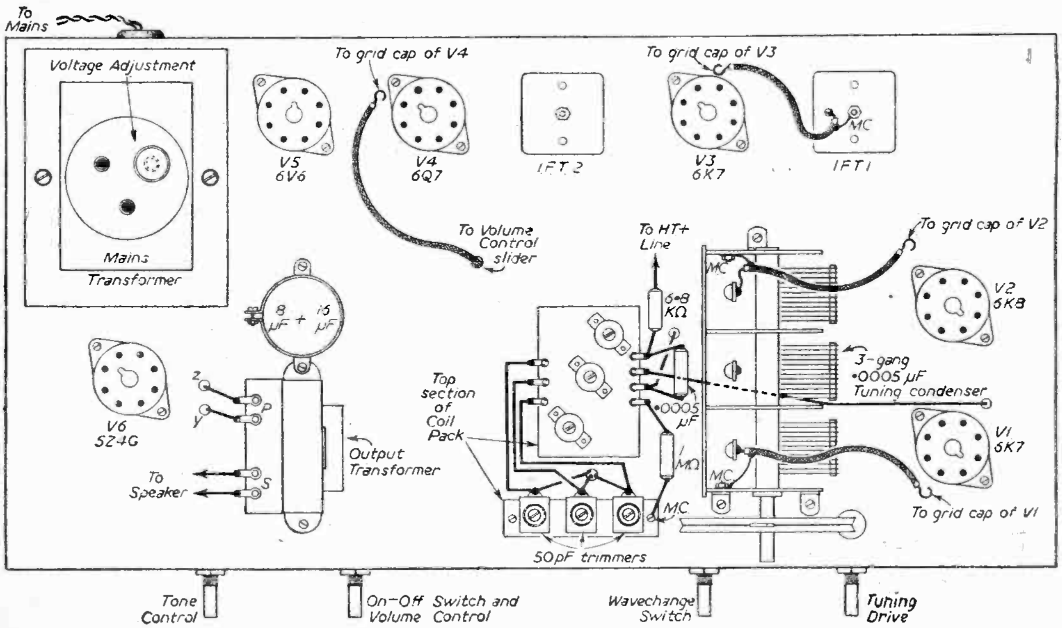



*Fig. 2.—(Above) and Fig. 3 (below).—Above and Below Chassis Wiring.*



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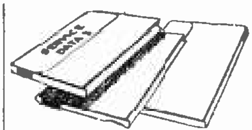
Full constructional details of this superhet and of the Picnic Player unit which, by the undoing of four screws, slips into the cabinet in place of the radio, will be found in our booklet "The Stroller," price 2/6 (returnable if parts purchased). Cost of portable cabinet and all parts for "Stroller" including valves, speaker, but not batteries, is **£8 17s. 6d.** (H.P. deposit **£2 19s. 2d.**), carriage 5/-. Cabinet available separately, price 37/6, plus 3/6 postage.



### SERVICE DATA

100 service sheets, covering British receivers which have been sold in big quantities, and which every service engineer is ultimately bound to meet. The following makers are included: Aerodyne, Alba, Bush, Cossor, Ekco, Ever-Ready, Ferguson, Ferranti, G.E.C., H.M.V., Kolster Brandes, Lissen, McMichael, Marconi, Mullard, Murphy, Philco, Philips, Pye, Ultra. Undoubtedly a mine of information invaluable to all who earn their living from radio servicing. Price £1 for the complete folder.

Our folder No. 2 consists of 100 data sheets covering most of the popular American T.R.F. and superhet receivers "all dry," etc., which have been imported into this country. Names include Sparton, Emmerson, Admiral, Crossley, R.C.A. Victor, etc. Each sheet gives circuit diagrams and component values, alignment procedure, etc., etc. Price for the folder of 100 sheets is £1. Post free.

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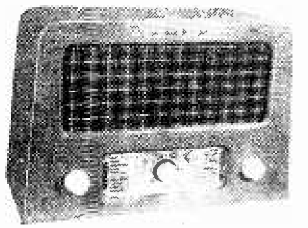

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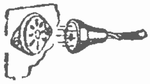

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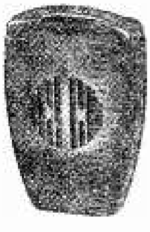

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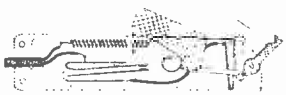

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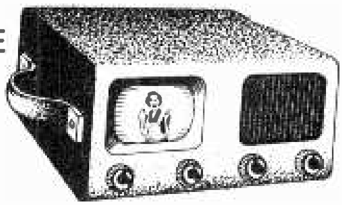

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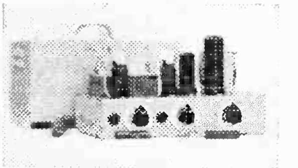

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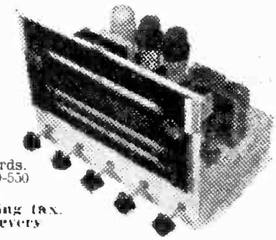

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drum, where it is knotted and kept under tension by means of the spring supplied. No backlash or slip should be encountered, and the holes through which the cord passes must be sufficiently large to prevent the cord fraying against the chassis. The dial should be bolted in place, and the pointer be placed horizontal, with the tuning condenser fully closed.

A good aerial and earth will be found helpful in obtaining maximum volume from weak, distant stations. Many stations may, however, be received at adequate strength with no earth and a poor aerial. A longer aerial, can, however, result in better reception since signal-to-noise ratio is improved, and a larger input is available for A.V.C.

**Alignment**

Though coils and I.F. transformers are to some extent pre-aligned, increased sensitivity may be obtained by aligning when the receiver is completed. Good results, with approximately correct dial-readings, should be obtained without any such adjustment—if not, wiring, etc., should be checked. If no signals are obtained, random adjustment of trimmers, etc., should not be undertaken, since the fault will lie elsewhere, and alignment may be upset. When, however, good results are being obtained, *careful* adjustments may then be made. In this way it was found that very accurate dial-readings throughout all bands could be achieved, with high sensitivity on all frequencies.

A strong local station should first be tuned in, and its volume kept down by removing the aerial and earth, or by using a very short piece of wire for aerial. The adjusting screws of the I.F. transformers should then be turned, one by one, until maximum volume is obtained. An insulated tool should be used for this and all other adjustments. A screwdriver with a metal blade is not suitable, since its presence will modify stray capacitances and also alter the inductance of a coil into which it is introduced. When no further adjustment of any transformer screw brings about an increase in volume, the transformers may be left.

The set may now be switched to M.W. (switch in central position) and a station about one-quarter from the high-wavelength end of the band tuned in. If the pointer indication is incorrect, the oscillator core is *carefully* turned, the tuning control meanwhile being manipulated to keep the station correctly in tune. In this way, a correct dial reading will be found. The tuning control is then left untouched and the aerial and F.C. signal-frequency coil cores (M.W.) adjusted to bring volume up to maximum. As the cores are screwed in and out, a definite tuning point will be found for them—this is the correct setting.

A station about one-quarter from the lower-wavelength end of the M.W. band is then tuned in and the oscillator trimmer (M.W.) adjusted for correct dial-reading. The other M.W. trimmers are then adjusted for maximum volume.

It is important to keep signal strength down by choosing very weak stations, or by using a poor aerial—*not* by turning back the volume control. The procedure outlined above should also be repeated at least twice, since adjustment of the trimmers makes some readjustment of the coil cores necessary.

The coils and trimmers used for each band are wholly separate from those in circuit when other bands are tuned. The L.W. band may therefore be treated as explained, the three L.W. coils and three L.W. trimmers receiving attention. The S.W. band can then be aligned, the three S.W. coils and three S.W. trimmers being adjusted.

