

PRACTICAL WIRELESS, NOVEMBER, 1944.

## RADIOGRAM CIRCUITS

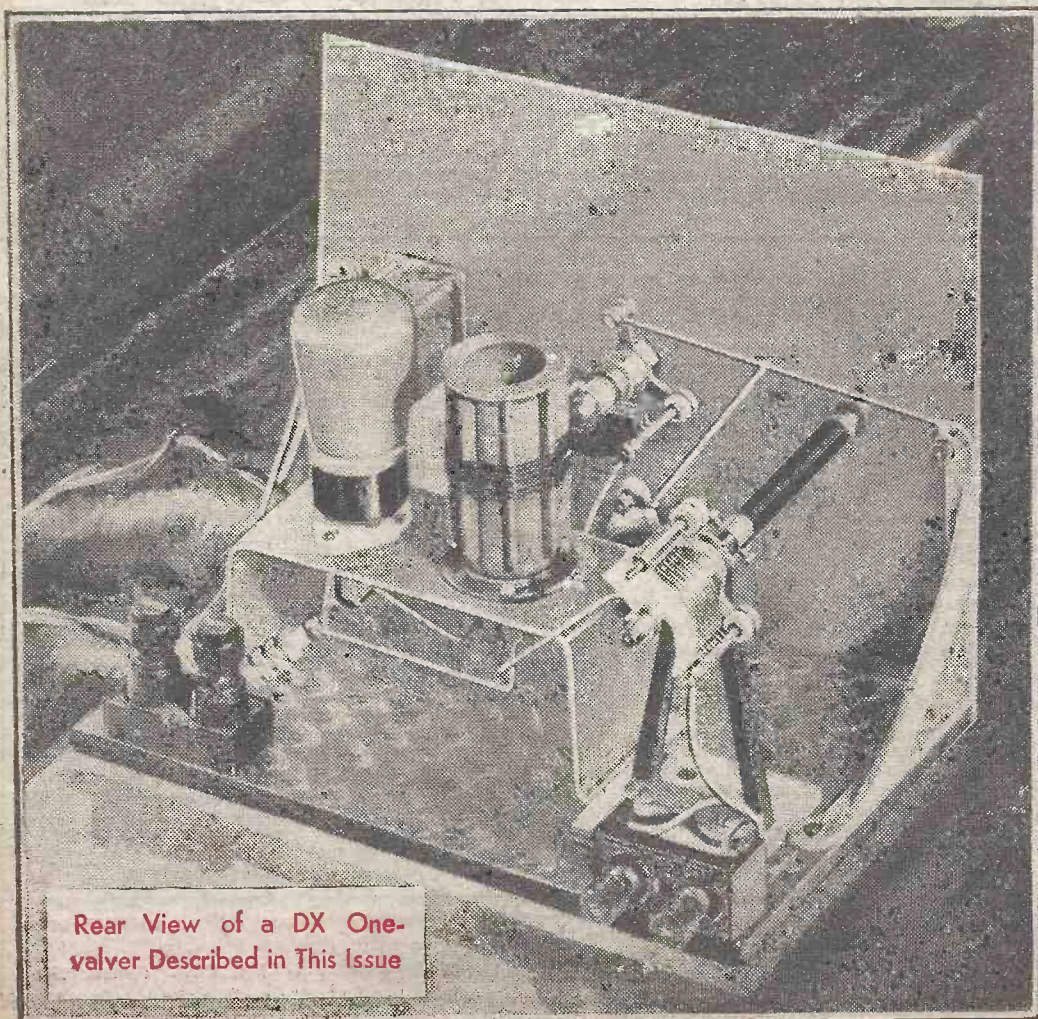
# Practical Wireless <sup>9<sup>D</sup></sup> COVER

*Editor*  
F. J. CAMM

Vol. 20 No. 461

NEW SERIES

NOVEMBER, 1944

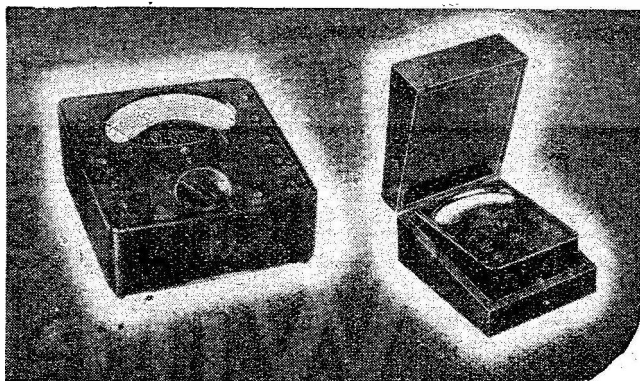


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04C	41.94 m.	...	2/6	06C	41.94 m.	...	2/6
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# Practical Wireless

12th YEAR  
OF ISSUE

and PRACTICAL TELEVISION

EVERY MONTH.  
Vol. XX. No. 461 NOVEMBER, 1944.

Editor F. J. CAMM

## Comments of the Month

By F. J. C.

### Rehabilitation of Radio Servicemen

OUR correspondence columns have contained in past months several letters on the question of the status of the service engineer. There is general complaint of overcharging, ignorance, incompetence, and in some cases, fraud. Steps have been taken by important firms to ensure that their servicemen are fully qualified and adequately instructed, similar to the motor trade, in which motor agents undertake a servicing course.

But not all men calling themselves service engineers are agents for commercial receivers. Many of them keep small shops and undertake as a side-line to put customers' defective receivers into working order. There is thus an implied warranty that the work will be satisfactory, and customers who are disgruntled have the obvious remedy at law for breach of implied warranty, for obtaining money under false pretences (where new parts not supplied have been charged for) or even for fraud.

The public, however, does not like to take these extreme measures and goes away disgruntled, and transferring their custom elsewhere is often to repeat the costly and bitter experience. Some system of ensuring that a service engineer is qualified and trustworthy must be devised, for all schemes to that end up to the present have failed to eliminate the plausible shark.

At present anyone can start in business as a repairer of wireless sets. There is no standard system of charges as in other trades, and to those to whom a wireless set is still a box of mystery the charges may seem reasonable. As in the watch trade the public ignorance of mechanisms enables the dishonest to reap a rich harvest by making large charges for small work.

### Fully Qualified Men

NOW that we are nearing the end of the war, many of those formerly engaged as service engineers will return to civilian life only to find their connections in the hands of those opportunists who escaped service and found by the fortuitous circumstance of war a profitable business ready to hand from which they could make small fortunes without merit or ability, by cashing in on the large demand and the small supply. No doubt a high percentage of those in the Services are highly qualified men, for it was precisely because of their knowledge and experience that the Services needed them. Some, however, will be of the other type, and in any scheme of rehabilitation this must be borne in mind; if the war has taken them out of the industry they should not be allowed to re-enter into it until they have become fully qualified under some Government training scheme. There are

many who entered the Services knowing nothing of radio, but who to-day, as a result of training in the Services, have a good theoretical knowledge and practical training. Some of these will wish to start in business as service engineers, and it is from the two qualified pools that we should draw our post-war supply of servicemen. We are thus provided with a golden opportunity of cleansing the Augean stables, and of eliminating the quacks and the sharks who have battered themselves like barnacles on to this comparatively new industry.

### National Servicing Association

THESE thoughts were encouraged by perusal of a new scheme for rehabilitation of servicemen, by the creation of a National Radio and Television Servicing Association. The objects are to employ men and women who have been trained in radio servicing in the Services, and to provide a reliable and efficient chain of radio and television servicing stations throughout the country, for the benefit of both the radio and television industry, and to the purchasing public.

The proposals are that an Association be created in conjunction with the Radio Manufacturers' Association to erect, equip, and staff the stations, and a parallel has been drawn between this scheme and the motor industry where a purchaser of a given make of car can find a well organised and equipped servicing station in the nearest town. It is further proposed that each applicant for employment in the Association shall receive suitable training in the maintenance and servicing of commercial sets in order to maintain a high standard of efficiency in the servicing. Each applicant will be required to pass

an examination of proficiency both in theory and practice, and each member will receive refresher courses in manufacturers' laboratories and workshops. Each station will be self-contained with full equipment and tools, keep a separate set of accounts and run its own collection and delivery service. It is proposed to seek the assistance of the Ministry of Labour, which is naturally interested in the rehabilitation and the employment of ex-servicemen.

We wish the new scheme well.

It is not known whether the radio manufacturers will support this new scheme, which is only in the tentative stage, and a possible criticism they may raise is that it usurps the functions of the R.M.A. We are unaware, however, that the industry has any similar scheme in mind, and in any case it could be run under their aegis. The radio trade up to the present has been too concerned with problems of war and post-war production to devote time to the nebulous subject of post-war employment.

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The fact that goods made of raw materials in short supply owing to war conditions are advertised in this paper should not be taken as an indication that they are necessarily available for export.



# ROUND THE WORLD OF WIRELESS

## Army Signals Exhibition

**A**N exhibition of Army Signals held recently at Charing Cross Underground Station (booking hall), was designed for the War Office by the Ministry of Information.

Several of the latest field wireless sets were shown, including one complete wireless station in a handcart as used on the beaches in Normandy during the assault stages. There was a working exhibit of the high-speed apparatus—perforator, transmitter, re-perforator, undulator and page-printer—as used on the wireless links from the War Office to all theatres of war, and the public were able to operate a wireless training set which is used to accustom the operator to read morse through typical interference.

Wireless transmissions made during battle on the British sector in Normandy were recorded by the Royal Signals specially for this exhibition and were reproduced in headphones for the public to hear.

Other exhibits included a display of Army lines, and line transmission equipment, and diagrams showing the chain of communication in an armoured division, which has approximately 1,500 wireless sets. There were also a number of photographs of the work of Signals in the Army in various theatres of war.

## Atlantic Spotlight

**A** FILM starring Greer Garson, Gracie Fields, C. Aubrey Smith, Basil Rathbone, Herbert Marshall and Ronald Colman would draw packed houses wherever it was shown. Such a film has yet to be made, but this very cast of British Hollywood stars appeared in a broadcast on September 16th, specially written by James Hilton, as a tribute to the men who fought in the Battle of Britain just four years ago.

It will be the American contribution to the weekly programme, "Atlantic Spotlight," heard every Saturday in the G.F.P. The British contribution will be announced later.

"Atlantic Spotlight" is a joint venture of the N.B.C. and the B.B.C. and is heard simultaneously in both countries. Production is by Ross Filion in America and James Dyrenforth and Tom Ronald in Britain.

## Station Identity Ban Lifted

**S**OUTH AFRICAN radio stations have begun to announce their identity again. For nearly three years they have remained anonymous in order to prevent enemy aircraft from identifying particular radio stations.

## Relayed Television

**A**CCORDING to a recent report from the United States, General Electric engineers have invented a remarkable electronic tube, now being used in war applications, which will enable the radio relaying of television programmes for quick expansion of the service after the war.

## New Radio Drama Technique

**U**P to ten years ago everyone in the B.B.C. Drama Department was experimenting. By then certain forms had evolved, and for the last decade form and technique have been more or less static. With the introduction of the G.F.P., however, it was decided to expand certain types of programmes in the Home Service and to conduct further research into the technique of radio dramatic adaptation.

Lance Sieveking, one of the Corporation's most experienced writers and producers, is now making fresh experiments in adaptation from plays, stories, novels and films.

One of the first fruits of this research was *Thunder in the Air*, by Robins Millar. The radio version of this play, produced by Walter Rilla, was heard on September 2nd. Lance Sieveking has to some extent rewritten



British mechanics at work on the wireless bench in an advance base workshop in Italy. Here everything from the smallest part of a watch to a Sherman tank is supplied or repaired.

the play and says that it presented him with a very interesting problem. The leading character, a young officer, appeared in turn to six other characters exactly as they each remembered him. Sometimes these different "manifestations" were all on the stage at the same time. How they were distinguished from each other and yet were sufficiently alike to make it clear that they were all the same person was done by an ingenious overlapping device.

## B.B.C. War Reporters

**C**OVERING the new front in the South of France are two B.B.C. war correspondents, Wynford Vaughan Thomas and Rupert Downing. Downing, born at Seaford in Sussex, was educated at St. Paul's. He was secretary to Sir John Simon, worked at Scotland Yard for two years, and was then with the N.S.P.C.C. He was correspondent for the *New York Times* from 1937 and broadcast on the B.E.F. in France from 1939 until the French collapse. Returning to England he worked on the *Illustrated London News* until he

joined the B.B.C. in 1942 as sub-editor in the European Division. He became Air Correspondent in the European Division, March, 1943, and transferred to War Reporting Unit in December of the same year. Publications include a novel, *If I Laugh*, and a book on the English at war called *What Kind of People?*

### "Immortal Mission"

"IMMORTAL Mission" was the first of several feature programmes dealing with the "back room boys" whose achievements have been important in preparing the way to victory.

It told the story of the dark days towards the end of 1940, when the U-boat menace was growing steadily greater, and more ships were sunk than could be replaced by new building. At this grave hour Cyril Thompson and Harry Hunter, one the managing director of a famous firm of British shipbuilders, the other one of the best marine engineers in the world, set sail for America to find out what aid could be given to Britain in this desperate crisis.

When Thompson and Hunter arrived in America they met Admiral Land, chairman of the American Maritime Commission, and told him of Britain's imperative need for at least 60 ships of 10,000 tons each. The admiral told them that facilities for building such a large quantity of ships were not available, but that he was willing to help in any way he could. Thompson and Hunter afterwards saw a great many people in the U.S.A. without result, until they at length met Henry J. Kaiser, the man who built the Boulder Dam.

### Planning Great Shipyards

KAISER realised the necessity for immediate action on a vast scale. This was no easy matter, for not only had the ships to be built, but also the yards in which they were to be constructed. Kaiser was not dismayed by the stupendous size of the project. Two great shipyards were planned, one in America, and one in Canada. Here the ships would be assembled from engines and subsidiary parts made in different workshops and yards all over the North American Continent. This vast prefabrication scheme was planned and worked out by Kaiser, Thompson and Hunter, who in a fortnight travelled 11,000 miles throughout North America arranging it.

Thompson returned to Britain with blueprints of the scheme. The ship in which he travelled was torpedoed. He lost everything except his attaché case containing the precious blueprints, which, soggy and water-stained, were just in a fit condition to be copied and worked on in Britain.

In a broadcast programme on September 15th "Immortal Mission," written by Donald Stokes and based on his recent book, "Men Behind Victory," told the story of how these merchant vessels later became world-famous as "Liberty" ships. Planned in the autumn of 1940, the first convoy of "Liberty" ships sailed to Britain in August, 1941.

### "Music for All"

WHEN Frank Gillard, now a B.B.C. war correspondent in France, returned recently from covering the Mediterranean battlefronts, he told the B.B.C. Music Department of a club in Cairo run specially for the Forces. Admission is five piastres (about a shilling to the uninitiated), which entitles you to a day's membership. At the club you can eat, read, write lounge around, get hot baths and, most

important of all, music, in the small, intimate club theatre. Sometimes there are live performers—Ensa artists or professional musicians now stationed out there in the Services—but the backbone of every day's programme is the symphony concerts given on gramophone records.

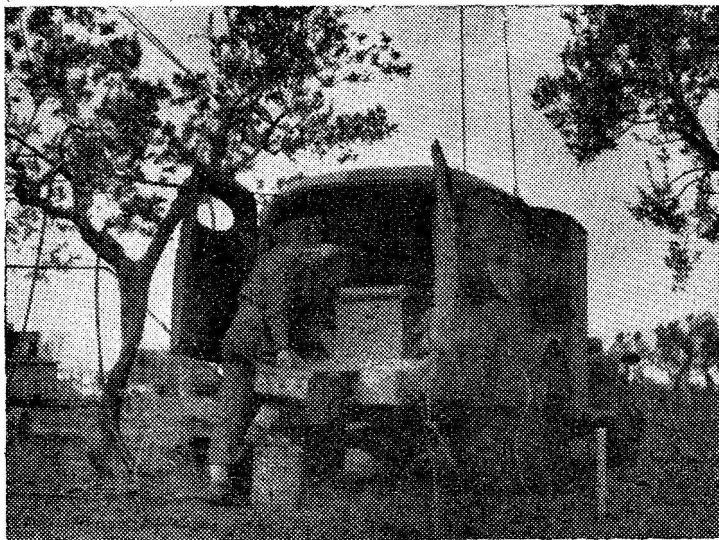
The name of this music club is "Music for All." It so happened that at the time Gillard was giving his description of it to the Music Department they were planning a new series of concerts of popular music to be given before a Forces audience, and could find no appropriate title. The idea behind the concerts is the same as that of the music club in Cairo. What could be more suitable than to adopt the name for the new series, which will contain music ranging from a Sousa march or a Strauss waltz to a popular symphonic movement, such as the last movement of Tchaikovsky's "Pathetic" Symphony.

The new series started on Sunday, September 17th. It will be given fortnightly after the nine o'clock News in the Home Service throughout the coming season. The full B.B.C. Symphony Orchestra of 95 players will take part, under its conductor, Sir Adrian Boult, and in each programme a well-known soloist will appear. Freddie Grisewood will present the series, and the concerts will be run on more or less "non-stop" lines. All the programmes will be light and popular.

### "Citizenship" Broadcast Series

THE general title "Citizenship" has been used for some years to cover a wide variety of broadcast series. This year in the Autumn Term, "When We Started Work" will succeed last year's "When We Start Work," as a series for young people leaving school. Young people over 16 will come to the microphone to give the kind of advice they would like to have received themselves, before they set out on their first job. Some of the subjects to be discussed are "Getting the Job You're Fitted For," "Living at Home Once You're Earning," with a group of three broadcasts under the title "Making the Most of Your Free Time."

"Some Modern Techniques of Social Investigation" is the subject in the Talks for Sixth Forms. Government to-day depends increasingly on the scientific collection of data about people and their way of life. Some of these (vital statistics, for example) are collected as a routine of modern government. Others have to be gathered by investigations specially designed to throw light on particular problems.



A wireless station with U.S. equipment attached to the 8th Army in the field.

# What is Miller Effect?

This Article Supplies the Answer

**M**ILLER Effect may be described as the effect whereby the grid input impedance of a valve with a load in its anode circuit is different from that with no load. If the load is a resistance, then the input impedance is purely capacitive, but if the load is reactive (e.g. consists of a choke or transformer) the grid input impedance will be resistive. The reader may perhaps feel that this is a technical point, of interest only to the professional designer and need not concern the home experimenter. This, of course, is true if he is content to follow implicitly the circuits of the expert, but should he wish to try his own hand at designing—who does not?—then an understanding of the meaning and significance of Miller Effect is essential to the success of his experiments.

## Example

Take the case of an HL2 with 100,000 ohms load and 100 volts on the anode. The static input capacity is 5.2 mmfd., but under these conditions it rises to 206

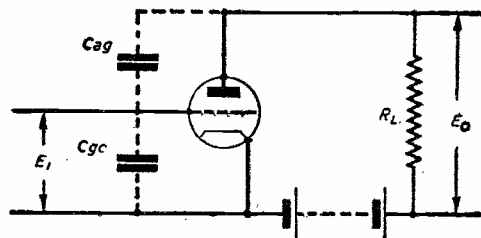


Fig. 1.—A triode valve circuit in which the capacities concerned are indicated and in which the anode load is resistive.

mmfd., an increase of nearly 40 times. Admittedly this is a somewhat extreme case, but it illustrates the necessity for taking the Miller Effect into consideration when designing radio equipment.

\$E\_i\$ represents input voltage.

\$E\_o\$ represents output voltage.

\$R\_L\$ represents load resistance.

\$C\_{ag}\$ represents anode-grid capacity due to electrode structure.

\$C\_{gc}\$ represents grid-cathode capacity due to electrode structure.

The condensers \$C\_{ag}\$ and \$C\_{gc}\$ represent the capacities inevitably present between closely spaced electrodes and for the sake of convenience are shown as external to the valve. Their values are given on manufacturers' data sheets.

In Fig. 1 \$E\_o = -ME\_i\$ where \$M\$ is the voltage gain of the stage, the minus sign being due to the 180 deg. phase reversal in the valve.

Since the charge on any condenser = capacity \$\times\$ voltage

The charge on the grid due to \$C\_{gc} = E\_i C\_{gc}\$

The charge on the grid due to \$C\_{ag} = (E\_i - E\_o) C\_{ag}\$  
 $= [E_i - (-ME_i)] C_{ag}$   
 $= E_i (1 + M) C_{ag}$

The total charge on the grid = \$E\_i C\_{gc} + E\_i (M + 1) C\_{ag}\$  
 $= E_i [C_{gc} + (M + 1) C_{ag}]$

The resultant effective input capacity = charge \$\div\$ voltage  
 $= C_{gc} + (M + 1) C_{ag}$  ..... 1

This puts into words that with a resistive load the static input capacity is increased by the anode-grid capacity multiplied by the stage gain plus one.

Thus if a 6 mmfd. 5 valve with a grid-cathode capacity of 6 mmfd. and a grid-anode capacity of 2 mmfd. is

used with a resistance in its anode circuit such that the voltage gain is 80, the effective grid input capacity  
 $= 6 + (80 + 1) \times 2$  mmfd.  
 $= 168$  mmfd.

Account must also be taken of the stray capacities due to wiring and valve-holders when estimating the inter-electrode capacities. If exact figures are not available the capacities between adjacent modern valve-holder pins may be taken as approximately 1.5–2 mmfd., and that between others as 1 mmfd. Stray wiring-capacities will also amount to several mmfd. particularly when the grid is brought out at the base. When the top cap is grid this capacity should be very small and nothing need be added for the valve-holder.

## Stage Gain

Thus in the case of a 41 MH where the grid pin is brought out at the base of the valve, and which has a grid-cathode capacity of 12 mmfd. and a grid-anode capacity of

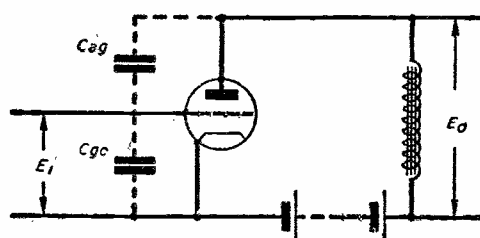


Fig. 2.—The anode load in this instance is an L.F. choke and is therefore reactive.

5 mmfd. when the stage gain is 50 the effective input capacity may be

$(12 + 2 + 6) + (50 + 1) (5 + 1 + 2)$   
 $C_{gc}$  valve-holder wiring capacity capacity  $C_{ag}$  valve-holder wiring capacity capacity  
 $= 20 + (51 \times 8) = 428$  mmfd.

The value of \$M\$, the stage gain, is best obtained from the anode current/anode voltage valve curves by drawing a load line, but it may also be obtained fairly accurately from the formula

$$\frac{M = \mu R_L}{R_A + R_L} \dots \dots \dots 2$$

where \$\mu\$ represents the valve amplification factor.

\$R\_L\$ represents the load resistance.

and \$R\_A\$ represents the valve anode impedance.

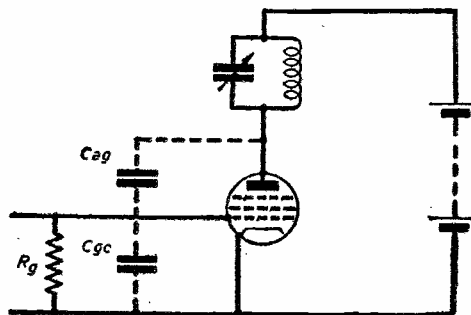


Fig. 3.—Method of varying the applied frequency.

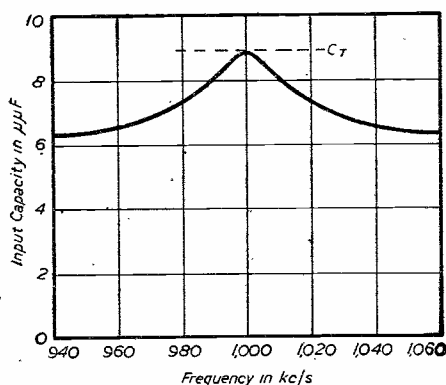


Fig. 4.—Input capacity variation as the applied frequency is varied above and below resonance.

It should, however, be borne in mind that though  $\mu$  remains substantially constant it decreases up to about 20 per cent. as the anode current decreases, particularly when the negative grid voltage is also high, and due allowance must be made for this.

As already stated, if the anode load has an inductive or capacitive component, i.e., consists of an inductance or a tuned circuit resonant at a frequency below that which is applied to the grid, a resistance—either positive or negative (the significance of the negative sign will be explained later)—will appear across the grid input circuit, whose magnitude is given by the expression

$$R = \frac{1}{\omega C_{ag} M \sin \theta} \dots \dots \dots 3$$

Where  $C_{ag}$  represents the anode-grid capacity

$M$  represents the voltage gain of the stage

$\theta$  represents the phase angle of the anode load, being positive for an inductive load and negative for a capacitive load

and  $\omega = 2\pi f$ ,  $f$  being the frequency under consideration.

Since, however, the only case of a reactive load likely to be encountered in audio-frequency amplifiers is that in which the anode circuit contains either a choke or a transformer whose D.C. resistances are low compared with their reactances (which are given by the expression  $\omega L$  where  $\omega = 2\pi f$ )  $\theta$  the phase angle will be approximately 90 deg. and therefore  $\sin \theta = 1$

$$\text{Hence } R = -\frac{1}{2\pi f C_{ag} M} \dots \dots \dots 4$$

When  $\theta = 0$ , i.e., when the load consists of a resistance,

$$\sin \theta = 0 \text{ and therefore } R = -\frac{1}{0}$$

$$= \text{Infinity.}$$

i.e., the grid input is purely capacitive as previously stated.

#### Reactive Load

It will be seen that whereas the Miller Effect, due to a resistive load, is dependent solely upon the stage gain and the anode-grid capacity

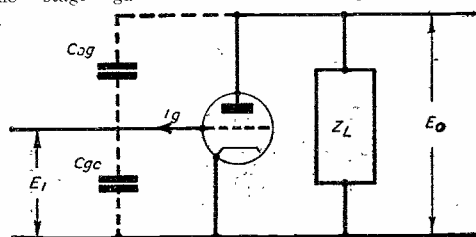


Fig. 6.—The triode circuit when the load impedance is inductive.

(Expression 1), that due to a reactive load is also dependent upon the frequency (Expressions 3 and 4) becoming increasingly severe at the high frequencies. The negative value of  $R$  in these two expressions means that energy instead of being extracted from the input circuit is fed back into it (as with an oscillator) and there is therefore an increased tendency towards self-oscillation. When the load is capacitive,  $\theta$ , and therefore  $\sin \theta$ , is negative and  $R$  becomes positive, resulting in increased stability. The resistance appearing across the grid circuit at audio frequencies is, however, very high and may usually be neglected. The following example illustrates the Miller Effect when the anode load consists of an inductance.

$$\text{Assume } M = \frac{E_o}{E_i} = 50$$

$$C_{ag} = 3 \text{ mmfd.}$$

$$\text{and } C_{gc} = 12 \text{ mmfd.}$$

The input capacity will be (from Expression 6)

$$12 + 3 (1 + 50 \cos 90^\circ)$$

$$= 12 + 3 (1 + 50 \times 0)$$

$$= 15 \text{ mmfd.}$$

i.e., the input capacity becomes the same as for no load,  $C_{gc} + C_{ag}$ .

#### Pentodes

At radio frequencies pentodes are normally employed and, due to the fact that the grid and anode circuits are usually tuned, the additional input capacity can be incorporated into the tuned circuit. The reflected input resistance is, however, much more serious, due to the fact that it decreases with increasing frequency, and is a factor that must be reckoned with in the design of R.F. and I.F. amplifiers.

$$\text{Assume } C_{ag} = 0.3 \text{ mmfd.}$$

$$C_{gc} = 6 \text{ mmfd.}$$

$$M = 100$$

$$f_0 = 1,000 \text{ kc/s} = \text{resonant frequency of tuned circuit}$$

$$Q = 50$$

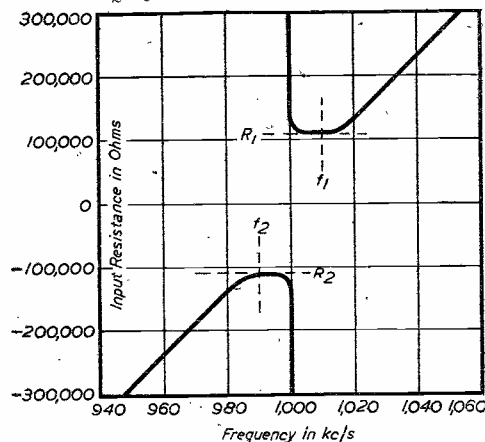


Fig. 5.—Input resistance variation as the input frequency is varied above and below resonance.

Figs. 4 and 5 illustrate the variations in input capacity and resistance as the applied frequency is varied above and below resonance in Fig. 3.

In Fig. 4,  $C_1 = 6 + (101 \times 0.3) \text{ mmfd.}$  (from Expression 1)  $= 9 \text{ mmfd.}$

In Fig. 5 it may be shown that

$$R_1 \text{ (the minimum value of } R_g) = \frac{2}{\omega C_{ag} M}$$

$$\text{and } R_2 \text{ (the neg. minimum value of } R_g) = -\frac{2}{\omega C_{ag} M}$$

$$\text{at frequencies } f_1 = f_0 + f_0/2Q$$

$$\text{and } f_2 = f_0 - f_0/2Q$$

Since accurate plotting of the curves in Figs. 4 and 5 is somewhat laborious, and demands the use of universal resonance curves, as well as a knowledge of the "Q" of the circuit, it will be found easier in practice to design the amplifier simply with a view to minimising this effect.

### Proof

For the benefit of those readers who dislike taking too much on trust a general proof will now be given for Expressions 1 and 3.

Cag represents anode-grid capacity.

Cgc represents grid-cathode capacity.

Z<sub>L</sub> represents load impedance.

I<sub>g</sub> represents A.C. grid current (i.e., the current through the condensers Cag and Cgc).

M represents stage gain =  $\frac{E_o}{E_i}$

$\omega = 2\pi f$ .

$\theta$  represents the phase angle of the voltage across Z<sub>L</sub> (i.e., the angle by which it lags or leads that across a pure resistance, which, in the case of a choke, is approximately 90°).

Then the grid current due to Cgc =  $E_i \div \frac{1}{j\omega Cgc}$   
(from Ohm's Law)

$$= E_i j\omega Cgc$$

where  $j\omega Cgc$  is the reactance of Cgc at the frequency under consideration, and "j" signifies that this reactance is 90° out of phase with the resistance input.

The grid current due to

$$Cag = [E_i - E_o \cos(\theta + 180^\circ)] \div \frac{1}{j\omega Cag}$$

since the voltage across Cag is the difference between the grid and anode voltages. Since, however,

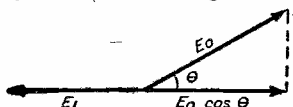


Fig. 7.—The vector diagram for  $E_i$ ,  $F_o$  and  $E_o \cos \theta$ .

the input voltage  $E_i$  is considered as being developed across a resistance, and that across Z<sub>L</sub> has a reactive component, the resistive component of  $E_o = E_o \cos \theta$ , as will be seen from Fig. 7.

Also, due to the 180 deg. phase reversal in the valve, the relative phase angle between  $E_i$  and  $E_o \cos \theta = 180^\circ$ .  
∴ the voltage across Cag =  $E_i - E_o \cos(\theta + 180^\circ)$   
and the grid current due to Cag =  $[E_i - E_o \cos(\theta + 180^\circ)] j\omega Cag$

∴ the total grid current  $I_g = j\omega Cgc E_i + j\omega Cag [E_i - E_o \cos(\theta + 180^\circ)]$

But  $E = IZ$  or  $\frac{I}{Z} = \frac{E}{E}$

Hence,  $\frac{I}{\text{Grid input impedance}} = \frac{\text{Total grid current}}{\text{Grid input voltage}}$

$$\text{i.e., Grid input resistance} = \frac{I}{j\omega Cgc E_i + j\omega Cag [E_i - E_o \cos(\theta + 180^\circ)]}$$

$$= j\omega Cgc E_i + j\omega Cag [I - M \cos(\theta + 180^\circ)] \dots \dots \dots 5$$

Collecting the reactive terms (i.e., those prefixed by "j")

Grid input reactance =  $\omega Cgc + \omega Cag [I - M \cos(\theta + 180^\circ)]$

Dividing by " $\omega$ "

Grid input capacity =  $Cgc + Cag [I - M \cos(\theta + 180^\circ)] \dots \dots \dots 6$

since  $\cos(\theta + 180^\circ) = -\cos \theta$

Collecting the terms containing a resistive component [i.e.,  $M \cos(\theta + 180^\circ)$ ]

$$\text{Grid input resistance} = -j\omega Cag M \cos(\theta + 180^\circ)$$

But "j" signifies a phase shift of 90 deg.

$$\therefore \text{Grid input resistance} = -\frac{I}{\omega Cag M \cos(\theta + 270^\circ)}$$

$$\text{But } \cos(\theta + 270^\circ) = \sin \theta$$

$$\therefore \text{Grid input resistance} = -\frac{I}{\omega Cag M \sin \theta} \dots \dots \dots 3$$

A brief outline will now be given of the way in which this effect modifies the design of audio and radio frequency amplifiers. To save constant reference to the first article the formulae for the calculation of the effective grid input capacity and resistance will be re-stated.

$$\text{Effective grid input capacity} = \frac{Cgc + Cag(I + M \cos \theta)}{\dots \dots \dots 6}$$

$$\text{Effective grid input resistance} = -\frac{I}{\omega Cag M \sin \theta} \dots \dots \dots 3$$

where Cgc represents grid-cathode capacity

Cag represents anode-grid capacity

$\theta$  represents phase angle of anode load

$\omega = 2\pi f$

$$M = \text{stage gain} = \frac{\mu R_L}{R_A + R_L} \dots \dots \dots 2$$

In A.F. amplifiers as stated previously the resistive grid component may be neglected whereas the input capacity often represents the major part of the capacity shunting the previous anode load.