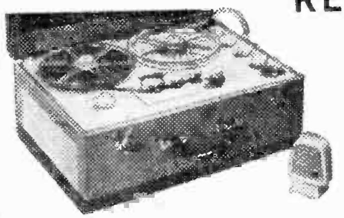
## A SIMPLE SIGNAL GENERATOR

(*Continued from page* 402)

**Construction**

The original model was made up on a small, wooden chassis covered with copper foil, and a small panel in the front on which are mounted the .0005 $\mu$F medium and long-wave tuning capacitor, that of .0001 $\mu$F for short waves, the switch for shorting out the long-wave winding, and the short-wave band selector switch. At the rear are mounted the four-way switch for selecting the range and three sockets marked Output 1 and 2 and Earth. On the front panel may be fixed a piece of thin, white card or other suitable material on which may be marked positions of the switches and various calibration details. Calibration is easily carried out with the aid of an ordinary three-waveband receiver such as is in normal domestic use in most homes to-day. Dealing with short waves first, the coil covers three bands of approximately 13-25 metres, 20-45 metres and 40-85 metres ; setting the signal generator to one of these ranges and connecting the " Earth " socket to chassis of the radio set together with a lead from one of the output sockets to the receiver's aerial terminal, the receiver is tuned to a similar waveband to the generator. The latter can then be tuned and indications made of various frequencies over the band. Each of the short-wave bands can be treated similarly and, as this is not a laboratory precision instrument, one or two frequency-indicating points spread over the band to serve as guides for trimming receivers. The medium and long wavebands can be calibrated in the same way. The two I.F. coils need a little care for exact calibration, the simplest method being to feed the output from the generator into the I.F. circuit of a superhet of which the intermediate frequency is known. For instance, if the domestic receiver is a superhet employing 465 kc/s I.F.s (and if it is fairly modern they are almost sure to be in this region), the generator output can be clipped on to the top-cap of the I.F. amplifying pentode, the unit being set, of course, to operate on the 465 kc/s coil. The trimmer is then set to the point where the modulation note is at maximum strength in the speaker of the receiver. It will probably help to use the No. 2 output terminal with the condenser adjusted for a fairly weak note. The other method is to connect the output of the generator to the aerial terminal of the receiver (it need not be a superhet), which is tuned to 322.5 metres on the medium waveband. If this cannot be found exactly, Brussels II station on 324 metres (926 kc/s) will be near enough. The trimmer is adjusted for maximum output of the note in the speaker. Here we are using the second harmonic for tuning purposes, that is twice our required frequency of 465 kc/s, or 930 kc/s, which is 322.5 metres. When the optimum trimmer position is found it may be fixed with a spot of wax or cellulose adhesive. If the 110 kc/s coil is included it may be calibrated in the same way by using the second harmonic. The receiver should be tuned to 1375 metres on the long wave, but the Oslo wavelength of 1376 metres (218 kc/s) will suffice.

# THE *Editor* TAPE RECORDER



A Review and Test Report

THIS particular product is claimed to be the smallest fully automatic mains-operated tape recorder on the market. It actually measures 17in. by 12in. by 7½in. and is finished to resemble an attaché or travelling case. The sample we tested was finished in two tones, with gilt-finished hinges and fittings. The lid is removable and the desk is finished in the now popular linen-finished formica. All the desk fittings, control knobs, etc., are in white or cream and the mains lead and microphone are housed, when not required, in a section at the rear of the recorder, access to which is gained through a small door. The left-hand side of the cabinet is finished off with a plastic grille, behind which is mounted the elliptical speaker. The "control panel" on the right of the desk consists of a magic eye for indicating the modulation level, a combined volume control and on/off switch, treble and bass controls and a record-replay switch. Finally, there is a recessed pair of input jacks into which the microphone or other apparatus is plugged.

The two heads are of the half-width track type, utilising the upper section of the tape (this is an important point for those who wish to exchange recordings), the right-hand knob has three positions—off, re-wind and record/playback—whilst the left-hand knob provides high speed for forward and reverse and a record/playback position.

The amplifier employs six valves, EF40s being used in the two input stages, with an EL41 feeding the speaker and the recording head.

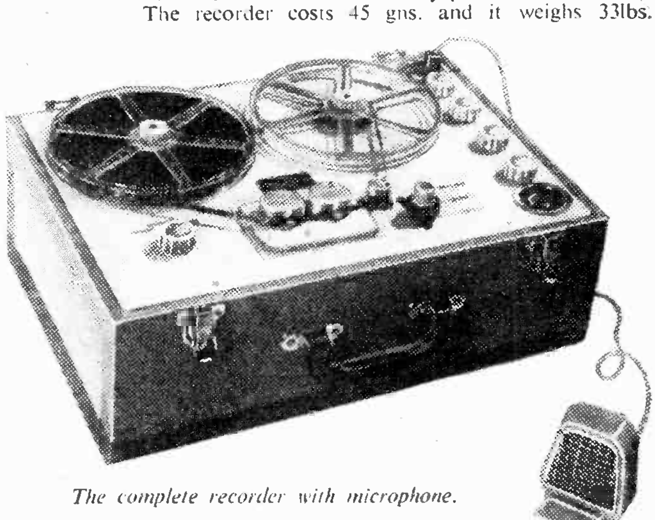
### The Circuit

The same type of valve is used as the oscillator, whilst the remaining two valves are the magic-eye and the mains rectifier. The valves are all operated at good levels, the H.T. line being 350 v., with adequate decoupling and screening incorporated to ensure a good hum-free and stable circuit.

The instrument is designed to accommodate 7in. reels, and the door which gives access to the mike, etc., should be left open during use to ensure adequate ventilation. Only one speed is available, and the instrument was tested with the standard microphone input. After threading the instrument is switched on, and the input level adjusted by means of the volume control so that the eye just flickers. As with most instruments of this type some initial experiments are desirable to gain an idea as to the amount of movement to allow for the recording material which is to be made. Overloading will prove difficult to erase, whilst if the material to be recorded varies in intensity over a very wide range it may be desirable to keep the volume control manually operated during recording. The instrument was tested with a length of our standard recording, containing portions of a broadcast performance, and with the microphone provided. The quality is quite satisfactory and may be adjusted in reproduction by means of the treble and bass controls to give any desired type of reproduction. The controls provide both boost and cut at extreme ends of the travel on both recording and play back. With these set to a mid-way position, the tone on the microphone is very natural and does not appear to suffer from any coloration. It may, of course, be changed, if desired, on replay. On musical items a good full-blooded tone is again provided without any adjustment of the tone controls. The amplfier may be used independently, if required, for other purposes, and the entire unit is built on a metal framework which enables it to be removed from the case intact.

### A Criticism

The only criticism we would make is that concerning the controls. These are not interlinked beyond a certain level and, therefore, there is some risk of damaging the tape. The rewind control may, for instance, be left on "reverse" or "forward" when one wishes to record, and the operating arm may be moved to record, with the result that the tape would start to move rapidly, perhaps in the wrong direction, and the user may quickly adjust the switch with the result that the spools will reverse in high speed and throw a loop in the tape. In trying to stop it the braking effect may then tear the tape. This is, of course, not a very serious point, as after a short period of use the operator will become familiar with the two knobs and make quite certain that they are correctly adjusted. In the early stages, however, failure of the controls to be interlocked may produce this trouble. The recorder costs 45 gns. and it weighs 33lbs.



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**RESISTORS.**—All values : 10 ohms to 10 megs. ¼ w. 4d. ; ½ w. 6d. ; 1 w. 8d. ; 2 w. 1/- ; High Stability, ½ w. 1%, 2/-.
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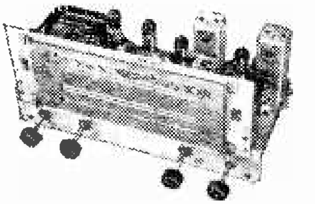

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| 6A8G | — | 8/0 | 6Q7GT | 10/0 | 8/9 | EB91 | — | 7/3 |
| 6AK5 | — | 8/6 | 6SH7 | 5/6 | — | EC31 | — | 3/6 |
| 6AM6 | — | 6/3 | 6SK7 | 6/9 | — | ECC31 | — | 7/0 |
| 6F6G | 7/6 | — | 6V6GT | 8/6 | — | EF80 | — | 10/6 |
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| 6J5GT | 5/0 | — | 916 | — | 7/9 | KTZ41 | 5/9 | — |
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# The Beginner's Guide to RADIO

The Fifteenth Article of a Series Explaining the Fundamentals of Radio Transmission and Reception. This Month Methods of Coupling Valves are Discussed with Particular Reference to Amplification

By F. J. CAMM

HAVING explained how detection of the signal takes place and the operation of the detector valve, we can now proceed to consider the work of the second valve.

We have already seen that the current flowing in the plate circuit of the first or detector valve fluctuates in accordance with the speech or music being transmitted from the broadcasting station. It follows that if a pair of headphones is connected in this circuit we could hear the signals, and by doing so we should be using the receiver as a one-valve set. Indeed, this method affords a simple test of checking the detector circuit if faults develop. The signals, of course, would not be very strong, and so we must amplify the currents by passing them through one or more other valves coupled to the detector circuit. According to the ratio of the transformer used, or other method of coupling, so will the signals be amplified in that ratio. If we use a three-to-one transformer between the detector and the second valve of the two-valve set, the amplification will be three. Readers will remember that we dealt with the transformation ratio in an earlier issue (see Figs. 67 and 68).

**R.C. Coupling**

Let us see how the second valve is connected up and how it increases the currents produced by the first. There are two methods of coupling in general use, one by means of a resistance and the other by the use of a transformer. In the receiver under discussion the resistance method is used. Now a resistance, as its name implies, is a device which resists the passage of an electric current, and its degree of resistance is decided by its ohmic value. Thus, a resistance having a value of 1,000 ohms has half the resistance of one of 2,000 ohms. You will remember that resistances may be connected either in series (as would be necessary if a single resistance of a required value was unobtainable or not available), or in parallel when it is desired to reduce the resistance. Sometimes resistances are connected in series-parallel, involving calculations according to Kirchhoff's Law. Of course, all conductors of electricity offer some resistance to current flow—even thick copper wire. The resistance of a wire is proportional to its length. That is to say, the resistance of 1yd. of a particular gauge of wire is half that of 2yds. of the same wire.

In the case of a resistance for coupling purposes the value is comparatively high.

**Potential Difference**

I have mentioned previously that an electric current flows in the plate circuit of the detector valve, and what is done is to include the resistance in the wire leading to the plate. It is known as an *anode resistance*, the term *anode* being another word for *plate*. Its presence causes a difference in pressure or voltage between one end of it and the other, just as a constriction in a water pipe would cause a difference in pressure between the inlet and outlet side (see Figs. 69 and 70). The lead to the plate of the valve is, of course, connected to H.T. positive. There is also another wire coming from the plate which leads first to a fixed condenser, called the coupling con-

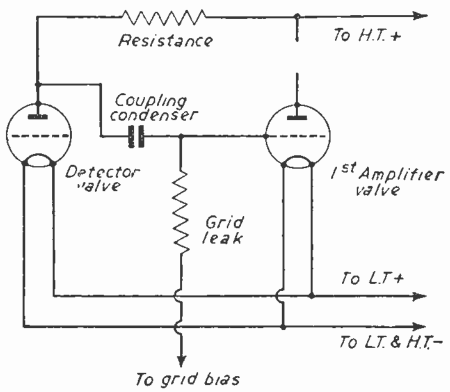


*Fig. 67.—Theoretical circuit of an R.C. coupling.*

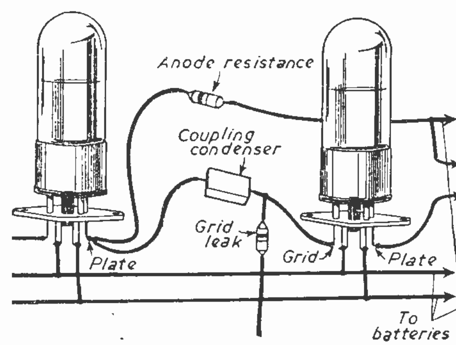


*Fig. 68.—Pictorial representation of Fig. 67.*

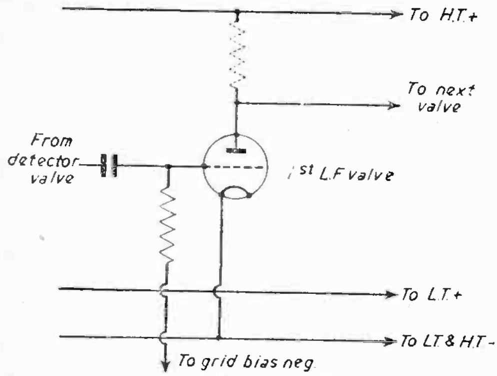


*Fig. 69.—Grid-bias may be applied through a grid-leak.*

denser, and thence to the grid of the next valve. This wire can be compared with a branchpipe rising from a water pipe just before the constricted part. The presence of the constriction causes water to rise in the branch pipe, whereas without it no water would enter it. If the upper end of the branch pipe were stopped up, the pressure inside would be the same as in the main pipe.

In the same way, the pressure or voltage in the wires of the condenser is the same as in the main wire from the plate to the resistance. We have seen that the current flowing in the plate circuit of the detector valve fluctuates in strength and speed in consonance with the variation in power and pitch of the music or speech which is being received. Naturally, this rise and fall in current will mean a rise and fall in pressure, and the pressure or voltage in the wire to the coupling condenser will rise and fall, too.

### How the Valve Amplifies

You will recall that when the grid of the detector valve becomes alternately positive and negative, it attracts and repels the electrons flowing from the filament to the plate and so increases or decreases their flow. Exactly the same alternating action takes place in the amplifying valve, although the grid in this case does not vary from positive to negative. In the case of a battery set the grid is connected by means of a *grid-leak* to the grid-bias battery, which keeps it negative all the time. The effect is the same, but instead of altering from positive to negative, the negative value itself varies. This variation in the negative state of the grid causes the number of electrons flowing from the filament to the plate to vary also, and it gives rise to a similar variation in plate current. The valve thus amplifies because small variations in the voltage of the grid cause large variations in the plate current.

The amplifying valve has a grid-leak just as the detector valve has.

### What is Low Frequency?

I explained that the speech or music sent out was represented by a variation in the amplitude (height) of the waves. This means a rise and fall in the strength of the H.F. currents. This rise and fall occurs at a comparatively slow rate, or *low frequency*. It is this L.F. variation in the strength of the H.F. current which corresponds with each vibration of the voice or of the musical instrument being broadcast. You will recollect that by means of the grid in the detector valve these variations in the strength of currents in the aerial circuit were able to make similar variations in the plate current.

There are thus L.F. variations in the plate current of the detector valve, and it is because the work of the following valves is to amplify these that they are called L.F. amplifiers. The one we are going to study is called the power valve, because it has to handle larger fluctuations in current than either of the other valves and produces more power.

Later on we shall see how two valves may be used in the output stage, connected in *push-pull* or *cascode*.

### The Transformer

In the set under discussion we are using an L.F. transformer to couple the last valve. Of course, a resistance could be used just as for the second valve, but a transformer has certain advantages. If we intended to use resistance coupling again we should insert a resistance from the plate to the H.T. battery (see Fig. 67).

(*To be continued.*)

CORRECTION: It should be noted that on the right lower corner of Fig. 64 of last month's issue, the draughtsman used the words "to L.T. negative and H.T. positive," instead of "to L.T. and H.T. negative."