Thus in Fig. 8 an average value for Cag is 7 mmfd. Stray wiring and valveholder capacities will probably double this value, which, however, is still considerably less than the effective input capacity of V<sub>2</sub> as given by Expression 6 since this may be as high as 300 or 400 mmfd. in the case of a triode. Since both this capacity and Cag are effectively in parallel with R<sub>L</sub> (as C<sub>gc</sub> has negligible reactance and the impedance between HT + and earth may also be ignored) the effective impedance of the anode load of V<sub>1</sub> (assuming R<sub>g</sub> to be much greater than

$R_L$ ) =  $\frac{R_L X_C}{R_L + jX_C}$  where X<sub>C</sub> is the reactance of the total shunt capacity from V<sub>1</sub> anode to earth. Thus when X<sub>C</sub> = R<sub>L</sub> the anode impedance =

$$\frac{R_L^2}{R_L + jR_L} = \frac{R_L^2}{\sqrt{2}R_L^2} = \frac{R_L^2}{\sqrt{2}R_L} = .707 R_L$$

i.e., at the frequency at which X<sub>C</sub> = R<sub>L</sub> the response will be .707 of the maximum or 3db down.

The following table shows the reactances of shunt capacities likely to be encountered in A.F. amplifier design.

Capacity mmfd.	Reactance ohms (approx.)	
	7 kc/s	12 kc/s
20	1,100,000	660,000
40	570,000	330,000
70	320,000	190,000
100	230,000	130,000
150	150,000	88,000
200	110,000	66,000
250	91,000	53,000
300	76,000	44,000

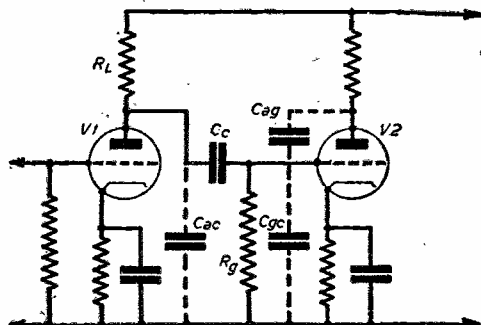


Fig. 8.—A typical resistance capacity coupled A.F. amplifier.



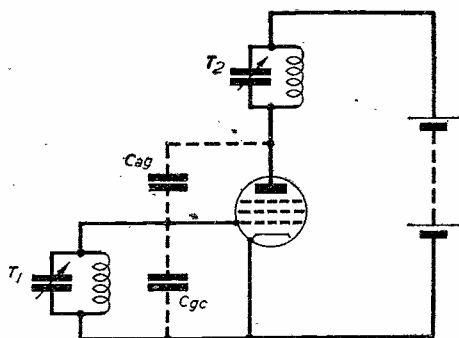


Fig. 9.—Amplifier grid and anode circuit employing a pentode.

The figures under "7 kc/s" should be used for normal and those under "12 kc/s" for high fidelity.

It is evident that the effective anode load for a given frequency response is limited by the shunt capacity appearing across it, which is in turn dependent upon the Miller Effect of the succeeding stage. Thus if in a high quality amplifier a certain stage has a total input capacity of 150 mmfd. (due principally to Miller Effect), reference to the table of reactances shows that the maximum anode load that can be tolerated in the previous stage is 88,000 ohms. Since, however, the optimum anode load (for maximum gain) of an H.F. pentode is usually about 250,000 ohms, it is clear that if a pentode is used in this previous stage, it must either work at considerably reduced efficiency (though it is sometimes possible to realise as great a gain by using a lower anode load with a valve of higher mutual conductance), or the Miller Effect in the following stage must be reduced. This second alternative may be accomplished either by reducing the gain (M) of the stage or by using a valve with a smaller anode-grid capacity. Since however the minimum value for triodes is approximately 1.5 mmfd., this is often impracticable and a better method (which also results in higher overall gain) is to substitute a pentode for the triode since an average value of Cag for an H.F. pentode is .005 mmfd. (neglecting valve holder capacity, etc.) due to the presence of an earthed screen between the grid and anode. Care must be taken to ensure that the grid input voltage is not greater than 0.1 or the output voltage than 10.

Thus as a general guide pentodes should be used in the early stages of an A.F. amplifier whenever possible and in any case should not be followed by a high gain triode unless careful analysis of the circuit shows that serious shunting will not occur.

In designing radio frequency amplifiers triodes can only be used if the anode-grid capacity is neutralised by an equal and opposite capacity, as is done in transmitters. Since where low power is to be handled (as in receiving equipment), it is much simpler to use pentodes or tetrodes, discussion of the design of such amplifiers will be confined to circuits employing these valves.

Assume  $C_{ag} = .005$  mmfd.

$C_{gc} = 6$  mmfd.

$M = 200$ .

$f_0 = 465$  kc/s = resonant frequency of tuned circuit.

$Q = 50$ .

Consider first the capacitive component appearing across the grid circuit in Fig. 9.

Although  $C_{ag} = .005$  mfd., stray capacity, even supposing the valve to have top cap grid, will probably increase the total grid-anode capacity to not less than .05 mmfd. Then from expression 6, the total grid input capacity when  $T_1$  and  $T_2$  are tuned to resonance (i.e.  $\theta = 0$ ) =  $6 + (201 \times .05)$  mmfd. = 16 mmfd.

This capacity may usually be accommodated within the tuned circuit  $T_1$  and does not, therefore, adversely affect the performance of the amplifier providing it

remains constant. Should the value of M change, however, as will occur if A.V.C. is applied to the valve, the grid input capacity will change and thus  $T_1$  will no longer be at resonance. In I.F. amplifiers, providing the circuits are not too sharply tuned, it is usually satisfactory to align them on a weak signal and to accept the detuning that occurs on strong signals. In a sharply tuned amplifier, however, it is advisable to use a tuning capacity of not less than 100 mmfd.

Consider now the resistive component appearing across the grid circuit. As stated in the previous article at frequencies  $\pm \frac{f_0}{2Q}$  from resonance, i.e., at 460 and 470 kc/s approximately, the grid input resistance

$$= \pm \frac{2}{\omega C_{ag} M}$$

$$= \pm \frac{2 \times 10^{12}}{2\pi \times 465 \times 10^3 \times .05 \times 200} \text{ ohms approx}$$

$$= \pm 68,000 \text{ ohms approx.}$$

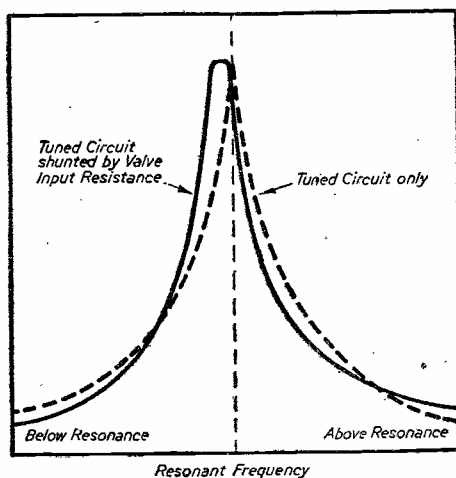
From Fig. 5 it will be seen that if the grid input voltage is applied across a tuned circuit as in Fig. 9 (and in nearly all I.F. and R.F. amplifiers), the response curve will take the form shown in Fig. 10, since energy is being fed back into the circuit and reducing the losses (cf. reaction in straight receivers), below resonance, while above resonance the response is reduced.

The negative value of resistance below resonance will cause oscillation if it is less than the dynamic impedance of the grid circuit (given most conveniently

by the expression  $\frac{Q}{\omega C_T}$  where  $C_T$  is the total capacity across the grid coil), which normally has a maximum value of about 200,000 ohms. To reduce the asymmetry of the response curve to negligible proportions, the grid input resistance should be not less than ten times the dynamic impedance of the tuned circuit.

Expression 3 shows that for a given value the grid input resistance is inversely proportional to the frequency, the gain and the phase angle which is itself a function of the Q and the bandwidth. Since, however, the higher the frequency the smaller the ratio of bandwidth required to mid-band frequency and therefore the more constant the phase angle, it is found in practice that the asymmetry produced at—for instance—higher intermediate frequencies is less serious than when using 110 kc/s, providing the bandwidth is narrow.

Thus, in a high gain I.F. amplifier, particularly at the lower frequencies, great care must be taken to avoid any stray wiring capacity between the grid and anode, and if trouble is still experienced, due to asymmetry, damp the tuned circuits with shunt resistances.



Resonant Frequency

Fig. 10.—Response curve.

# Sound Amplifying Equipment—3

Assembling and Wiring the Components in the Chassis

(Continued from page 454, October issue)

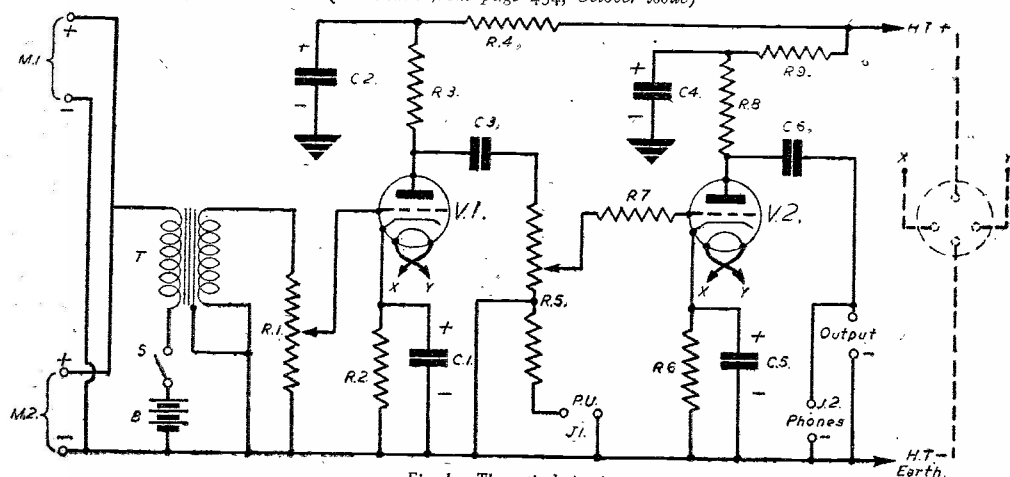


Fig. 1.—Theoretical circuit.

**W**HEN assembling a new piece of apparatus there is usually present the great desire to get it completed and tested. This is all very well, provided one does not become impatient to the extent of skimping some of the work. With the apparatus in question, after having spent a good deal of time seeing to the metalwork, etc., it is only natural to be anxious to get on with the assembly of the component parts, their wiring, and, finally, the testing. However, experience proves that it is far wiser to do a job thoroughly, and this applies in particular to painting; therefore, if supplies permit, at least two, but preferably three coats should be given to the case and chassis described in the two previous issues. The colour must rest with individual tastes (and/or supplies), but the writer was fortunate enough to have some silver-grey hard gloss available, and this certainly gives a most pleasing—and quite professional—finish. A thin flattening coat was applied first, and when that was truly hard, all surfaces were rubbed down with a piece of old felt and pumice powder until a perfectly smooth finish was obtained. The metalwork was then washed well in cold water, and, when perfectly dry, the second coat was applied, this being a shade thicker than the first. Care should be taken to see that brush marks are not left, and that the paint is well and evenly spread, always watching out for the slightest sign of "running." This second coat was rubbed down as before, and a dry cool day was selected for applying the final finish. Be sure and see that the brush at this stage is absolutely clean, and that the work when completed is placed somewhere where dust will not settle on it. The case should, of course, be completely dismantled for painting, including the handle. Allow two or three days for the last coat to harden, and, when commencing the assembly work on the chassis see that the working part of the bench or table is covered with three or four layers of paper, and see that this is kept free from anything likely to mark the paint.

## The Circuit

The theoretical diagram is shown in Fig. 1, and it brings to light a slight error in the original description. In the first article (September issue) it was stated that a "fader" was connected across the "mike" circuit; well, this should have read across the gramo-mike circuit, thus allowing one to be faded into the other.

Two triode valves are used, V1 being a Cossor 41MHL and V2 a Cossor 41MHL. These valves have reasonably high amplification factors, which is what is wanted in a pre-amplifier which is solely concerned with voltage amplification as against power when thinking in terms of output valves.

To eliminate the characteristics normally associated with L.F. transformers, and to reduce the possibility of hum, resistance-capacity coupling is used in the anode circuits of V1 and V2.

On the input side it will be seen that only one microphone transformer is incorporated in the actual assembly, and that the input sockets (two pairs) are connected in parallel across the complete primary circuit. This arrangement is not intended to represent the method of connecting two separate microphones to the input (although results would be obtained), but it is one used by the writer so that the operator's "mike"—which is fitted inside the lid of the case—could be plugged in conveniently during tests or for speaking back to the main amplifier operator without using the performer's microphone, which may easily be some little distance from the pre-amplifier. On plugging-in the "live" side of the operator's "mike" the "live" plug of the main microphone can easily be pulled out, and vice-versa, but more about microphone circuits, etc. in a later article.

The primary circuit is completed through the switch S and the energising battery B, the negative side of which is connected to the common negative earth line through the chassis. Across the secondary is the first volume control, and this has a value of 250,000 ohms. On the panel it is the control next to the switch, thus allowing the operator to have both circuits under complete control with one hand.

The bias for V1, is provided by the voltage drop across the cathode resistor R2 the L.F. voltages being by-passed by the large capacity electrolytic capacitor C1. A high degree of decoupling in the anode circuit is secured by the resistor R4 used in conjunction with the decoupling condenser (8 mfd.) C2. The output from V1 is passed on to the grid circuit of V2 via the coupling condenser C3 which has a value of 0.1 mfd. The strength of the signal fed into V2 can be controlled by the "fader" potentiometer R5, which, as the symbol

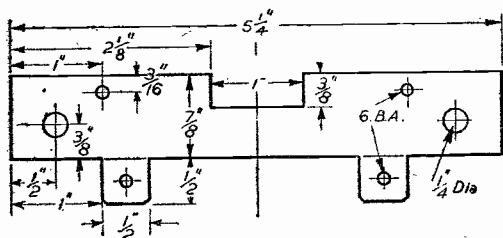


Fig. 2.—Base for condenser and resistor panel.

indicates, is to all intents and purposes, two 0.25 megohm potentiometers connected in series, but in the actual component, the moving arm sweeps over one-half of the resistance element (0.25 megohms) and then continues over the other half, which is of the same value. The centre of the track of the complete element, is connected to an additional terminal, therefore, a component of this type has four terminals, the fourth usually being well spaced from the other three to prevent confusion. If the centre point is connected to earth, as in the circuit in question, and if the output from  $V_1$  is connected across the top half, and a pick-up across the lower half, then it will be possible to fade from microphone (signal from  $V_1$ ) to pick-up and/or control the input of either to  $V_2$ . This arrangement is most useful as it actually serves three purposes, but it must not be thought of as a "mixer," i.e., the controlled mixing or blending of two or more inputs.

The resistor  $R_7$  is incorporated as a grid-stopper or decoupler, its value being 100,000 ohms. Bias for  $V_2$  is obtained by the normal cathode system, while anode decoupling is also provided for this valve by the resistor and condenser  $R_9$  and  $C_4$ . The output is taken from the fixed condenser  $C_6$  (0.25 mfd.) and the earth-negative line. Two insulated sockets are fitted to the right-hand side of the panel for the output to the main amplifier, but connected in parallel with them is the single-circuit jack, which is located between the fader control and the output sockets. The jack is to allow monitoring of the amplified signal, so that the operator can judge the strength of the signal being passed on to the main amplifier, and adjust his controls accordingly. It does not follow, however, that the 'phones will be in circuit the whole time, in fact, it is better to make checks now and then, unless, of course, the inputs are such that it becomes essential to adjust controls frequently.

The H.T. and L.T. are connected to the unit by means of a chassis mounting type of four-pin valve holder, the anode pin being used for H.T. positive; the grid pin for H.T. negative and the two filament pins for L.T.

### Construction

Only three more holes have to be drilled in the chassis, in addition to those shown in the original diagrams. Two of these are for the fixing of the microphone transformer, and they were not given in the September issue, as they naturally depend on the type of component used. A word about such components is called for at this stage, as it seems that microphone transformers, or rather their selection, receive scant consideration from other discerning constructors. These transformers, like their output counterparts, play a very important part towards securing satisfactory reproduction, therefore, when purchasing, do see that a component specifically designed for the work is secured. A good "mike" can be ruined by a poor transformer.

The two valve holders, the switch and the six insulated sockets can be fixed in position, and then the heaters can be wired, taking care to twist the wire between the two

valve holders and to see that the right-hand pin of one holder is connected to the right-hand pin of the other. Arrange the wiring so that it can be pressed well down on the inside of the chassis, and so that it is kept well clear of the grid and anode pins. Leave about four inches from  $V_2$  to make the connections to the power supply holder.