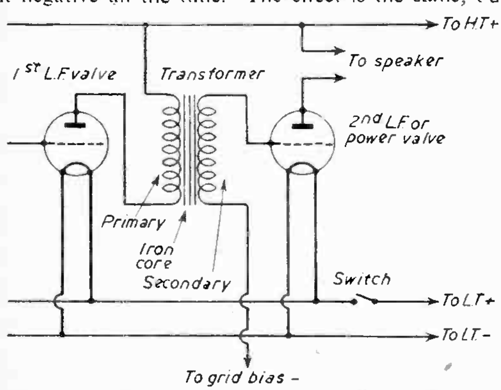


*Fig. 70.—Theoretical circuit of a transformer coupled stage.*

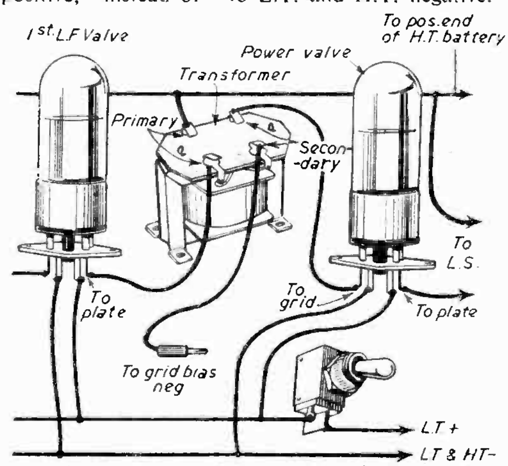


*Fig. 71.—Pictorial representation of the arrangement shown in Fig. 70.*

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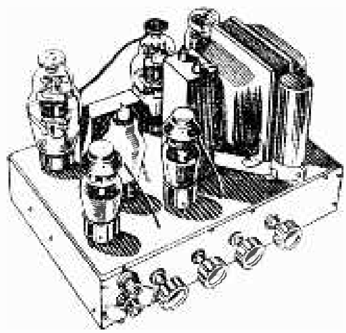

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| 16 μF 350 v. | 2/3 | 32 μF 350 v. | 2/11 |
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## THE EXPERIMENTER WILL FIND THESE CIRCUITS OF INTEREST

IT is generally recognised that the diode is one of the better means of detection. The term diode here, of course, includes the modern crystal diodes, which are almost identical in operation. The principle on which these work was first noticed by Edison, who just regarded it as another nuisance. Being of a more practical than scientific nature, the matter was recorded and forgotten. Later, an English physicist, Ambrose Fleming, wondered if this Edison Effect, as it was known, could be used for the rectification of A.C. for traction usage. The man did a large amount of research into the matter and the diode valve resulted. Other people had been experimenting with the rectification of radio waves with the aid of certain non-linear materials, and of these Hertzite became famous. Research has since those times followed two separate lines, and now we have two distinct and highly efficient types of diode, the thermionic and the crystal. For general radio work the two are interchangeable as far as the circuit is concerned. Of course, the thermionic diode requires a heater supply.

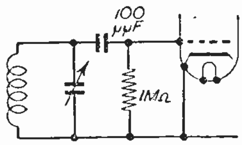


*Fig. 1.—Simple detector circuit, which is, in fact, a diode coupled to an amplifier.*

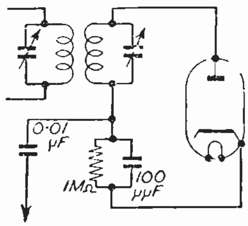


*Fig. 2.—This form of circuit is known as a series circuit.*

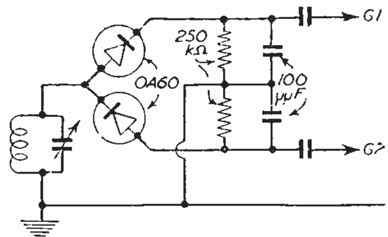


*Fig. 3.—A push-pull circuit utilising crystals.*

The simplest type of diode circuit is the shunt circuit. It can, in fact, be said that the leaky grid detector is a shunt diode circuit directly coupled to an amplifying valve. In this case, the control grid acts as the diode anode. This can be seen in Fig. 1. The grid " leak " in this circuit can either be across the condenser or between grid and cathode, as is shown in the diagram. The series circuit is shown in Fig. 2. It is basically the same in action and is used for superhet receivers, as provision for a volume-control is included. Both of these circuits give an output that is negative.

A positive output, or one in which the polarity of the rectified signal is reversed, can be obtained by the use of a diode connected in the reverse direction. This cannot be carried out with the normal multiple double-diode triode, but it can be arranged with some of the valves with separate electrode assemblies, such as the 6H6 or the new Mullard EABC80. Crystals provide another solution to the problem. If, then, we can get a reversed polarity by the use of a reversed valve for detector, why not use two detectors and get a push-pull output? It is, in fact, just as simple as it sounds. Looking for a moment at Fig. 3, we see a simple push-pull output circuit that can either be used with a superhet or a T.R.F. receiver. One of the advantages of the push-pull detector is that the output contains even harmonics instead of odd. The harmonics are introduced by non-linearity in the diodes at very low input levels. This trouble has been almost eliminated in modern valves, and can only be detected by using a 100 per cent. modulated signal and then measuring the distortion. The second push-pull detector circuit (Fig. 4) uses one of the latest valves, the EABC80. This has two signal diodes and an A.V.C. diode. The latter shares a cathode with one of the signal diodes and the triode, the other signal diode is independent, and this allows a push-pull circuit to be arranged. If required, a stage of equal voltage gain to the triode section of the EABC80 can be obtained by the use of an EBC41. The triode sections of the two valves are identical.

Voltage doubling in the detector can be obtained from the circuit shown in Fig. 5. This circuit shows the two diodes in series; the two condensers are also shown in series, but as regards the charging are in parallel with the coil and diodes, but for discharge purposes are in series. This voltage doubling has the effect of providing four times the power output for the same signal, and if the detector is an EABC80 and the output valve is an EL41, then with an R.F.

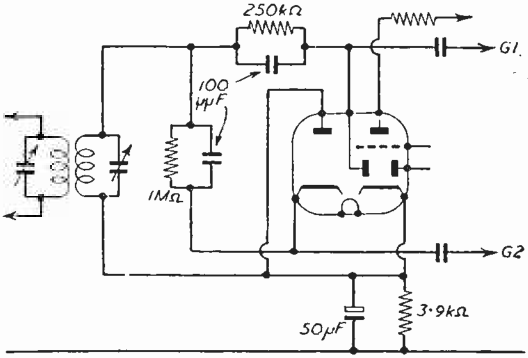


*Fig. 4.—This push-pull circuit employs a valve—the EABC80.*

voltage at the detector of only one-twentieth of a volt, full output power will be obtained. It is interesting to note here that the conventional 6Q7 and 6V6 are being used at the same degree of modulation of R.F. So much for modern valves and developments in circuitry. Since it was mentioned earlier in the article that the distortion at low levels of detection with R.F. is greater than at high, it is only correct to mention that the amount of distortion introduced with the EABC80 at very low levels is extremely small due to their exceptionally low diode impedance. The third diode of the EABC80 is designed for use as an A.V.C. detector in the normal manner, with the delay voltage being developed across the cathode resistor.

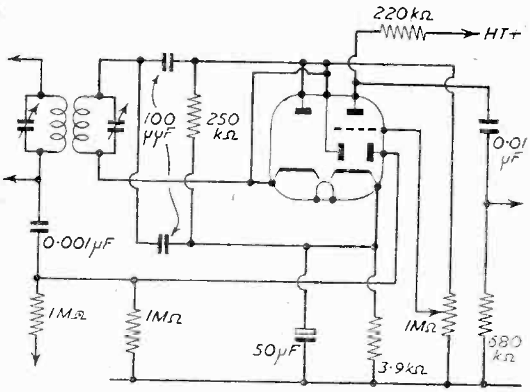


*Fig. 5 (right).—Circuit using an EABC80.*

# News from the Clubs

**CLIFTON AMATEUR RADIO SOCIETY**
**Hon. Sec.:** C. H. Bullivant (G3DIC), 25, St. Fillans Road, London, S.E.6.

THE acquisition of the workshop is proving a great asset and every alternate Friday evening a group of members can be found constructing new equipment, repairing faulty equipment or aligning receivers with the club's own test gear. On April 23rd Mr. D. Bennett gave a talk on Direction Finding and he gave details and recommended procedure to be adopted in the forthcoming D.F. Field Days, the first of which is being held on Sunday, June 13th.

On May 1st a party of members visited the Deptford Power Station and were given a cordial welcome.

Visitors and new members will receive a warm welcome any Friday evening at the club rooms, 225, New Cross Road, S.E.14.

**READING RADIO SOCIETY**
**Hon. Sec.:** L. A. Hensford (G2BHS), 30, Boston Avenue, Reading, Berks.

AT the meeting on April 24th a successful junk sale was held. The programme for May included talks on "Power Units and Transformers," by Mr. C. Thomas, and "Measuring and Test Instruments," by Mr. I. G. Benbough. Arrangements are being made to visit the British Electricity Authority's Power Station at Earley in the near future.

**BRADFORD AMATEUR RADIO SOCIETY**
**Hon. Sec.:** F. J. Davies, 39, Pullan Avenue, Bradford, 2.

THE Bradford Amateur Radio Society held its annual general meeting on March 30th, when the following officers were elected: President, D. Skirrow (G3GFD); Vice-president, V. W. Sowen (G2BYC); Secretary, F. J. Davies; Treasurer, G. F. Browne (G3JMF).