Now connect the two bottom input sockets together, again pressing the insulated wire well against the metalwork, and then repeat with the two upper sockets. Fix the microphone transformer in position after locating and drilling carefully the necessary holes for the bolts. The secondary side should be towards the front panel, as this allows easier wiring and shorter leads to the volume control  $R_1$ , which can now be fastened to the panel so that its tags are pointing upwards when viewing the inside of the chassis. Make sure that the 0-100 dial, which is held in position by the fixing nut of  $R_1$ , is located properly and not twisted round when the nut is tightened.

The microphone transformer, the switch, volume control and the grid circuit of  $V_1$  can now be wired. Note that the connection between the moving arm of  $R_1$  and the grid pin on the valve holder is screened by a short length of the metal braid sleeving over the usual systoflex, the braid being connected to the case of the potentiometer and earth or chassis.

The fader,  $R_5$ , and the two jacks  $J_1$  and  $J_2$  should next be fitted to the panel noting that  $J_1$  (the one in the centre) is upside down compared with the other. This is necessary to give clearance to the decoupling condenser as will be seen later. The output condenser  $C_6$  is of the tubular type and nestles tightly up in the corner alongside the two output sockets. The fader, the two jacks and output sockets can be connected in the manner shown on the photograph Fig. 4, but when soldering the coupling condenser  $C_3$  to the anode pin of  $V_1$  either solder another wire as well to the pin, or cut the systoflex covering the condenser wire in two pieces, so that a connection can be made to it about a  $\frac{1}{4}$  in. away from the body of the condenser. This extra wire or connection is needed for linking up with the anode load resistor  $R_3$ .

### Resistor Panel

When undertaking a compact assembly, it is usually better to try and arrange a sub-panel for carrying all

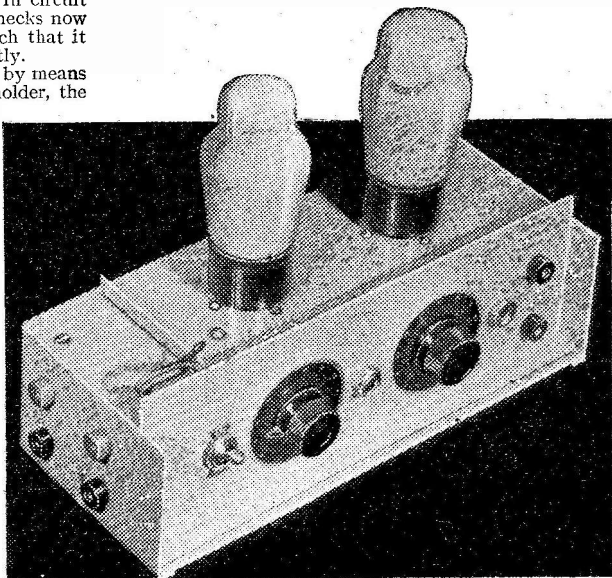


Fig. 3.—View of the completed unit.

resistors and, in some cases, fixed condensers. In this instance, a simple mounting is used to secure the resistors and the two bias condensers, but, if the reader should secure his bias condensers of the tubular carton type, it would be advisable to modify the arrangement shown by making the insulating panel longer and dispensing with the existing condenser fixing holes in the metal bracket. The latter is shown in Fig. 2, the shape being cut out of a piece of fairly stout tinplate, and the two projecting tongues bent upwards, after the 6B.A. clearance holes have been drilled in them. The two  $\frac{1}{4}$  in. holes, one at each end of the strip, are for the fixing of the Dubilier electrolytic condensers C<sub>1</sub> and C<sub>5</sub>, as they are provided with threaded shank and nut at one end of their metal cases. It is necessary to cut off the surplus threaded portion, once the condensers are bolted in position, to prevent them forcing the metal bracket strip upwards.

The resistor panel is cut, to the dimensions shown in Fig. 5, from a piece of paxolin or fibre, and two pin holes are drilled to coincide with the ends of each resistor, and the two fixing bolt holes along the bottom edge. The wire ends of the resistors are threaded through the pin holes and back again, thus anchoring the components firmly in position. Note the bottom ends of R<sub>2</sub> and R<sub>6</sub> are soldered to the metal strip, which, in turn is eventually earthed.

Assemble all the resistors on the panel, and complete connections as far as possible, i.e., join the H.T. ends of R<sub>4</sub> and R<sub>9</sub> together, connect R<sub>8</sub> to R<sub>9</sub>, and R<sub>3</sub> to R<sub>4</sub>, and solder on leads of tinned copper wire to the anode ends of R<sub>3</sub> and R<sub>8</sub>. Now bolt the panel to the metal strip bracket and, after placing C<sub>4</sub> in position, i.e., under J<sub>1</sub> across the heater wiring, fasten the bracket to the side bolts holding the valve holders by means of additional nuts.

The power supply valve holder can be bolted to the end of the chassis, and more wiring completed, the last component to be placed in position and wired being the remaining decoupling condenser C<sub>2</sub>. A word of warning regarding earthing the chassis. It is best for the contact to the chassis to be made near V<sub>t</sub>, therefore a soldering tag is fitted under one of the feet of the microphone transformer, and this is connected to various parts of the circuit as shown in the wiring plan. Whatever system is used, one must remember to scrape away all traces of paint, get right down to bright metal, at the earthing contact spot.

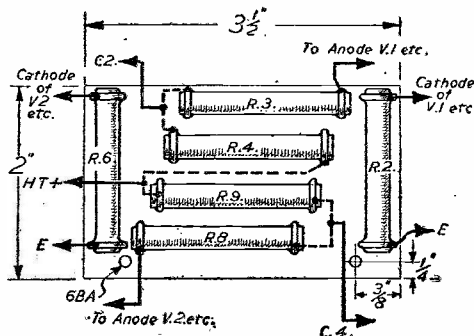


Fig. 5.—Resistor Panel.

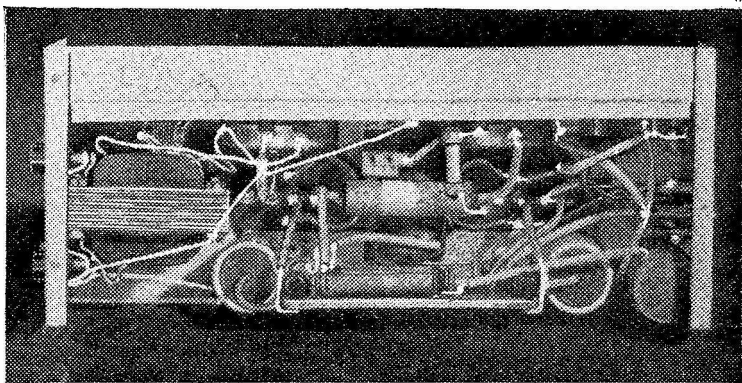


Fig. 4.—Underneath view.

### COMPONENTS

- One microphone transformer, 30:1. (T.)
- One vol. control, 0.25 megohm. Pot. Dubilier. (R1.)
- One faded vol. control, 0.25+0.25 megohm. Dubilier. (R5.)
- Two 8 mfd. elect. condensers, 350 v. Hants. (C2 and C4.)
- Two 20 mfd. elect. condensers, 12 v. Dubilier. (C1 and C5.)
- One 0.1 mfd. condenser. Dubilier, T.C.C., etc. (C3.)
- One 0.25 mfd. condenser. Dubilier, T.C.C., etc. (C6.)
- One toggle switch. On-off. Bulgin. (S.)
- Two single circuit jacks. Bulgin. (J1 and J2.)
- Two 0-100 dials. Bulgin.
- Six sockets (insulated type).
- One 100,000 ohm resistor,  $\frac{1}{2}$  watt. Dubilier. (R1.)
- One 50,000 ohm resistor, 1 watt. Erie. (R3.)
- One 25,000 ohm resistor, 1 watt. Erie. (R4.)
- One 20,000 ohm resistor, 1 watt. Erie. (R9.)
- One 30,000 ohm resistor, 1 watt. Erie. (R8.)
- One 1,000 ohm resistor, 1 watt. Erie. (R2.)
- One 750 ohm resistor, 1 watt. Erie. (R6.)
- Two 5-pin chassis type valveholders. Clix.
- One 4-pin chassis type valveholder. Clix.
- One Cossor 41 MH. (V1.)
- One Cossor 41MHL. (V2.)

### Connections

With a circuit of the type in question, one cannot be too careful about good connections. Soldering is strongly advised, in fact it is practically impossible to build the design without using this method, but, even so, for soldered joints to be effective and trouble free, they must be good. Avoid excessive use of flux, and on no account use a "killed acid" flux. See that the parts to be soldered are perfectly clean and tinned, and that the soldering iron is likewise and at the correct temperature. If the solder does not flow smoothly, or the parts are moved during cooling, there will always be the risk of a "dry" joint, which can prove very troublesome. (To be continued)

### "VICTORY ANTHEM"

DR. RALPH VAUGHAN WILLIAMS has written a "Victory Anthem" at the request of the B.B.C. It will be broadcast when victory comes.

Scored for soprano solo, narrator, organ, chorus, orchestra and children's voices, the work is described by Sir Adrian Boult as being well up to the composer's high standard. Dr. Vaughan Williams has taken the words of the anthem from various sources—passages from the Apocrypha; Shakespeare's "Henry V.," the Book of Isaiah and Kipling's "Puck of Pook's Hill."

The 71 year old composer was awarded the Order of Merit in 1935, and during the week of his 70th birthday the B.B.C. broadcast some of his most important works.

At the Promenade Concerts last year his Fifth Symphony in D major was given its first performance. It made a great impression on critics and public alike.



# Radio Examination Papers—35

Double-humped Tuning, Power Factor, Secondary Emission, Noise Suppression and Tone-compensated Volume Control, Form the Subjects of This Month's Questions and Answers

By THE EXPERIMENTERS

## QUESTIONS

1. Explain the term "double-humped tuning," and state how and when it occurs.
2. What is meant by power factor in relation to an A.C. circuit? Illustrate your answer by means of a vector diagram.
3. Draw a diagram for a simple noise-suppression circuit, and briefly explain its action.
4. What is secondary emission, and what is its effect when it occurs with certain types of receiver valve?
5. How may an L.F. volume control be modified to prevent its affecting the tone, as well as the volume, of reproduction?

### 1. Tuning Circuits

WHAT is generally described as double-humped tuning is easily recognised by the fact that maximum signal strength is obtained at two settings of the tuning condenser. The settings are very close together, and minimum signal is heard at a point between the two maximum signal settings. The reason for the name is explained by Fig. 1, which is a diagram showing the response or output of a tuned stage for different settings of the tuning condenser, or frequency control.

There are three curves in Fig. 1. One, shown by a broken line, is for a sharply-tuned circuit, with which the output falls rapidly as the condenser is moved slightly to each side of the signal frequency,  $f$ . Tuning of this sort is described as "peaky," due to the shape of the curve. A second curve is shown as a chain line. This represents a less sharply-tuned circuit, where the peak is well rounded. The third curve, shown as a full line, is that which represents a circuit in which "double-humped" tuning occurs; the two humps, one on each side of the correct frequency setting, are evident.

If the circuit represented were that of an intermediate-frequency amplifier, the peaky curve would indicate

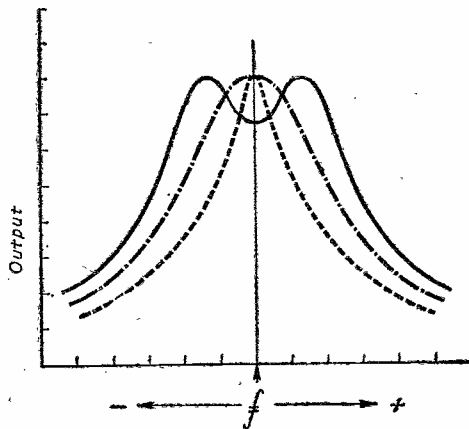


Fig. 1.—Different types of resonance curves for tuned circuits. That shown by a broken line is for a sharply tuned or loose-coupled circuit, that in a chain line is for a critically tuned circuit, while the double-humped curve shown as a full line is the result of the coupling being too tight.

.. P.

very loose coupling between the primary and secondary windings of the I.F. transformer. The second curve would be that obtained by increasing the primary-secondary coupling, while the third one would result from excessively tight coupling between the two windings. Similar curves could be plotted for an aerial or other inter-valve circuit in which inductive coupling is used between two coils. It should be pointed out, however, that the second and third curves would probably be lower than the first, since the maximum or peak output would generally fall somewhat. This does not always follow, but, in any case, it is unlikely that all curves would reach to the same maximum point; as show for greater clarity.

The double-humped effect could be caused by overloading of the valve at maximum coupling, or to the action of A.V.C. It can also result from the reaction of one tuned circuit on the other.

Use can be made of the principle of double-humping to provide band-pass tuning, but in that case the two "humps" would be brought closer together than shown, so that the "trough" between them was not so marked. For the two "humps" to be equal it is necessary to take great care that the two coils which are coupled together have the same  $L/r$  (inductance to high frequency resistance) ratio.

### 2. Power Factor

In a D.C. circuit, power is measured as a product of current and voltage; for example, if the current through a circuit is 5 amp. and the voltage across it is 12, the power dissipated is 60 watts.

The same general principle applies in an A.C. circuit, but there is the important difference that current and voltage are not in phase, when the circuit includes inductance and capacitance, as it generally does. And if the voltage and current are not in phase the power cannot be determined merely by multiplying the two figures together. In fact, the resultant would be simply "apparent" power; this is correctly given in terms of volt-amperes—not in terms of watts.

In order to convert apparent power in volt-amperes

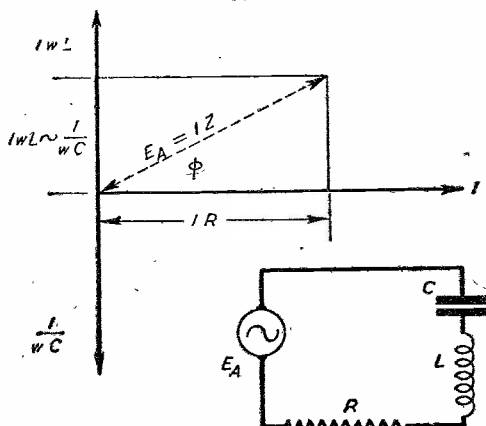


Fig. 2.—A simple A.C. circuit, and a vector diagram used to illustrate the meaning of power factor, which is dealt with in the reply to question two.





# ON YOUR WAVELENGTH.

By THERMION

## A New Flux

ONE of the difficulties in radio construction concerns the fluxes for soldering certain parts. A flux must ensure a sound joint, and yet be non-corrosive; that is why zinc chloride must not be used. For most purposes a resinous flux such as Fluxite serves the purpose.

I learn, however, that a new flux known as Levulinic acid, which is a derivative of ordinary laundry starch, is being blended with resin to form a satisfactory fluxing agent for soldering steel parts of radio equipment, for which resin alone is too inactive, and zinc chloride requires extensive washing afterwards to prevent corrosion.

Personally, I use either Fluxite or one of the resin-coated solders; which reminds me that for many years I have been using one of the Fluxite methylated spirit blow-lamps. I have in it a handy and faithful friend, immediately available as a source of heat for doing small soldering jobs, especially out in the open where an ordinary soldering iron rapidly chills, and when it is desired rapidly to make a soldered joint. I realise that this is not a suitable method for some components with Bakelite and other forms of plastic cases, for they melt under the heat.

## After the War

AFTER five years of war more than 3,000,000 homes need new radio sets, and equipping them again will take a considerable time after the radio industry is able to get back into full production. Many listeners who have been without a set for a long time may still have to wait, and that is why the Board of Trade, working in co-operation with the industry, organised the production this year of 250,000 standard sets. These are competently designed receivers with a very efficient performance, differing only in superficial details from normal peacetime sets of a similar type. People who expect to find plenty of brand new sets in the shops three or four months from now may be disappointed. Those who need and can buy sets now should do so, for whilst production of receivers for civilian purposes may be expected to begin shortly after the war, some time must elapse before output in pre-war quantities is achieved.

## Television

MANY people are anticipating that large quantities of television receivers will be available immediately after the war, as the result of an ill-advised article in a Sunday newspaper which stated that a television service was likely to start almost immediately. This is most unlikely, and I can say that the B.B.C. has denied it, and members of the industry state unequivocally that they will not be ready with television receivers until the B.B.C. is ready to put out worth-while programmes several nights a week. No firm intends to invest large sums of money in television if the B.B.C. does not

intend to put out daily programmes of considerable duration in order to create public demand. There is also the question of the erection of a network of television transmitters so that the whole country can be served.

Pre-war the television service amounted to nothing more than a local service, and the demand for receivers was therefore local, and hence small. When the B.B.C. has made its announcement on its post-war policy so will firms produce designs.

It is also possible that there may be another reshuffling of wavelengths on an international basis; if, indeed, any sort of cosmos can be created out of chaotic Europe after the war.

There is also the question of sponsored programmes. Is British money in the post-war period going to Radio Normandy and Luxemburg to attract British listeners away from B.B.C. programmes? The B.B.C. in its half-hearted attempt some years before the war to encourage sponsored programmes accepted large sums of money from firms who merely obtained in return the doubtful advertisement "this programme is sponsored by Messrs. So-and-So." Naturally, firms were not anxious to pay so much to get so little, and that is an adequate answer to the B.B.C. who, when challenged concerning their policy towards sponsored programmes, airily answer that they did try it once, but firms were not anxious to repeat the experiment! And no wonder. Industry is not a philanthropic institution anxious to pay large sums of money for public entertainment unless they get something back for it.

## Car Radio

THE removal of the ban on car radio, a ban which I always thought unnecessary and ill-advised, has naturally created a demand which cannot be supplied. In chatting over the matter with car manufacturers, I was informed that post-war cars will not incorporate car radio as standard equipment until at least two years after the war. They will not be able greatly to modify the cars they were selling in 1940, and the rubber shortage will certainly prevent full output for some time, so they intend to concentrate on their pre-war models until normality returns to the world, if it ever does! In the meantime, car radio sales will be left to firms to supply as an extra, and these firms are, of course, outside the motor trade.

Very little experiment has been undertaken during the war on the involved problems of car radio which will not be rendered less easy if television develops; for interference from the ignition system of cars was one of the problems with which designers of television receivers had to contend, and this superimposes itself on the problem in obvious ways.

## DUET: "RADIO PARIS CALLING."

LA BELLE FRANCE:  
Ici Radio Parée! Ici Radio Parée!  
The Nazis have gone, and again we are Free.

BRITANNIA:  
Hearty congrats! We welcome the chance  
To tune in again to the voice of Free France.  
Now that *Achtung!* no longer that horrible word  
From your radio stations again will be heard,  
His doom drawing nearer, let Hitler beware  
For by radio together this oath let us swear:  
That never again shall such monsters as him  
Broadcast through the ether their gospel of sin;  
And, if ever they try to, their end shall be fitting—  
They'll be blasted to Hell from where they're transmitting.  
"TORCH."

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G. Clark (AC/1 R.A.F.).  
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I. P. Brennan (Wireless Mech. R.E.M.E.).

# Modifying Moving Coil Meters

**A** LOW-DEFLECTION moving coil meter is a useful instrument, for by means of suitable shunts and series resistors it can be made to cover almost any desired voltage and current range; it will also measure resistance when used with a small battery. Unfortunately, such meters are very expensive and difficult to obtain these days. However, a few meter movements (generally of a fairly high full-scale deflection) are still obtainable from advertisers in PRACTICAL WIRELESS, and it is usually possible to convert these to give a low full-scale deflection. The main methods of doing this are given here. It is best to obtain a large movement if possible, as it is easier to modify.

## Measuring Deflection

First remove any shunts connected across the meter. It should then be tested to ascertain its approximate full-scale deflection. This may be done by connecting the meter with a 10,000 ohm series resistor to various voltages from a H.T. battery. 24 volts will pass 2.4 mA. through the meter; 36 volts 3.6 mA., and so on. Note down the full-scale deflection.

The general construction of a moving coil meter is shown in Fig. 1, and this should be studied in relation to the points mentioned.

## Rewinding the Coil

First rewind the moving coil. Carefully note how it is fitted, so that it can afterwards be replaced. It will be found that the ends of the winding are connected to the hairsprings which serve to return the pointer to zero. The new winding should be of the finest wire to hand and similarly connected. Give it a thin coat of varnish when wound to hold the turns secure. The number of turns which will provide a given deflection may be calculated from the F.S.D. of the meter as it originally was and the number of turns then on the moving coil. Putting on twice as many turns will halve the current for F.S.D.; four times the turns will quarter it, and so on. A movement obtained had 20 turns of fairly thick wire and a F.S.D. of 20 mA. It was possible to rewind with 350 turns of fine enamelled wire from an old L.F. transformer. 400 turns would have given a F.S.D. of 1 mA., but there was not sufficient room for this.

Do not wind on so much wire that the coil cannot turn freely between the pole pieces when replaced. This work must be carried out with care, of course. Detailed instructions are not given, because a careful examination of the movement obtained before dismantling will enable it to be easily reassembled.

## The Hairspring

If as many turns as possible have been wound on the coil and the F.S.D. is still too high, the hairsprings should receive attention. Stout ones are sometimes used, and replacing these with finer springs (obtainable from a clockmaker or jeweller) will make the movement much more sensitive. Steel springs are not suitable. The old hairsprings are carefully unsoldered and the new ones fixed in their position. Twisting a length of 14 s.w.g. wire round the soldering iron with about  $\frac{1}{2}$  in. projecting to use as an extension for soldering will enable this to be done without undue difficulty.

It will probably be found that it is not necessary to replace the hairsprings at all unless they are very thick.

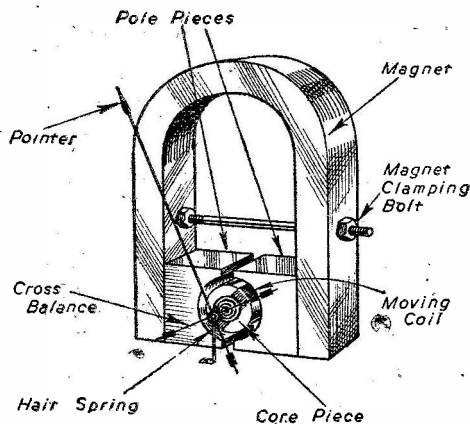


Fig. 1.—Diagrammatic view of a moving coil meter.

## The Pointer

The pointer may be lengthened, and this is a very easy method of arriving at a certain deflection, such as making a 1.5 mA. movement read 1 mA. full-scale. When rewound the movement mentioned had a deflection of approximately 1.2 mA. This was reduced to 1 mA. by increasing the length of the pointer by about  $\frac{1}{2}$  in. A  $\frac{1}{2}$  in. long pointer will need to turn through approximately 50 deg. for a  $\frac{1}{2}$  in. deflection; if the pointer is lengthened to  $\frac{3}{4}$  in. it only need turn through 35 deg. for a similar deflection of  $\frac{1}{2}$  in. With the instrument mentioned, a deflection of  $\frac{1}{4}$  in. is obtained with 1 mA.

After altering the length of the pointer, or rewinding the moving coil, it is desirable to balance the movement. Small balance weights can be seen in Fig. 1. They are usually coiled lengths of wire upon an aluminium cross-piece. The pointer is similarly counterbalanced by a small weight on its opposite end. To balance the movement, first lie it flat. Tipping it to one side and then the other will immediately show upon which of the cross members additional weight is needed. Small pieces of thin wire may be crimped on to the arms where necessary with pincers and secured with a touch of varnish when the proper balance is obtained. Treating the movement in this manner will assure that it gives the same reading in whatever position it is held.

If the movement is very insensitive it is possible that the permanent magnet has become weak, although this is very unlikely. Magnets of many sizes are obtainable, and a new one of the correct dimensions must be obtained to replace the old one.

## Mounting

The method of finally mounting the converted meter depends upon the individual details of the unit. Brackets, cut from non-ferrous metal, and held to the unit by the magnet-clamping bolt, or the screws which held the original scale in position, are one convenient method of mounting. The brackets are then secured to the panel upon which it is desired to fit the meter. If the pointer has not been lengthened the movement may be replaced in its original case. If this is done the original scale can be removed and a new one drawn out with suitable markings for volts, mAs., etc., in accordance with the new deflection, and the purpose for which the meter is to be used.

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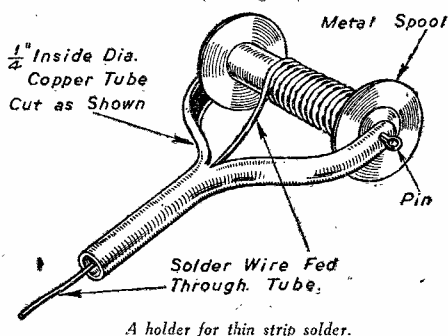


# Practical Hints

## Handling Thin Strip Solder

**R**ADIO-SERVICEMEN and other users of rolls of solder will find the following a neat and convenient way of handling same, and eliminating waste.

A wooden or metal spool, such as a roll-film spool, is fitted with a tubular guide formed by splitting a piece of copper or brass tubing lengthwise, as shown in the sketch. Two holes are drilled through the ends of the split tube, and a pin is inserted through the spool and the holes in the tube. When in use the solder is fed down the tube while the spool itself may rest on the back of the hand.—V. CARTY (Erdington).



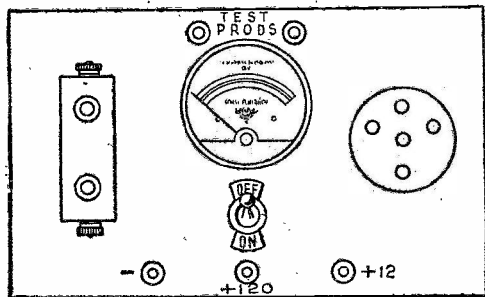
A holder for thin strip solder.

## A Continuity Tester

**T**HE accompanying diagrams show the circuit and layout of a simple continuity tester. The circuit is a very simple one but the instrument is extremely useful, especially when valves and coils are to be tested.

A plug-in coil holder, the filament (or heater) terminals of a valve holder, and two terminals for test prods were wired in parallel. In series with these were wired an old voltmeter and a  $4\frac{1}{2}$  volt battery. A plug-in coil or the filament of a valve may be tested by simply inserting them in their respective holders. If the needle of the meter flicks over, the component is in working order, at any rate as far as continuity is concerned. Other components may be tested with the test prods. The instrument will test almost any component, provided that the resistance is not too high. It will not, of course, test more than one at a time.

A switch was included in the circuit so that the battery would not run down if the test prods were accidentally short-circuited and three other terminals



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## SPECIAL NOTICE

All hints must be accompanied by the coupon cut from page iii of cover.

were connected to those of the voltmeter for battery testing. The completed instrument was mounted on a cigar box about an inch deep, with the battery fixed underneath.—R. L. STOKER (Market Harborough).

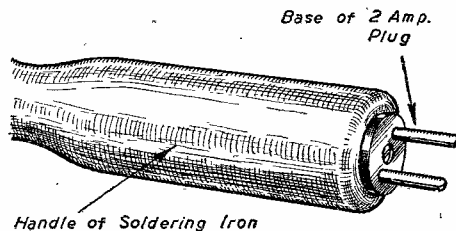
## Improved Connection for Soldering Iron

**A** GREAT deal of trouble can be experienced in repairing the connections to an electric soldering iron. I am using a very simple dodge which makes the only repairs necessary outside the handle of the iron. I have attached to the handle of the iron a 2-amp, 2-pin plug, and to the mains lead a 2-amp. socket.

By means of this simple dodge the most common trouble with an electric iron (other than a burn out) is eliminated.—N. L. COWELL (Cheshunt).

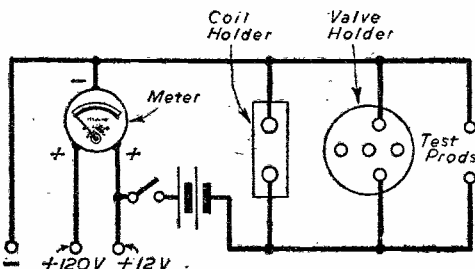
## Extension Speakers

**D**URING a recent week-end I was asked to examine a friend's receiver which had been gradually losing its sensitivity. I applied the usual voltage and current tests; and contrary to my expectations I found them to be normal, indicating that the valves and batteries were in order. The grid circuit components also seemed to be in order so I suspected the speaker, which was an old cone model plugged into a socket board attached to the wall, the sockets being connected to the speaker



A handy method of connecting an electric soldering iron.

terminals of the set by means of long flex leads. Another speaker happened to be available so I joined this direct to the receiver L.S. terminals, and signal strength increased threefold. At first, I thought that my friend's speaker was at fault, but when this was joined direct to the set instead of to the wall socket satisfactory reception was again obtained. The loss of volume was eventually traced to a leakage across the two flex leads connecting the set to the wall sockets, and when these leads were replaced signal strength reached normal level.—R. PRITCHARD (Wembley).



Front view of finished tester, and diagram of connections.

# Aerial Principles and Practice-4

This Final Article of a Short Series is Concerned With Directional Aerial Systems for Both High and Ultra-high Frequencies

IT has already been explained that most aerial systems have certain directional effects; these are evident from a study of their polar diagrams. But it is often necessary to employ an aerial in which the directional property is very marked. This may be in order to obtain greatly increased range in one direction, or in order to minimise interference with receivers not intended to pick up particular transmissions. Highly-directional aerials are normally used with transmitters only, but directional receiving aerials have their use, chiefly in connection with the elimination of interference.

In the case of a receiving aerial for use on medium waves, a rotating loop is often suitable, although its sensitivity is much less than that of a normal fixed

governed by the frequency or wavelength on which the aerials are to be used.

## The "V" Bi-directional Aerial

Perhaps the simplest type of long-wire directional aerial is the co-called "V," which is illustrated in Fig. 1. This consists of two wires, each a multiple of one quarter-wave in length, and mounted at an angle to each other (in plan). The "V" aerial is bi-directional; that is, it has maximum radiation along two lines in opposite directions. The form taken by the horizontal polar diagram is shown inset in Fig. 1. The width of the beam, and hence the gain of the aerial, is governed by the length of the two arms and the angle between the arms. The upward angle of radiation is largely governed by both the height and length of the aerial.

It is possible to determine the beam width if the length of the arms, in terms of wavelength ( $\lambda$ ), and the angle between the arms ( $\alpha$ ) are known, and tables and graphs are given in various textbooks. It would not be possible to give all of the relevant data in the space available here.

## Matching to the Aerial

Reference to Fig. 1 will show that two alternative methods of feeding the "V" aerial are possible. If the length of the arms is an odd number of quarter-waves long, the apex can be current fed through a 120-ohm feeder, but if they are an even number of quarter-waves in length, voltage feed is necessary. As the resistance at the apex of the latter type of aerial is very high, it becomes necessary to use a quarter-wave matching stub in conjunction with 600-ohm lines. It has previously been stated that a quarter-wave section can be used to match a high-resistance aerial to a lower-resistance circuit. By choice of suitable tapping points on the quarter-wave stub, it is a fairly easy matter to match the high-resistance aerial to the 600-ohm lines.

(Continued on page 503)

aerial. Other aerial systems intended for direction-finding can also be used with a receiver. They are fully satisfactory, but generally require to be somewhat more complex than is necessary for purposes other than D.F. As the subject of direction-finding has been dealt with in these pages on a number of occasions in the past, it is not proposed to consider D.F. aerial systems here.

## Long- and Short-Wire Arrays

The loop or other form of D.F. system is not satisfactory for use with a transmitter, because of its relatively low efficiency. What is required is an aerial that will produce a "gain," or increase in radiation in one or two directions only. That a gain in radiation can be obtained is not difficult to understand when it is realised that the whole of the transmitted power is confined to a more or less narrow beam of a few degrees width, instead of being radiated through a full 360 deg. In the case of all of the aerials which will be described it should be understood that they can be used with either a receiver or transmitter, although reference to them may relate to their use with a transmitter only.

In dealing with directional aerials it is customary to subdivide them into long-wire and short-wire or multi-element systems. The former are generally at least one wavelength long, and preferably not less than one half-wavelength in height. The latter, on the other hand, are generally no more than about one half-wavelength long, although there may be various half-wave units connected together. There is no really sharp line of demarcation, however, and the length in any case is invariably

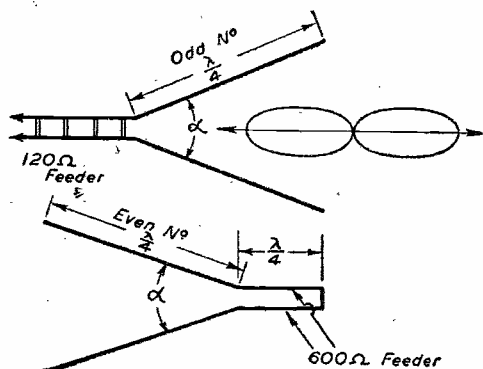


Fig. 1.—Details of the "V" type of bi-directional aerial. Two different methods of feeding it (according to whether the arms are an even or odd number of quarter-waves long), and inset is shown the form of the horizontal polar diagram.

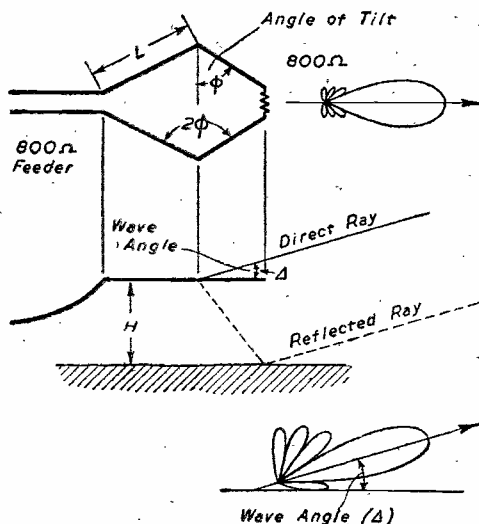


Fig. 2.—These diagrams show a rhombic aerial in plan and elevation, whilst the horizontal and vertical polar diagrams indicate the general radiation pattern.