An interesting syllabus is being arranged for the 1954-55 session and we invite anyone interested in any branch of amateur radio to get in touch with the secretary.

**SOUTH MANCHESTER RADIO CLUB**
**Hon. Sec.:** M. Barnsley (G3HZM), 17, Cross Street, Bradford, Manchester, 11.

THE club continues to meet at Ladybarn House, Mauldeth Road, Fallowfield, Manchester, 14, and the publication of last month's report resulted in three enquiries for details of membership of the club.

Our future programme of lectures is as follows:
June 18th.—"Transistors" by W. L. Robinson.
July 2nd.—Junk sale and general discussion.

**SOUTHEND AND DISTRICT RADIO SOCIETY**
**Hon. Sec.:** J. H. Barrance, M.B.E. (G3BUJ), 49, Swanage Road, Southend-on-Sea, Essex.

THE Hamfest this year took place in the ballroom of the London Hotel on May 8th, and marked the 34th year of existence of the Southend and District Radio Society. It was a successful evening in all respects.

The president, Mr. W. J. B. Fitch, and the chairman, Mr. J. L. Coss, were in control, ably assisted by their wives in the awarding of cups and distribution of prizes. Many of the latter had been donated by local and well-known radio firms.

Mr. C. Berners-Lee of Ferranti, Ltd., kept his audience absorbed while he explained the working of an Electronic Computer (electronic brain) at a recent meeting.

**LEICESTER RADIO SOCIETY**
**Hon. Sec.:** W. N. Wibberley, 21, Pauline Avenue, Belgrave, Leicester.

ON the night-morning of May 4/5th the L.R.S. top-band transmitting network assisted G3CCA to make the first all-transistor contact, and, without the aid of any thermionic valves, that station made contact with G6FO in Buckingham (a distance of 45 miles). Although this was followed at a later date by a successful contact with a Kentish station (over 100 miles). It is believed to be the first time in radio history that an all-transistor transmitter and receiver had been used for two-way radio contacts.

The meetings on July 5th and 19th will be devoted to members' nights, when discussion will take place on equipment which has been constructed by club members.

New members are always welcome at the Club Room, Holly Bush Hotel, Belgrave Gate, Leicester at 7.30 p.m.

**BIRMINGHAM AND DISTRICT SHORT WAVE SOCIETY**
**Hon. Sec.:** R. W. Yates, 28, Daimler Road, Yardley Wood, Birmingham, 14.

THE annual field day of the Birmingham and District Short Wave Society, takes place at Oak Farm, Catherine De-Barnes, Solihull, Nr. Birmingham on Sunday, June 7th. The call signs will be G2BON/P and G3DSM/P, and the following bands will be used: 20, 40, 80, 160 metres and 70 CMS.

Talks arranged for the June meeting are "Simple Cells and Accumulators," in the Basic Theory series of talks for the beginner, and L. F. Amplifiers as the main topic. New members and visitors are welcome at The Colmore Inn, Church Street, Birmingham, 1, on the second Monday of the month at 7.45 p.m.

**TORBAY AMATEUR RADIO SOCIETY**
**Hon. Sec.:** L. H. Webber (G3GDW), 43, Lime Tree Walk, Newton Abbot.

REPORT of meeting held at 7.30 p.m., on Saturday, May 15th, at the Y.M.C.A., Torquay.

In the unavoidable absence of the Chairman (G2GK), the meeting was conducted by G3JD. Final details for the RSGB NFD "A" and "B" Stations were settled—many members are taking part in this.

It was agreed to call the first meeting of the TVI committee at 7 p.m., on June 19th at the Y.M.C.A., Torquay, for the purpose of voting funds and other matters in connection with the committee.

At the next meeting of the society, on June 19th, at 7.30 p.m., Mr. Thommasson, of Exeter, has kindly consented to give a lecture on "Mobile VHF Operation"—members are asked to support this in full strength.

**WARRINGTON AND DISTRICT RADIO SOCIETY (G3CKR)**
**Hon. Sec.:** G. H. Flood, 32, Capesthorne Road, Orford, Warrington.

MAY 2nd, saw club members looking across the Cheshire Plain from Stretton golf links. The occasion being a very fine demonstration of portable 2-meter equipment by Ralph Taylor (G2HCJ/P), who is well known for his portable operation from those "rare" counties.

Future events:
June 12/13th. Portable Week-end Activity—Dark Lane, Higher Whitley, Cheshire.
June 15th. Business and Ragchew.
June 20th. Annual Social Outing—Trentham Gardens.
July 6th. Lecturettes for Beginners.

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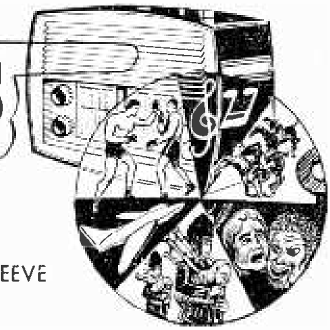


By MAURICE REEVE

### " Any Questions ? "

CONGRATULATIONS to " Any Questions ? " on its two-hundredth performance. It was good to have both Arthur Street and Ralph Wightman on the platform, for they are, by and large, the two most forceful personalities as well as being two of the shrewdest and wittiest members of the team or panel. I wonder which four the votes of the listening public would go to for the first four places ? I have also wondered this regarding the Sunday morning " Critics." Both programmes are only at their very best when they have a woman present. The Critics are particularly fortunate in this respect, as they have five places in which they can accommodate any one or two of five or six very brilliant and entertaining ladies.

### Correspondence on the Air

" Dear Sir " is one of the numerous programmes designed for the airing and publicising of questions of the moment. Designed on much more " popular," or, perhaps I should say, " less highbrow " lines than either " Any Questions ? " or " The Critics," it is rather like seeking one's points of view from *The Daily Bash* or *Bon Bouche* than *The Times* or *The Spectator*. Consequently, it seems to fall between two stools. The trouble would seem to lie in that it suffers from far too much commentary—padding and stuffing would be more appropriate terms—from its editor and introducer, Mr. Adrian Thomas, instead of being allowed to stand on its own two feet. The signature theme of the typewriters ticking merrily away is excellent and arouses an interest and an expectation which if it were the immediate prelude to some letters could be easily sustained. But, instead, a damper is thrown over the proceedings by an unnecessary, or an unnecessarily long, explanation of the subjects of the letters to be dealt with, recapitulations, to what extent public opinion is divided on the subject and how some people think such and such a thing is good and some think it bad and so on and so forth. Then after a few letters have been read the proceedings are repeated. If all this deadwood were cut out the programme could be speeded up and enormously improved.

### " Wit and Gaiety "

Listening to two numbers of " Life with the Lyons " and " Take It From Here " in close juxtaposition the former did not suffer in any particular from comparison with what, I suppose, most listeners would say is the more illustrious show of the two. The episode of the Lyons saga that I heard sparkled with wit and gaiety from start to finish.

That never-to-be-forgotten West Indian cricketer L. N. Constantine was given the " freedom of the air " for half an hour, and memorable use he made of it. Talking of Anglo-Colonial relations and of his own experiences in particular, Mr. Constantine talked beautifully, compassionately and feelingly. All critics with whom I came in contact " fell over themselves " in praise. I fell over myself.

### Sunday Serial

The Sunday evening serial, " The Mill on the Floss," is developing on dramatic and well-constructed lines, largely, I feel, because the characters in the story are being allowed to stand up for themselves instead of having, as used to be the case with these programmes, a wretched narrator doing all the talking and story-telling for them. The result is a play full of character and incident, as is the original masterpiece. The narrator, who is in the cast, does not speak more than is necessary to keep the weekly instalments held nicely together. The cast is excellent.