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It should be noted that a "V" aerial cannot be of very much value unless the aerial wires are at least one-and-a-half wavelengths long; it is also important that the height should be not less than one half-wavelength. By way of example, it may be stated that for wires two wavelengths long the angle between the wires should be approximately 70 deg. Such an aerial one half-wave high would produce an upward wave angle of about 25 deg.; this angle may be approximately halved by increasing aerial length to eight wavelengths.

Obviously, the chief objection to the "V" aerial is the large ground area required for its erection.

### The Rhombic Array

Another type of directional long-wire aerial is the so-called rhombic; the reason for the name will be evident from a glance at Fig. 2, which shows the form taken by the aerial in plan. The system is of diamond shape, and is terminated at one end in an 800-ohm non-inductive resistor. It is uni-directional, in the direction of the terminating resistor, whilst the gain

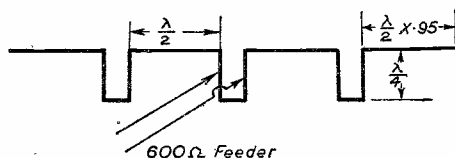


Fig. 3.—A four-section co-linear broadside aerial with quarter-wave matching stubs.

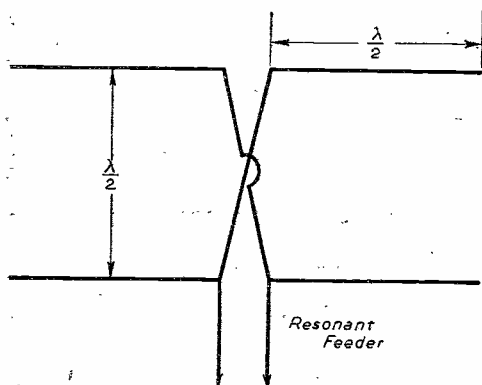


Fig. 4.—The "azy-H" broadside aerial array.

(and hence the narrowness of the angle of the beam) is governed chiefly by the length of the sides of the diamond. The upward angle of radiation, or wave angle, is determined by the length, and also by the height of the aerial. An increase in length reduces the wave angle and calls for an increase in the angle of tilt. As an example, a rhombic aerial one half-wave high, with sides two wavelengths long, will give a wave angle of 22 deg., and the angle of tilt should be 66 deg. If the length is increased to 10 wavelengths, the wave angle becomes about 13 deg., and the angle of tilt should be approximately 77 deg.

### Use on Harmonics

It will be obvious that both "V" and rhombic aeriels can be used on wavelengths both above and below that for which they are designed, provided that the wavelengths are in arithmetic ratio. Thus, an aerial intended for 40 metres could be used also on wavelengths of 20 and 80 metres. In the case of a "V" aerial it would be necessary to use a length equal to an even number of quarter-waves.

### Co-linear Broadside Array

Another type of long-wire directional aerial is the so-called co-linear shown in Fig. 3. This is a broadside array, which means that the lobes of radiation have their major axes at right angles to the aerial. It will be seen that there are four half-wave sections, separated by quarter-wave stubs, the purpose of which is to ensure that the current in the various sections is in phase. One of the stubs is used for matching to the feeder, as illustrated. Although it has been stated that all four sections are one half-wave long, it will be understood that the two end sections must be only about 95 per cent. of that length, to allow for end effect, which has previously been explained. It is possible to increase the gain, and narrow the beam width, by adding additional half-wave sections. Alternatively, only two such sections are necessary if a broad angle of radiation will suffice.

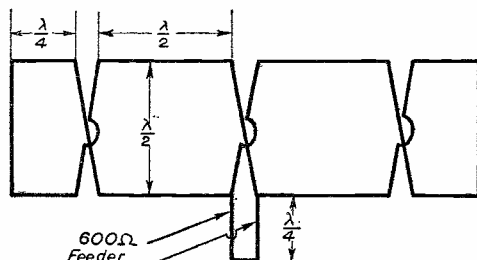


Fig. 5.—The Sterba aerial. Its directivity can be increased by the use of additional half-wave sections. A reflector may be placed a quarter-wave behind the aerial to render the system uni-directional.

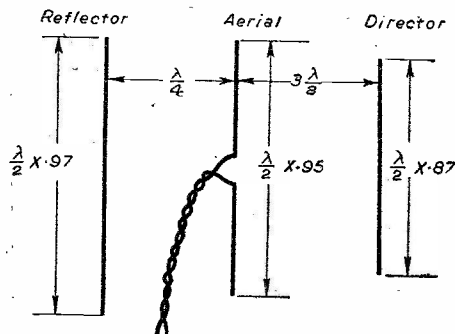


Fig. 6.—Details of a simple Yagi aerial having only one director. The beam angle may be reduced—and the aerial gain increased—by the use of additional directors.

### Half-wave Arrays

Fig. 4 shows an aerial array which is in some respects similar to the co-linear in that four half-wave sections are so arranged and fed that the currents are in phase. This gives a broadside directional effect, but the beam is fairly wide. Tuning of the system is not very critical, and it can, therefore, be used a little on each side of the frequency for which it is designed. The gain can be increased by "stacking" a greater number of half-wave elements, and by using one or more extra "stacks" alongside. In all cases all aeriels must be fed in phase.

Although resonant feeders are indicated in Fig. 4, it is just as easy to replace the feeders by a quarter-wave matching stub, as previously explained, and to attach a 600-ohm line to this. Uni-directional instead of bi-directional radiation can be obtained by placing a reflector, such as a wire-mesh screen, one half-wave behind the array.

### The "Sterba" Aerial

Another broadside array, which has a high gain, is that known as the "Sterba," and shown in Fig. 5.

(Continued on page 504)

# Calculator for Resistances

A Useful Device for Calculating According to the R.M.A. Code. By E. G. BULLEY

**T**HE R.M.A. colour code for deciding the values of resistances are set out below:

Black .. 0	Orange . 3	Violet .. 7
Brown .. 1	Yellow.. 4	Grey .. 8
Red .. 2	Green .. 5	White .. 9
	Blue .. 6	

Resistances controlled by this code are marked in various colours, namely the body, the tip and the dot.

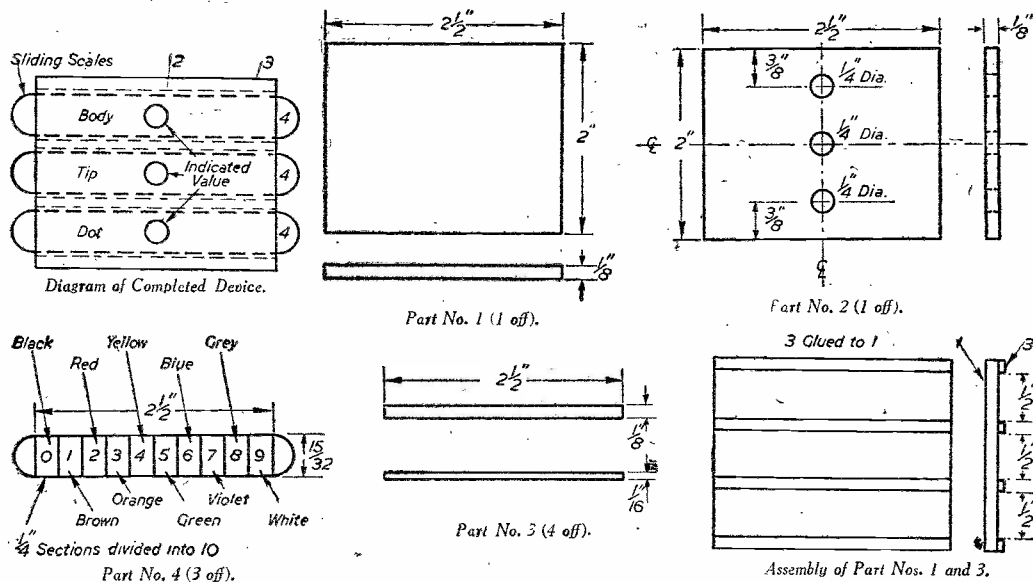
The colour of the body gives the first figure of the resistance value, whereas the colour of the tip denotes

Our next step is to obtain some stiff white cardboard and proceed to make up as Part 4, painting the different colours as shown, not forgetting to mark the specified number on the painted surface.

These scales should then be inserted into main assembly, and to further aid the user suitable labels can be stuck on to the front of Part 2.

Having completed the calculator, the method for calculating is as follows:

*Example:* A resistance with a red body, blue tip and orange dot, what is its value?



the figure that follows and the colour of the dot indicates the number of noughts that follow the two previous figures.

To calculate these values by a quick and easy method, a small calculator can be constructed at a cost of a few pence. The construction is simple and is as follows:

Obtain an old celluloid set-square, approximately 1 in. thick and cut two pieces, as shown in Parts 1 and 2. No. 3 can be made from stiff cardboard and glued to Part 1, as shown. After Part 3 has completely and firmly stuck to Part 1, proceed to glue Part 2 to the Part 3 assembly, then allow to dry; this forms the main part of the calculator.

**Method:** Move top scale until colour red appears in top indicator hole and note the number=2.

Move centre scale until blue appears in indicator hole—note number=6.

Move bottom scale until orange appears in indicator hole—note number=3. This figure indicates the number of noughts that are to follow the two previous figures.

The value is then 26,000 ohms.

This calculator can also be used vice-versa; that is to say, if you know the value in ohms, the colours can be derived.

## AERIAL PRINCIPLES (Continued from page 503)

This calls for little explanation, but it should be added that virtually any number of half-wave sections may be used on each side of the feeders, provided that each side is terminated in a quarter-wave section as shown. An aerial of this type occupies a good deal of space, even when used on U.H.F., but it is very effective. It can be made uni-directional by the use of a reflector of the kind previously described. Its erection can be arranged by providing a wooden frame, or two masts with support ropes and insulators between them. A much simpler type of directional aerial is shown in Fig. 6. This consists of a half-wave dipole, with a reflector situated one quarter-wave behind it. There may also be one or more directors in front of the aerial. The greater the number of directors the higher the gain of the aerial,

which is known as the "Yagi." This is uni-directional, and is ideal for use on U.H.F. and in a confined space. The aerial, reflector and directors would normally consist of metal rods attached to a horizontal support of good insulating material.

When working on centimetre wavelengths very narrow beam aerials are satisfactory and fairly easy to produce. It is necessary only to mount a small dipole at the focus of a parabolic reflector. This reflector requires to have a diameter equal to several wavelengths, for which reason it would scarcely be a practical proposition for wavelengths in excess of, say, half a metre. Even for a wavelength such as that the reflector would have to be 2 ft. or more in diameter! As it is unlikely that many readers will ever have an opportunity of making and using an aerial system of this type, it is not intended to attempt to give a fuller explanation.

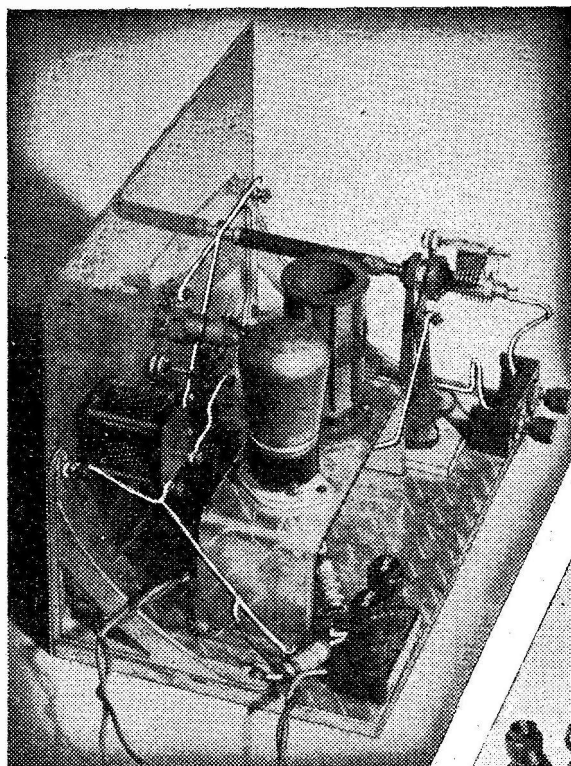
# Short-wave Radio-3

Local Conditions. Planned Listening.

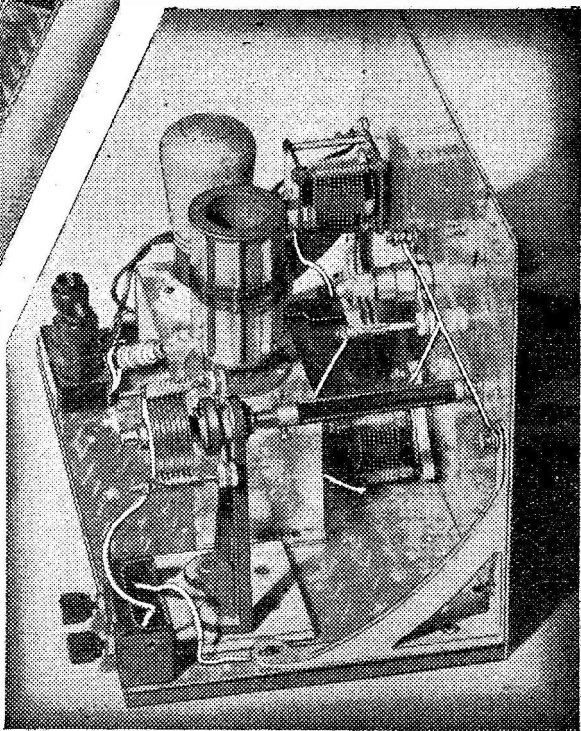
Constructing a DX One-valver.

By 2CHW

*(Continued from page 469, October issue.)*



WHEN dealing with the design, operation and installation of broadcast receivers covering the normal medium- and long-waves, one is able to estimate within quite narrow limits the results likely to be obtained. This is not guesswork, but a simple application of data which is now available, and it is reasonable to say that anyone well versed in such matters could tell whether this or that particular receiver would be suitable for use in a given district, and whether it would receive certain specified transmissions. In the early days of broadcasting, before the introduction of high-efficiency valves, circuits and components, and before those concerned had been able to determine reliable figures relating to "field-strength" all over the British Isles, many listeners were sorely disappointed with the results they obtained from the Blank Super Three, which in the next county enjoyed such popularity owing to the wonderful results it gave. Experience and progress have enabled the manufacturers to tabulate these poor reception areas and take steps to ensure that the receivers most suitable for the various local conditions are supplied to those areas, while, on the other hand, the B.B.C. engineers do everything in their power to try to provide transmissions which will give a field-strength over the whole of the service area sufficient to ensure satisfactory reception. Whatever steps are taken by the designers, manufacturers and the B.B.C. the fundamental cause of the poor reception in any one area still remains, and to give it a name, one cannot do better than use that ambiguous expression "local conditions," an expression which, unfortunately, can be used as an excuse for poor performance of a poor receiver, or to cover geographical, geological and atmospheric conditions in the area concerned, or between it and the transmitting station.



Figs. 1 and 2.—Two views of the DX 1-valver.

When considering the shorter waves, or the higher frequencies, it is extremely difficult to predict results at any given spot, as so much depends on the vagaries of the two conducting belts or layers in the "ionosphere", known as the Heaviside and Appleton layers, which directly influence the propagation of radio signals, especially those of high frequency. The effect of these layers varies with the time of day and seasons, as they are formed by the ionisation of the earth's outer atmospheric belts by the sun, but as they have been fully described in past issues, the subject will not be dealt with in detail now. Solar disturbances or "sun-spots," and severe electrical storms, will also affect the ionisation of the layers, while local conditions—and in this instance local can be restricted to a mere two or



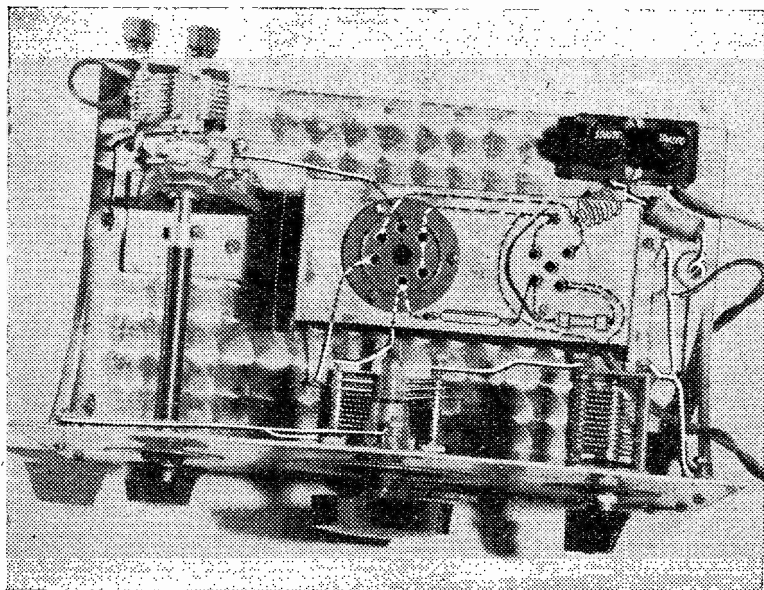


Fig. 4.—Top of chassis view of DX 1-valve.

The four-pin valve holder, and the six-pin coil holder are mounted on a raised metal platform so that their connections to their respective condensers, etc., are reduced in length, and so that the capacity to earth between them—the holders—and the metal-covered baseboard is reduced to negligible proportions. The metal strip forming the platform is cut from a piece of aluminium approximately 18 gauge, the dimensions being 10in. x 4 $\frac{1}{2}$ in. After squaring off the strip, mark lines parallel with the narrow sides,  $\frac{1}{2}$ in. and 2 $\frac{1}{2}$ in. in from each end. These form the bending lines for the  $\frac{1}{2}$ in. wide feet and the two vertical supports. Do not do the bending until the two holes have been drilled for the holders. These are located on a centre line running the length of the strip, and their centres are 1 $\frac{1}{2}$ in. in from the top edge of the platform for the coil holder and 1 $\frac{1}{2}$ in. in from the opposite edge for the valve holder. The diameter of the holes is 1 $\frac{1}{4}$ in. and 1in. respectively. After drilling these holes, locate the holders in position, noting how they are placed on the plan view, and mark the drilling spots for the fixing bolts.

When the holders are bolted down, with short 6BA round-head bolts, solder all connections to the pins, using for preference 18 s.w.g. tinned copper wire. If each wire is shaped correctly, there will be no need to use any insulating covering. The grid condenser, which is a Dubilier flat moulded mica dielectric type, is soldered directly between the grid pin of the valve holder and pin No. 1 of the coil holder; the 3 megohm grid leak being also taken from the grid pin to the negative filament pin. Coil pins Nos. 4 and 6 are connected together and joined to the negative filament pin, which is also earthed by a short connection to one of the bolts holding the valve holder to the platform. Pin No. 5 on the coil goes to the anode of the valve, which, in turn, is taken to one side of the phones via the S.W. H.F. choke, one end of the latter being soldered directly on to the anode pin. The reaction circuit is completed by coil pin No. 2, being taken to the fixed vanes of the reaction condenser, the moving vanes of which are returned to earth. It should be noted that although a metal panel is used, the moving vanes of all the condensers mounted on it have their earthing wire, thus eliminating any possibility of poor contact. In this respect, a word of warning will not be amiss about the aerial series condenser. This com-

ponent is mounted on a metal bracket—an Eddystone product—and controlled by means of the Bulgin extension rod, but as both sets of vanes are in the aerial circuit, care must be taken to see that the metal bracket is insulated from the metal baseboard and panel. The former can be taken care of by mounting the bracket on a small piece of insulating material such as ebonite, fibre or dry wood (shellaced), and this screwed to the baseboard. As regards the panel, the spindle (moving vanes) of the condenser is effectively insulated from it by means of the ebonite extension rod. The size of the panel is 10ins. by 8ins., and that of the baseboard, 10ins. by 6ins.

In the next article, operating notes and voltages will be given, together with details concerning A.C. operation, and the addition of an L.F. stage.

(To be continued)

### COMPONENT LIST

- One Eddystone Bandspread Tuning Outfit (one 10 x 14 mmfd. and one 20 mmfd.).
- One Eddystone slow motion drive No. 1026.
- One Eddystone 100 mmfd. variable condenser.
- One B.T.S. 150 or 180 mmfd. condenser.
- One chassis mounting 6-pin coil holder.
- One low-loss 4-pin valve holder.
- One S.W. H.F. choke.
- One Dubilier mica condenser .0001 mfd.
- One  $\frac{1}{2}$  watt 3 megohm grid leak.
- One Bulgin extension rod.
- One Triode valve, H.L. type, Cossor, Mullard, Osram.
- One T.C.C. .001 mfd. fixed condenser.
- One bracket for A/S condenser.
- Two terminal blocks with terminals.
- Two metal panel brackets.
- Aluminium for panel, platform and baseboard.
- Three knobs and scales.
- Three Eddystone 6-pin coils.

## THE FRIDAY DISCUSSIONS

WITH events moving so fast on the battle fronts, the public will expect to hear more controversy on the air, so as to make up its mind on the many questions which become more urgent the nearer we approach final victory. The B.B.C. has, therefore, planned a series of autumn discussions in the Home Service covering a wide field of controversial issues. It is hoped that they will combine frankness with sound reasoning.

There will be eleven discussions in the autumn quarter, on Fridays from 7.30-8.0 p.m., and these eleven will be divided by a special series of talks and discussions on "Jobs for All," which will be concentrated in the last two weeks of November.

The Friday Discussions will have no general title; the subjects vary widely, and so the presentation will differ, too. In some, the controversy will take a simple black and white form; others will be in the form of a symposium, in which four or five speakers will be chosen; either because of their contrasting points of view or because of their contrasting experience.

# Radio Gramophone Circuits

## Some Practical Circuits and Details of Operation

IT is a simple matter to arrange that a recording can be picked up on the receiver in the same way as a station, so much so that it is surprising that more use is not made of this method. It can only be presumed

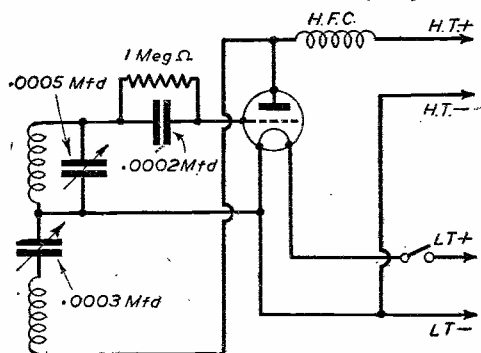


Fig. 1.—Oscillating Triode.

that the average amateur is not aware that it is possible to reproduce records in this manner.

The advantages are many. In the first place, it avoids all instability due to the insertion of a pick-up into the circuit of the receiver; even though no audible howl be present it is possible for inaudible oscillations to "colour" the reproduction and cause it to sound harsh and disagreeable. This is avoided by the radio link, since the receiver is used in its entirety, i.e., no external connections are made to it in connection with the gramophone, and if it is stable and capable of good reproduction on radio, then it will be equally good on gramophone. Also, since all the valves are used, including H.F. in a straight set and frequency-changer and I.F. in a superhet, the combination is very sensitive.

The radio link which is necessary with this class of gramophone reproduction is nothing more or less than a weak transmitter. As such it might be thought that a transmitting licence would be required before such apparatus could be used. This, however, is not the case, the P.O. authorities having waived the necessity for a licence, on condition that the radiation is such that it is imperceptible outside one's own home.

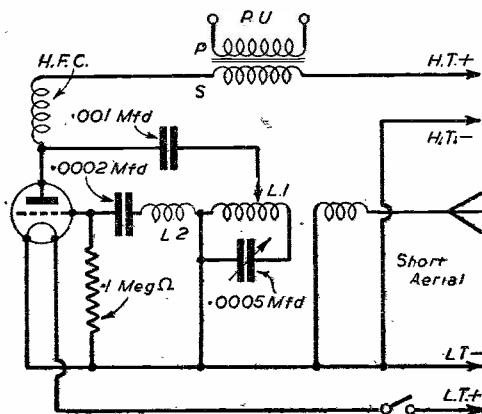


Fig. 3.—Simple tuned anode transmitter.

The prime necessity for an apparatus of this description is an oscillating valve. Once the valve is generating oscillations at a suitable frequency, we can modulate this "carrier" at L.F. periodicity by any suitable means, such as a microphone or pick-up. Since it is extremely easy to cause a valve to generate oscillations, this is the least difficult part of the scheme; the impressing or modulating of the H.F. oscillations by the L.F. impulses giving the greatest scope for experimentation in order to find the right combination. It will be appreciated that, since the power must be kept extremely small in order not to infringe the P.O. regulations, overloading can occur with a sensitive pick-up. This will spoil the quality at its source, and no amount of juggling with the controls of the receiver will cure this distortion. With this proviso we will now see what circuits are suitable for this class of work.

### Oscillating Triode

In Fig. 1 we have an oscillating triode. It will be seen that this is identical with an ordinary detector valve with reaction, both in regard to the coils and the values

Short Aerial (See Text)

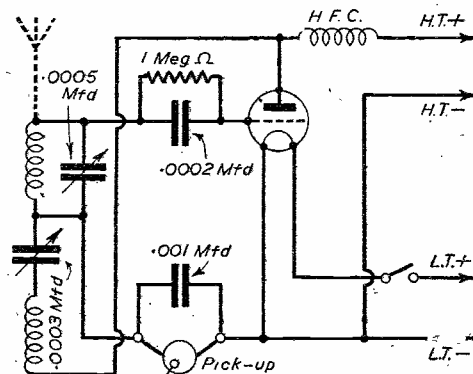


Fig. 2.—Circuit shown by Fig. 1 with pick-up connection added.

of the components, particularly the grid condenser and grid leak. Such a valve will give a beat note in a straight receiver, or a gentle rushing sound in a superhet, when the two circuits (the oscillating valve and the receiver) are in tune. It is presumed that they are working on the medium waves, although there is nothing to prevent them from operating on the long, short, or ultra-short wavelengths. If the coil is unscreened, then sufficient pick-up (of H.F. radiation) should be obtainable within a few feet of the coil; otherwise a few feet of wire as an aerial will be required unless the connecting wires radiate sufficient energy.

### Connecting Pick-up

Fig. 2 is Fig. 1 redrawn to show the method of connecting the gramophone pick-up. This is known as grid modulation, and providing the input from the pick-up is not too high satisfactory results will be obtained with an ordinary detector valve and normal values of grid condenser and leak, i.e., .0002 mfd. and 1 megohm respectively. If the input is too high and blasting occurs, it is preferable to reduce the input rather than lower the grid-leak value, but a compromise may be effected by lowering the leak to, say, .5 or .25 megohm. The lowering of the input can be brought about by means of a 100,000 ohms variable resistance across the pick-up.



If, on the other hand, music is weak while the "carrier" is strong, this points to under-modulation. This may be due to the use of a pick-up with low output volts, and the use of a transformer between the P.U. and the valve will increase the voltage. A microphone transformer is unsuitable, and a good L.F. transformer, preferable with a ratio not greater than about  $1/3\frac{1}{2}$  should be chosen.

By a suitable choice of location for the gramophone unit, and a suitable length of wire as an aerial (about 6ft. usually suffices) it should be possible to provide a good "signal" for the receiver to pick up. With insensitive receivers the aerial on the gramophone unit may be draped close to the lead-in of the main receiving aerial.

Hitherto we have confined ourselves to the tuned grid type of oscillator, as being more easy to comprehend by comparison with the reacting detector. Nearly all transmitters, however, use tuned anode, and we will now consider this class of oscillator.

### Tuned Anode Transmitter

Fig. 3 shows a simple tuned anode transmitter suitable for our purpose. The coils  $L_1$  and  $L_2$  can be either two separate coils wound in the same direction, with their near ends taken to negative filament; or one coil with tapings so that the degree of coupling

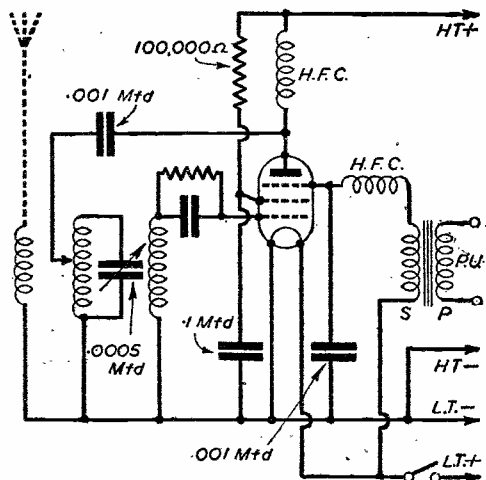


Fig. 4.—Suppressor grid modulation.

between them can be varied. In either case it is the grid coil which is the "reaction" coil, the anode coil forming the tuned circuit. For a coil with a diameter of 2ins., if the constructor prefers to make his own, the entire coil should have 100 turns, of which 60 form the tuned circuit and the remaining 40 form the grid (or reaction) coil.

This circuit also makes use of anode modulation. It will be seen that a transformer is connected in the H.T. lead to the H.F. choke. The ratio of this transformer depends upon the output of the gramophone pick-up in use. If this has a high output of two or three volts the transformer should be of  $1/1$  ratio; a class B driver transformer is suitable. Otherwise an ordinary L.F. transformer is suitable, whilst if a microphone is to be used for announcing titles of records, etc., the ordinary microphone transformer having a ratio of about  $1/100$  should, of course, be used. In the latter case it is convenient to have the two secondaries in series. This does away with switching, and one can talk at any time independent of whether the pick-up is in operation or not, although for aesthetic reasons it is not advisable to sing an accompaniment to the records unless one can

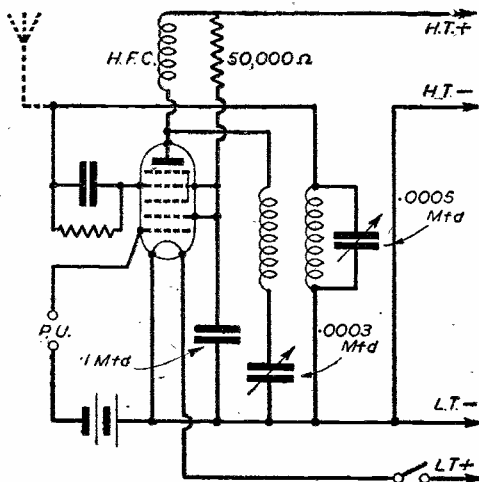


Fig. 5.—Circuit employing a heptode.

be certain that the microphone, and incidentally the singer's voice, will do them justice!

### Connecting the Aerial

As to the method of connecting the aerial to Fig. 3, a few turns of wire (not more than 10) wound on the former close to the main winding, is all that is required. One end of this short winding is connected to negative filament and the other goes to the aerial. It is recommended that no earth connection be made, and of course the actual length of the aerial will depend upon the sensitivity of the receiver; in most cases the oscillating coil alone will be sufficient without any aerial, unless it is desired to pick up the records in another room.

Another method is to use suppressor grid modulation, using a seven-pin H.F. pentode in order to have the suppressor grid brought out to a separate pin. An H.F. pentode used in this way will provide quite sufficient radiation for our purpose, the circuit being indicated in Fig. 4.  $T_1$  is a good make of intervalve transformer, for use only where the pick-up output is of low value. An H.F. choke is in series with the secondary, but in the case where the pick-up is used alone it (the pick-up) takes the place of the transformer secondary. The anode and control grid of the pentode

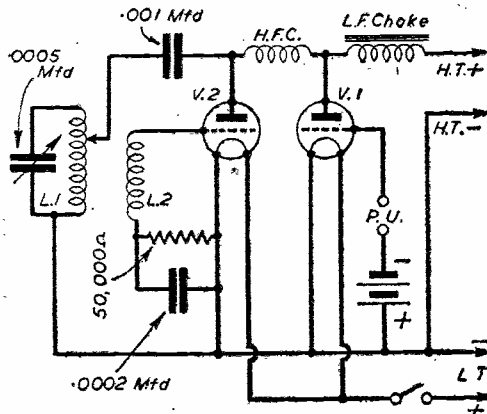


Fig. 6.—Circuit suitable for pick-ups with small output.

are coupled together in the usual way to produce oscillations.

A popular method is to use a heptode; this is a particularly satisfactory way to reproduce gramophone records, since the ratio of signal to carrier wave is of a high order without introducing overloading either of the oscillator or the receiver. It will be appreciated that if the carrier is strong in proportion to the signal, various adverse effects will be produced. In a straight set the H.F. energy may overload the detector without producing the wanted signal, while in a superhet the strong application of H.F. energy will bias the valves strongly, thus further reducing the already weak signal.

This can be overcome by shortening the aerial of the oscillator, or by removing it farther away from the set's aerial, and at the same time increasing the input to the oscillator either by the use of a more sensitive pick-up or by employing a transformer. The merit of the heptode (circuit shown in Fig. 5) is that it tends to prevent too strong a carrier whilst at the same time keeping up the signal; in other words, the H.F. energy is fully modulated, though weak.

Having set the oscillator at a part of the medium waves where no station is operating, the pick-up can be plugged in and set going. Providing the valve is oscillating, the records should then be tunable on the receiver in the same way as a station. The minimum

H.T. voltage, consistent with good results, should be used, and in many cases it will be found that satisfactory reproduction will be obtained with a voltage as low as 30.