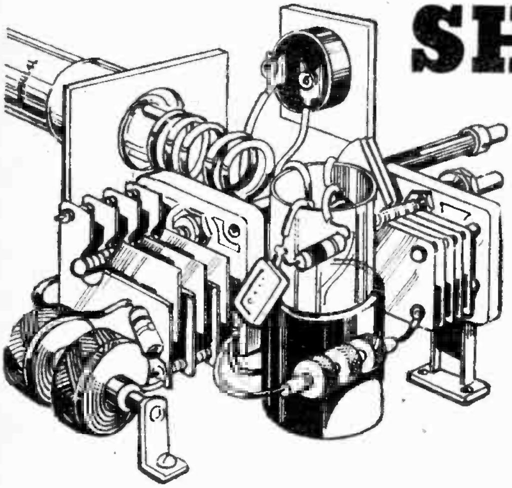
### " Variety Playhouse "

So far Cicely Courtneidge has not proved an adequate substitute for Vic Oliver as mistress of ceremonies in " Variety Playhouse." One can well imagine it to be a job that will take Miss Courtneidge some time to develop.

I was greatly taken by the conversation on Bunyan's " Pilgrim's Progress " between Malcolm Muggeridge and Aneurin Bevan, with the American scholar Dr. Lyman Bryson in the chair. Both speakers, of course, are at opposite ends of the political pole and each seemed to let these views influence his opinions on the famous book rather too much. They might have been more objective, though not if it had resulted in robbing the talk of its salt, of which there was a goodly though not too great a quantity.

### Drama

The plays of the month I enjoyed most were Pinero's " The Gay Lord Quex," Lydia Ragosin's " Order of Chivalry," Winston Clewes' " The Merry Month " and Elmer Rice's " Judgement Day." This latter was the most meaty and interesting, and concerned the taking of a political trial in an allegorical Communist State in the way they are alleged to be faked in the greatest of actual Communist lands. " Order of Chivalry " was a much less real seeming story of junketings in a Fascist State. Lord Quex was pleasantly nostalgic to some, historic to others. The change in manners and customs over a mere fifty years or so, revealed in plays of this genre, are truly astonishing.



# SHORT-WAVE SECTION

## BRITISH COASTAL RADIO STATIONS

By A. W. Mann

IN 1898 the East Goodwin lightship off Ramsgate, and the South Foreland lighthouse were equipped with wireless transmitting and receiving apparatus which established the first ship to shore radio contact.

Following this a number of shore stations were built and equipped. These were operated by Lloyds and the Marconi company respectively.

The stations were as follows: G.C.S., Caister, Norfolk; G.N.F., North Foreland; G.N.I., Niton, Isle of Wight; G.L.D., Lizard; G.L.V., Seaforth, Liverpool; and Cullercoats, together with two stations in Ireland which are no longer under the control of the British authorities.

While the fitting of wireless apparatus on board ship was not then compulsory, a number of far-seeing shipowners realised the advantage of being able to make direct contact with their vessels when some distance at sea, and commissioned the Marconi company to install the necessary equipment.

Later it was made compulsory that all ocean-going ships of 1,600 gross registered tons be equipped with wireless apparatus.

In 1909 the coastal radio stations operated by the two private companies previously mentioned were taken over by the Post Office authorities.

Compared with modern standards, the apparatus used in the early days of the coastal service was somewhat primitive. Those were the days of spark gaps, secondary and Leclanche cells, etc.

### Developments

Previous to the first world war, traffic was light, and station staffs few in number. The war, however, brought about a considerable increase in traffic and was responsible for further station developments and increased staff in order to cope with it efficiently.

Even though the thermionic valve had been developed and was available, spark transmitters were still in use. The valve was, however, used for signal amplification.

The effective range of the short-range transmitters was between 150-300 miles. At times traffic at the coastal stations was light due to ships being out of range. As they came within range, however, the operating staff were extremely busy.

The Devizes long-range station using a continuous wave transmitter covering a tuning range of 1,875-2,730 metres had an effective range of 1,500-2,000 miles, and could keep in contact with several of the larger ships when they were several days from port.

At this station the transmitters and receivers were located in the same building. This arrangement, however, had certain disadvantages.

When the new Burnham station was built and equipped the transmitters were transferred 20 miles distant to Portishead and operated by remote control from Burnham.

This proved to be most satisfactory as it enabled the simultaneous working of several ships to be carried on, and thus speeded up the work of the station.

### Long-distance Developments

The long-distance service which in 1925 was transferred from Devizes to Burnham, was carried

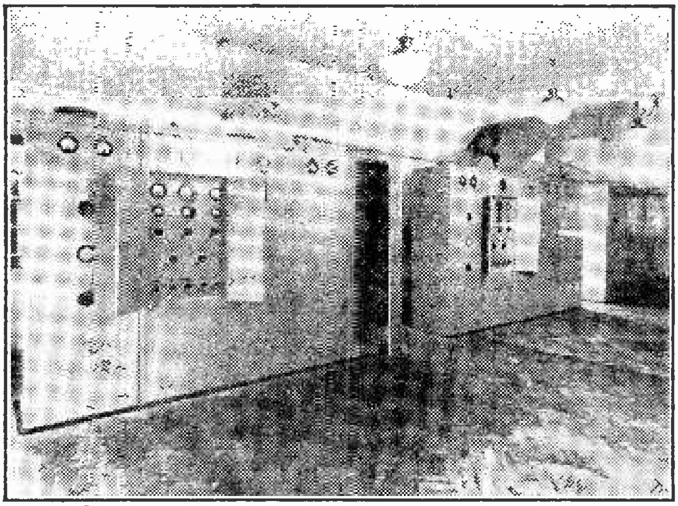
*The H.F. operating position at Burnham Radio Station.* (*Photo by courtesy of P.M.G.*)

out by three 110-160 kc/s transmitters and associated receivers, one to each transmitter unit. In the following year the first short-wave receiver was installed. At the beginning of the last war the number of transmitters at Portishead was increased to six and additional receivers were installed at Burnham, making a total of 15. As the traffic amounted to 3½ million paid words per year the additional equipment enabled the authorities to cope with the rapidly increasing demands made on it. In 1953 over 10 million paid words were handled.

**Modern G.P.O. Coastal Radio Stations**

Between the earlier coastal radio stations and their modern counterparts there is a vast difference. Not only are the station buildings built to house the radio and associated electrical equipment but to utilise it to the full.

Careful planning as to choice of site, suitability of subsoil, buildings layout and future development, and provision for the effective application of anti-electrical interference methods are essential.



*The transmitter room at Wick Radio Station.*

When it is required to operate distant transmitters from the receiving station by remote control a high standard of efficiency and reliability is desirable.

Where both transmitters and receivers are located on the same site it is necessary, in order to assure trouble-free operation, to build anti-interference screening into the walls and to glaze all window frames with wire mesh glass and effectively bond together and earth all metal ducting, etc.

Taking into account the amount of electrical machinery and associated equipment installed in modern coastal radio stations, the possibility of electrical interference and its effective suppression is a major problem.

As the number of radio-equipped vessels increases, so also does the amount of paid traffic handled by the coastal radio services. Lost time during which the station might be off the air due to breakdown must at all costs be avoided, and to insure against this, duplicate and other forms of stand-by apparatus is installed and available if and when required.

**Reconstruction**

Increasing traffic may tax the available facilities to such an extent that eventually a major reconstruction, as was the case at Burnham in 1946-1948, may be necessary. At Burnham 32 CR.150 Marconi communication type receivers are installed and the station staff number 115 members. The Portishead station includes eight two-channel transmitters amongst a grand total of 13.

Long watches with headphones, and tuning the receivers, can be rather fatiguing for commercial operators. That this is officially appreciated is denoted by the method of receiver mounting employed at the G.P.O. coastal stations, the receiver being sunk into the operating desk so that it may be tuned and the dials viewed at the most suitable angle.

Those who are interested in short-wave radio appreciate the value and usefulness of maps. This applies more especially to commercial radio operators, as maps greatly assist in the re-routing of messages and the locating of ships called, calling and worked by the G.P.O. coastal stations.

**Super Maps**

Burnham receiving station has what may be rightly considered as some outsize wall maps which are painted on sheet steel, one of them being 35ft. wide by 16ft. high. The reason why sheet steel is used is because it enables magnetic markers to be employed as the means of denoting the position and sailing direction of ships in various parts of the world and in defined areas.

This map shows the recognised ship and air routes, while another one shows the distress areas surrounding the British isles.

**Services**

The services provided by the G.P.O. coastal stations include short range traffic, telegraphy and telephony, medical aid, distress and casualty services, weather and warnings service, direction finding and long distance communication.

**Working Ships**

Working procedure varies, the long-distance area scheme being used in the case of ships of the British Commonwealth. This scheme divides the world into eight areas, each with its own radio station. This method has been found to be far more satisfactory than previous ones.

**Aircraft**

Communication between foreign ships and aircraft is carried out by direct contact. The procedure used in the case of the long-distance area scheme is somewhat complicated.

**Traffic Handling**

The busiest G.P.O. coastal radio stations are Wick in the north of Scotland, and Land's End. Wick deals with trawler traffic such as those fishing in the White Sea and Bear Island areas. Land's End handles traffic to and from ships in the English Channel.

### Medical Aid

Trawling is an arduous and at times a dangerous calling, especially in bad weather. There may be at some time an accident, or sudden illness which necessitates medical advice being sought, or the transfer of a member of the crew to hospital. The coastal services when contacted make the necessary arrangements with the minimum delay. If the trawler is fitted with radiophone apparatus the coastal station can make a direct link-up with the hospital via telephone land lines.

### Distress Warnings

Some of the larger ships are fitted with alarm apparatus. The idea of fitting such apparatus is so that notice of urgent messages about to be transmitted may be given in cases where the ship's operator is not always on duty. The coastal stations being equipped with apparatus which enables them to, as it were, trigger the alarm into operation.

### Safety

In order to assure the safety of his ship and crew, it is necessary that the captain should know just what kind of weather is to be expected, and act accordingly. The coastal services broadcast weather bulletins, gale warnings, and details as to navigational dangers, wrecks, etc.

### Subscribers

All coastal stations are fitted with apparatus for duplex working, and telephone subscribers can be put into direct contact with ships. Owners can call up their skippers, etc. In other stations, however, duplex apparatus is not available and the send-receive or "over" method must be used. Oban and Burnham, however, do not provide facilities for this service.

While many ships have direction-finding equipment available, this does not apply to all. A request from ships to the shore station for bearings to be taken enables the position of the craft at that particular time to be marked on the ship's chart. This, as a recent newspaper account proved, is very useful, especially in foggy weather.

### Short Range

This service is carried out by eleven G.P.O. coastal stations with a range of approximately 300 miles. As the various areas overlap effective coverage is assured. The international distress frequencies are 500 kc/s for the larger ships, using WT, and 2,182 kc/s for small craft using radiophone. Continuous day and night watch is kept on these frequencies.

The task of the coastal station operator is an exacting one calling for systematic searching and concentration, especially during stormy weather. While at intervals it may provide a thrill, busy periods with traffic piling up call for snappy operating. In spite of the long watches and hard work, some operators find time for a busman's holiday as licensed amateur operators during their off-duty periods.

### Super Efficient

As the illustrations which accompany this article show, the G.P.O. coastal radio stations combine orderliness with efficiency and are typically British.

### Licence Note

With reference to listening on the trawler and shipping bands secrecy regulations apply and should be observed, and interested readers are advised to re-read the regulations as outlined on the reverse side of their wireless receiving licence.

It may interest readers to know that British deep-sea trawlers fish as far south as the coast of Morocco. Other fishing grounds being near the Arctic Circle, Novaya Zemlya, Iceland, Faroes, and Lofoten Islands.

## New G.E.C. Transistor

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

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

All transistors are tested to ensure stability under emitter short circuit conditions up to a maximum collector voltage of $-25$ volts. The price is 37/6 each.

## Ship/Shore F.M. Link

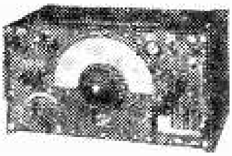
IN order to facilitate harbour communications at Hong Kong a comprehensive V.H.F. system has been installed there. The equipment was manufactured by The General Electric Co. Ltd., of England, and was installed by Cable and Wireless Ltd. It provides direct communication between ships in harbour and subscribers on the main Hong Kong telephone exchange and also affords a communication link between the ships themselves. The new system greatly simplifies loading and unloading operations.

When a ship enters the harbour, a portable battery-operated V.H.F. transmitter/receiver is taken on board and set up in a suitable situation. The ship is thus at once incorporated in a V.H.F. network covering the harbour and connected to the main Hong Kong telephone exchange.

Essentially the network comprises four groups of sub-stations, each group being allotted two wavelengths, one for transmitters and one for receivers. All the groups are linked directly to a main station set up at a permanent site on shore. This is connected to a C.B. cordless switchboard, which has five lines to the main Hong Kong telephone exchange.

The sub-stations are made up of mains-operated transmitter/receivers (fixed sub-stations) and battery-operated transmitter/receivers (mobile sub-stations).

**EX-A.M. RECEIVER TYPE R1155**



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5 Frequency ranges: 18.5-7.5 Mc/s; 7.5-3.0 Mc/s; 1,500-600 Kc/s; 500-200 Kc/s; 200-75 Kc/s
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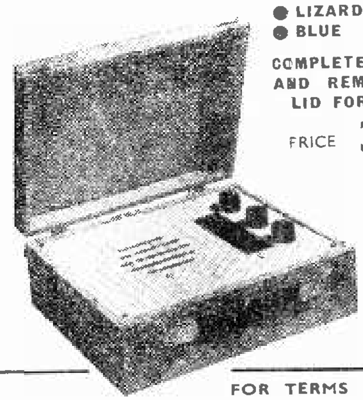

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# OPEN TO DISCUSSION

The Editor does not necessarily agree with the opinions expressed by his correspondents. All letters must be accompanied by the name and address of the sender (not necessarily for publication).

## Correspondent Wanted

SIR,—I am an enthusiastic reader of your excellent magazine, and I should like to establish correspondence through it with someone interested in the technology of radio for intercommunication ideas and results of experiences of our own.—JOSÉ MARIA FERNÁNDEZ DE LIENCRES Y PÉREZ (Hotel Comercio, Jaén, Spain).

## "Antique" Equipment

SIR,—It was interesting to read Mr. Gardner's account of the "First 12 Years" and I suggest that you ask him to write a postscript as to whether there is any desire by museums or collectors for this early apparatus. I am in process of scrapping mine soon. For example, I have five of those beautiful 1927 Loewe multi-valves, but no use now; a full set of Igranic honeycomb coils and eight heavy Ferranti transformers besides "Class B" Q.P.P. valves, etc. The Science Museum has a few items.

I started radio in March, 1914, and I did *not* wind 3ft. coils with ⅛in. wire! I used good crystals, which are now in a box. My longest crystal reception was Aberdeen from North Essex. In 1942 I typed out a "History" of this early radio, illustrated by photographs of my various sets and bound in the radio articles I used to get published by various papers. —H. E. ADSHEAD (Braintree).

*Whilst we are always pleased to assist readers with their technical difficulties, we regret that we are unable to supply diagrams or provide instructions for modifying surplus equipment. We cannot supply alternative details for receivers described in these pages. WE CANNOT UNDERTAKE TO ANSWER QUERIES OVER THE TELEPHONE. If a postal reply is required a stamped and addressed envelope must be enclosed with the coupon from page iii of cover.*

## The R1132A

SIR,—In reply to Mr. F. J. Walker's letter concerning modifying the R1132A for 2 metres, my experiences may be of help.

The P61 local oscillator was found to give up the ghost at around 128 Mc/s. It (with its associated mounting bracket and components) was removed, and replaced by a VR135 mounted with the valveholder at chassis level. Two-thirds of a turn was removed from each of the four R.F. coils, and the remaining wire opened out to make one loop. A similar circuit to the original was used. The cathode coupling to the mixer can in fact be dispensed with, as there is sufficient stray coupling to effect mixing. A 5 pF condenser improves the tracking of the new oscillator, as the valve capacitances are lower.

A further modification, which is well worthwhile, is the provision of I.F. regeneration. This can be provided with the minimum of rewiring by altering the second I.F. stage. The circuit goes into oscillation smoothly over most of the receiver's range (now about 120-150 mc/s.), gives a better note for C.W. reception than with the B.F.O., and allows NBFM signals to be read more easily, as the receiver is not sufficiently selective for this purpose in its original state.

In conclusion, although this receiver leaves much to be desired, it has been found considerably better than a modified RF27 unit into an R1155. A 10-minute C.W. sending period can be read without retuning, once the receiver has warmed up. With a very simple aerial ("H" at 18ft.) amateur stations using 'phone at up to 75 miles distant have been read during the few weeks the receiver has been in use.—D. R. EASSON (G3JLV) (Hornchurch).

SIR,—In the hope that they may help your correspondent Mr. F. J. Walker (June issue), I send you some notes on the R1132A receiver.

(1) The S.P.61 is not an efficient valve at 100 Mc/s and above, and although it is adequate in the frequency changer stage, it gives very little gain in the R.F. stage. A further difficulty in adjusting this stage for work at frequencies other than 100-124 Mc/s is that to overcome the attenuation due to the large input capacitance of the valve, capacitors have been introduced in the input circuit which at the centre of the band combine with the inductance of the wiring to form a series tuned circuit, so that the effective impedance between the grid and the "hot" end of the R.F. tuned circuit is very small. For 144 Mc/s working these capacitors would have to be changed.

(2) A more rewarding experiment is to remove the R.F. stage and its band-pass coupling to the frequency changer, and to substitute a new R.F. stage of the grounded-grid type, or a broadband stage using a single EF91 or equivalent, tuned to the centre of the desired band. The noise reduction is considerable, and the gain is greater than from the existing stage. This also has the advantage that it is unnecessary to try to get the existing three tuned circuits correctly aligned and tracking at a frequency considerably removed from that for which they were designed.

(3) The intermediate frequency is 21 Mc/s, and the oscillator runs below the signal frequency, i.e., at 88-112 Mc/s. It can therefore easily be used for the 87.5-100 Mc/s broadcast band with only slight trimming, running it *above* the signal frequency. However, for use below signal frequency on the 144 Mc/s band, its upper limit would have to be raised

to 132 Mc/s or higher ; it is possible that this might be done by removing plates from the oscillator condenser, or by inserting a very small capacity in series with it, but stray capacities might prevent the desired frequency from being reached, and the efficiency of the S.P.61 frequency changer would probably be much less on the higher band.

(4) A.V.C. is applied to the heptode used in the first A.F. stage. Considerably more gain and less distortion may be obtained by substituting a 6SL7, using both halves R.C.-coupled, and using the 6J5 output valve as a cathode-follower output stage to feed a large amplifier ; alternatively the 6J5 may be replaced by a 6V6 or other beam tetrode in order to make the set self-contained. There is room for a small power pack partly above and partly below the chassis beside the R.F. and frequency-changer stages.

I hope these notes may be of interest to Mr. Walker, and to other users of this receiver.—C. TERRY (Cambridge).

### Mathematics and the Service Engineer

SIR,—Mr. Apps, in the May issue, states, in effect, that a person having attained ordinary national standard in mathematics could tackle nothing beyond simple arithmetical problems.

I do not know how or where Mr. Apps obtained this information, but would venture to say that he has grossly underestimated the standard reached by holders of the ordinary national certificate in the mechanical section. Further, all the mathematics entailed in the formulae appearing in his article is covered in the year prior to the ordinary national, and would be considered elementary by a holder of this certificate.

As confirmation, the following are parts of questions set by Robert Gordon's Technical College, Aberdeen, in this year's ordinary national maths paper :—

(a) The distance-time relationship for a certain motion is $x=8\sin(4\pi t+\frac{\pi}{4})$.

Find the velocity and acceleration when $t=\frac{1}{48}$ sec. if x is the distance in inches.

(b) Evaluate $\int 2\sqrt{x}-\frac{5}{x^2}+\frac{3}{\sqrt{x}}\,dx$.

The above simple exercises on the differential and integral calculus would present quite a problem to students whose alleged mathematical knowledge does not exceed simple arithmetic !—W. F. RITCHIE (Rosehearty, Aberdeenshire).

(The Author states : The mistake was an error on my part in calling the certificate I referred to the Ordinary National Certificate, whereas what was intended was the General Certificate of Education.)

### "Walkie Talkies"

SIR,—If P. Bradley, of Cheshire, was really interested in obtaining an amateur transmitting licence so as to operate a "walkie talkie," then surely he would not mind (as he states) pounding a morse key for 12 fruitless months. Like a great many other people he wants to get on to the air the easy way. If there was no morse test, then I am sure the whole spirit of "The Ham Boys" would be lost, as there is already a great number of stations operating on the ham bands, making it hard to select one station with ease. Take away the morse test and I doubt if one would be able to work the band at all. If our friend was really interested he would not mind doing 12 months' morse. I will also hasten to say I do not hold a licence for ham bands, but I hope to one day and I don't mind doing my 12 months' morse. I think one may tend to say I have gone away from the point but, after all, a transmitter is a transmitter no matter what its power and range.—J. TRACE (Hainford).

## "TRANSMITTING TOPICS"

(*Continued from page* 406)

of all, for the full positive D.C. potential may be applied directly to the P.A. grid. In a typical neutralised stage, as shown in Fig. 7, the full R.F. potential plus the anode voltage appears across the neutralising condenser. Thus for C.W. working the peak rating of the neutralising condenser must be at least twice the D.C. anode supply voltage, and four times the D.C. supply voltage for anode modulated phone working. As a flashover direct to grid is to be avoided a generous safety margin is advisable.

Finally, one may be unable to find the rated peak working voltage of a surplus market tank condenser. This is not a serious difficulty, as the graph of Fig. 8 has been prepared to enable the safe working peak voltage rating to be read off.

With a ruler determine the spacing between adjacent surfaces of the airgap between the fixed to moving vanes. Then from the graph ascertain the peak voltage rating corresponding to this airgap. Note, however, that scratches, craters left by previous flashover, rough burrs, etc., will enhance the danger of flashover. The plates should be maintained polished with no sharp edges in order that flashover will not occur.

Finally, equipment kept in a cold place may get very damp if left unused. This may initiate surfaces discharges and minute arc which may trigger off a major flashover. This is particularly so in seaside locations due to the action of salt particles. The writer has seen high grade insulation sizzling and bubbling over a 6in. path on a high power transmitter. The remedy is to well warm up the work-room before switching on the high power, and the heat from the filaments of the P.A. stage is also helpful.

Finally, the best advice about flashover. Do not let it happen !

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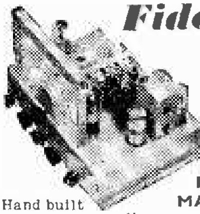

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Standard Four - valver Short-waver (SG, D, LF, P) ... ... ... WM383*

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PRACTICAL WIRELESS, July, 1954.

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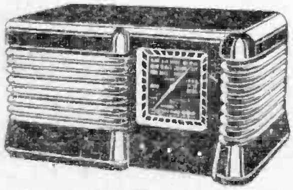

Used metal rectifier, 230 v. 50mA., 4/6; gang with trimmers, 6/6; M. & L. T.R.F. coils, 5/-; 3 Govt. valves, 3-v-h and circuit, 6/6; heater trans., 6/-; volume control with switch, 3/6; wave-change switch, 2/-; 32 x 32 mfd., 4/-; bias condenser, 1/-; resistor kit, 2/-; condenser kit, 4/-.

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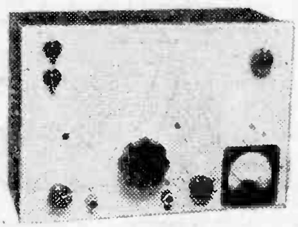

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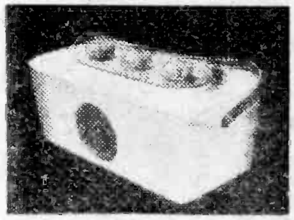

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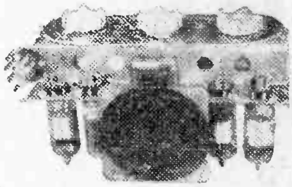

*View of chassis as it would look when assembled with valves inserted.*

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**Volume Controls.** Long spindle and switch, ¼, ½, 1 and 2 meg., 4/- each; 100 K. and 50 K., 3/6 each. ¼ and 1 meg., long spindle, double pole switch, miniature, 5/-. P. & P. 3d. each.

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