For the benefit of those who use needle armature or other pick-ups with a small output (1/10th of a volt or less) we have Fig. 6, which employs two valves. The first,  $V_1$ , is the modulator valve,  $V_2$  being the oscillator. The coils  $L_1$  and  $L_2$  are coupled together to produce oscillations, the circuit being tuned anode. The grid coil is in series with a .0002 mfd. condenser and 50,000 ohms grid-leak in parallel.

The valves should be fairly high impedance triodes; valves with an impedance of about 20,000 ohms are quite suitable. No trouble should be encountered with this circuit, but the constructor should be very careful that no radiation takes place outside the premises in which it is installed; for this reason it is recommended that no aerial or earth be used, the coil itself giving in most cases sufficient radiation.

With regard to the quality obtainable: The writer was puzzled by certain words in a recording, and no amount of juggling with tone controls, etc., would make them "stand out." On reproducing the recording through a radio link, however (actually Fig. 5) the words were reproduced with perfect clarity, thus demonstrating that the fault was not in the record but in the reproducing medium.

## Practical Study of Cathode Loading

Details of Some Interesting Experiments. By H. REES

**A**N instructive experiment can be carried out very simply by changing the position of the load resistance  $R$  in an ordinary amplifying stage, Fig. 1 (A), and insert it in the cathode side of the valve as in (B).

The result will be somewhat remarkable, for it will be found that, no matter what value is given the resistance, *the stage will show no voltage amplification*. In fact, there will be a small *voltage loss*, with the result that the output voltage  $V_o$  will always be slightly less than the original signal  $E_g$  applied to the grid. We say that the stage has a voltage gain of less than *unity*, and it constitutes what is termed a *cathode follower*.

This is not to say there will be no *power* amplification. Such a stage can easily supply enough power to drive a loudspeaker, or for many other purposes. If we assume  $E_g$  to be 1.0 volt, and a voltage gain of exactly unity so that  $V_o$  is also 1.0 v., then if  $R$  is, say, 10,000 ohms, the power output is exactly 1.0 milliwatt, which, though small in the case considered, is yet almost infinitely greater than the zero amount of power which may be assumed to be used in the grid circuit.

Before considering reasons for this state of affairs, let us make one more experiment that demonstrates a very valuable property of the cathode follower, namely, its low internal impedance or *output impedance*. Referring first to Fig. 1 (A). This may represent an ordinary voltage-amplifying stage of high impedance, approximating to the A.C. resistance,  $r_a$ , of the valve. If we took various resistances of say, 10,000 ohms and upwards to represent "loads" connected to the output terminals of this stage, a very marked effect would be observed upon the stage gain and available output voltage. The experiment shows that if such a high impedance stage were coupled directly to a succeeding stage whose *grid-cathode* impedance is likely to become low at high frequencies, or due to grid-current, the output voltage would suffer accordingly.

### Low Output Impedance

Now, if the same experiment were repeated on the cathode follower stage, we should find that loads of the order of 10,000 ohms have but negligible effect.

It can be shown mathematically that the internal impedance with cathode loading approximates to

$1/g_m$ , where  $g_m$  is the valve *mutual conductance*, expressed in *amperes per volt*. Thus, taking  $g_m = 2 \text{ mA/V.} = 0.002 \text{ ampere per volt}$ , the impedance is  $1/0.002 = 500 \text{ ohms}$ , and lower values still could be obtained by using steep slope valves.

If we load 500 ohms with 10,000 ohms, the result will not be appreciably different to 500 ohms. It is simply a case of resistances in parallel, and the answer actually works out to about 476 ohms. This is a difference of 4 ohms in 500 ohms, or 0.8 per cent. which is utterly negligible for all practical purposes. But if an ordinary stage of internal resistance of something like 10,000 ohms were loaded with 10,000 ohms, the combined parallel resistance would fall to 5,000 ohms—a 50 per cent. change, which will have a correspondingly marked effect on the voltage gain.

Therefore, although the cathode follower is not a voltage amplifier, it is the equivalent of a power stage, or a "generator" having a very low internal resistance. With sufficient signal on the grid, and a suitable valve, it can deliver as much output as any other power stage, and, as seen, the output voltage will remain nearly constant for wide changes in the load impedance, even if the impedance should become relatively low. For power amplification purposes, of course, a fairly low impedance valve would be used, having as large a  $g_m$  as

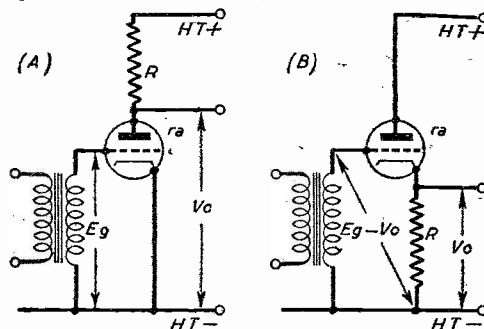


Fig. 1.—A, ordinary amplifying stage; B, cathode follower.

practicable to give the low output impedance. The load would be "matched" to the  $r_a$  of the valve, in the ordinary way, and *not* to the output impedance figure.

It can also be shown that the grid-cathode *input impedance* of the cathode follower is high as compared with an ordinary stage, which makes it an ideal "separator" between a high impedance stage and one whose input impedance is likely to be low. A further point concerns *phase-reversal* of the output voltage, which does *not* occur in the cathode follower: During a positive half-cycle of grid signal, the cathode end of R will have a potential change, of positive sign with respect to — H.T. line, whereas in Fig. 1(A), the anode potential falls during the same interval.

### Voltage Feedback

Why is it that changing the position of the load resistance causes so profound an effect on the behaviour of a simple amplifying stage?

The answer is, *negative feedback*. The load resistance is directly in the cathode circuit, in the same position, in fact, as a cathode bias resistor. But, unlike the bias resistor, it cannot be by-passed by a condenser, since this would defeat its object of supplying an output voltage. If we assume R to be an A.C. resistance which has negligible effect when the current is steady, e.g., a tuned circuit, or transformer, the effect of an alternating potential on the grid will be to run the — H.T. end *negative* during a positive half-cycle, and vice versa, as described above in connection with phase-reversal.

Now, the grid is returned directly to — H.T. end of the load resistance, which means that the full output voltage  $V_o$  is being fed back in a negative sense, i.e., in direct opposition to the signal  $E_g$ . This follows at once from the fact that there is no phase-reversal at the cathode end of R. Precisely the same effect would occur if we neglected to by-pass a cathode bias resistor, although here only a fraction of the total output voltage would be negatively fed back, since the bulk of the A.C. impedance would be in the anode circuit.

However, it will be clear that the *resultant* signal impressed on the grid will no longer be  $E_g$  itself, but  $(E_g - V_o)$ . The overall stage gain thus falls to a figure representing a much smaller effective signal on the grid. In fact,  $V_o$  will be something like  $0.8E_g$ , which leaves us with an effective signal voltage of only  $0.2E_g$ —or 20 per cent. The power output can be increased by applying a larger  $E_g$ , necessitating probably more amplification in previous stages. In any case, the purpose of the cathode follower is not for providing such voltage amplification, and it is easy to see why the voltage gain must necessarily be less than unity.  $V_o$  must be less than the original signal  $E_g$ , for the simple reason that  $(E_g - V_o)$  is the effective grid signal.

Suppose, now, that the load impedance (or the value of R) falls. The immediate effect will be to tend to reduce  $V_o$ . But this means less negative feedback, and consequently an increase in the effective grid e.m.f.  $(E_g - V_o)$ . This, in turn, will force more current through R, to restore the output voltage to a value not appreciably different to what it was before. The opposite reasoning applies if the load impedance tends to increase at some frequencies.

The negative feedback provides an automatic voltage compensation that holds the output voltage nearly constant with respect to load variations. The "equivalent generator" would be an alternator that delivers more e.m.f. as the load current increases, thus compensating for the "drop" in the internal impedance of the machine. In effect, the internal impedance has been apparently reduced to a small value, even though its actual physical value remains the same as before—it is simply the voltage loss that is made up.

This last statement explains why a load must be matched to the physical  $r_a$  of the valve in the ordinary way, i.e., for maximum power output. The *power loss* in the internal resistance is not affected by the voltage compensation. It depends only upon the current and the *actual* value of the resistance. Hence the ratio of R to  $r_a$  for minimum internal loss is not affected by the negative feedback.

## History and Development of Radio Science

Extracts from a Paper by HERWARD WAKE Presented to the Institute of Practical Radio Engineers

**B**IBLIOGRAPHICAL references to a chronological history of the *Science of Radio* very clearly indicate to a close student of the subject that it is neither branch nor offshoot of the "Tree of Electrical Progress," but rather is it a distinct and entirely separate department of systematised knowledge exhibited in an ordered and interrelated system that will possibly be acclaimed in the near future as the *Science of Radionics*.

### In the Beginning

A past geological age created a fossil. The early Greeks aptly named it *electron*. We know it as *amber*, that yellowish translucent resin that is capable of taking a very high polish and which by friction becomes strongly *electric*. Prehistoric man found that by rubbing it on fur it produced sparks, and this some thousands of years previous to the first written reference to it, in the year 600 B.C. There is also that iron-ore of metallic lustre called *lodestone* or *loadstone*, a *magnetite* possessing polarity like a magnetic indicator. This and *amber* were looked upon by the ancients with superstitious awe and regarded as having properties mysterious in nature. Even up to the 14th century experimenters with both wrote of either as not then being explainable by any known physical principle—*superphysical*.

### A.D. 1544-1600

A treatise on Physics, written by Melancthon in 1544, advanced the theory that the peculiar properties present in *amber* and *lodestone* were due to natural causes and that no true explanation was possible. But in

1600 Dr. William Gilbert, an Elizabethan scientist, proved by aid of his *electroscope*—an instrument designed to indicate the approach of a *charged body*—that what we to-day term static electricity was but the general result of a law of the physical world, and that certain natural elements were capable of retaining *electricity at rest*, which, however, could become active if certain conditions were complied with. Gilbert is credited with being the first scientist to use the *electric term*. He also reasoned that the earth was a form of huge magnet, surrounded with a magnetic field and having north and south magnetic poles.

### 1646-1730

The name of Sir Thomas Browne should not be forgotten, for it was he who first endeavoured to apply the forces of magnetism to a method of *communication through space*. He did this with two compasses, the letters of the alphabet being written on each, the theory being that were both pointers simultaneously magnetised and the compasses then separated, the "hand" of one, if placed on a certain letter, would cause the "hand" of the other to indicate a corresponding letter. A few years later, von Guericke, a German, made a globe of sulphur, so pivoted and geared that it could be revolved against the "flat" of his hands—for the purpose of charging the globe to attract certain particles, proving thusly that *like charges repelled* each other if close together. In 1730 we read of Gray and Dufay, English and French, respectively, Gray discovering "the effects and differences" between conductors and

insulators when used to convey charged impulses, and Dufray, in France, suspending a wet thread on glass tubes, a quarter of a mile in length, and succeeding in sending a "charged impulse" along it. He later substituted thin copper wire for the thread.

#### 1745-1800

It was an attempt to store frictional electricity in water that led to the discovery of the electrical condenser by Van Musschenbroek, at Leyden, Holland, in 1745, though tin or metal foil was not fastened to the outside of the *Leyden Jar* until later. Around this period, and due to the "jar," we find the first reference to the *shock* properties of electricity, the records stating that the Leyden Jar was used "with shocking effect" on a number of Dutch soldiers who, with linked hands, experienced the effects from the discharging jar. In 1751 the great American statesman and scientist, Benjamin Franklin, not only conducted his famous experiments with kites and lightning, but actually defined *positive* and *negative* electricity. He then proved the two laws of magnetism, that like charges repel and unlike charges attract; invented the lightning rod, and advanced the theory that air was a more satisfactory dielectric medium than was the glass of the Leyden jar. Galvani, the Italian, was experimenting with his "animal magnetism" and the nerves of dead frogs in 1780, though the true principles of galvanic electricity, taking title from his name, was quite unknown to him. Ten years later another Italian, Alessandro Volta, invented the *voltaic pile* consisting of zinc and copper discs alternately assembled and separated into pairs by moistened "paper couples." Later, he immersed joined zinc and copper strips in containers of acid solutions and thereby made the first storage cells, batteries or accumulators of electricity. But another decade of time had elapsed when Carlisle and Nicholson, in 1800, utilised Volta's voltaic pile to decompose water back to hydrogen and oxygen elements and thus put into original practice the process of *electrolysis*.

#### Oersted and Ampere

Some historians quote 1820, others, 1821, as the year when Hans Christian Oersted, a Dane, noted that when a compass was placed "in line" with a wire its "needle" deflected, but that the needle remained stationary when "across" the same wire, and that when it was above the wire the pointer deflection was opposite in direction to that when it was below the wire, this fostering the theory of the existence of *magnetic lines of force* and making possible the development of sensitive electrical measuring instruments of the meter type. About this same time Andre Ampere, a Frenchman, demonstrated that not only would a length of wire carrying an electric charge attract a magnetised needle, but that the needle could also *attract the wire*. He further proved that two charged wires parallel to each other and free to move, attracted either if the currents in each flowed in the one direction, and that they repelled each other if the currents were applied in opposite directions.

#### Faraday, Ohm, Morse, Maxwell, Loomis, and Bell

These are names that loom largely on the scientific horizon of the years 1824 to 1875. Michael Faraday, an Englishman, bent his researches in the direction of the production of alternating current, by reasoning that not only did a charged wire cause a magnetised element to rotate but that the magnetised element caused the charged wire to rotate also. He thus invented the principle of the electric motor and invented *electromagnetic induction*. Though credited to the Frenchman, Ruhmkorff, it was Faraday who actually invented the induction coil which was later improved and named the *Ruhmkorff Coil*. Faraday not only designed the transformer, but his work with *condensers* and *dielectrics*, conducted by almost countless experiments and numerous tabulations, provided the main data for the compilation of *dielectric constant factors*. The Bavarian, G. S. Ohm, in 1826, conceived the law named after him, though Cavendish (1731-1810) put forward similar theories expounding this law. Both reasoned that an electric

current flowing in a closed circuit was proportional to the force of the voltage and inversely proportional to the resistance of the conducting element. Joseph Henry, an American, in 1831, was the first man to cover a wire conductor of electricity with silk and other insulating mediums, the object then being to use more turns than was possible with bare wire when coils were employed with lifting magnets. The unit of inductance, the henry, perpetuates his name. It was about this same period, too, that Samuel Morse, another American, invented the wired telegraph and devised a code of dots and dashes for communication between distant wired points. While the *electromagnetic theory of light* was expounded by Faraday, it was James Maxwell, a Scot, who, in 1865, reasoned that electric waves, magnetic waves, and light rays or waves all travelled through a common medium permeating matter and thus conceiving the existence of a rarefied atmosphere or *aether*—now termed *ether*. Loomis, an American, in this same period, covered two kites with a tin copper mesh which was connected to flexible wires in the lofting ropes, a galvanometer being attached to the wires and the free terminals connected to buried coils, Loomis' theory being that a normally charged atmosphere must act as one conductor and the earth as the other. Flying these kites from the peaks of two high mountains, 18 miles apart, he succeeded in getting pointer deflection on the galvanometers when opening and closing his earth circuits. Alexander Graham Bell was a Canadian, and it was he who invented the microphone or *magnetic transducer*, an invention serving the purpose of transmitter and receiver in a wired telephone circuit. The instrument was later improved on by D. E. Hughes, an Englishman, by his invention of the *carbon button* type of microphone. In 1880 Hughes conducted experiments with wooden rods covered with copper filings, the purpose being to have them produce sparks when connected to an electrical circuit and cause the loose copper particles to *cohere*.

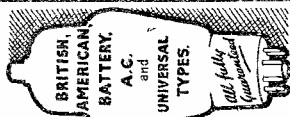
#### Hertz, Branley, Tesla and Marconi

The German, Heinrich Hertz, in 1888, was the first scientist credited with the construction of a *spark transmitter* and *receiver* able to generate and receive *ether waves*. It was he who first propounded the theory that ether waves and light waves were of similar velocity and that both were capable of measurement. Without question Hertz was the pioneer scientist of the present radio age. Hughes' coherer device was perfected by Branley, a Frenchman, in 1892, so that it is he who is credited (Branley) with the invention of the coherer, that tube of silver and brass filings which cohered or stuck together when accepting an initial spark. The Russian, Popoff, then invented the *decoherer* for separating the filings for repetitive function. This he accomplished by using the striking mechanism of an electric bell, the coherence and decoherence making possible the use of the device for *wireless telegraphy*. The following year, Nikola Tesla, a Serbian, suggested that the earth could be used as a conductor of wireless signals and at the same time produced the *high-frequency oscillating Tesla Coil*. Yet whilst the coil could be applied to the principles of wireless transmission, Tesla did not further his investigations to a point of receiving his generated ether disturbances.

#### Guglielmo Marconi

That was left to the great Italian, Marconi, whose initial experiments were done between 1895 and 1900. J. T. Bernsley, an American writer of repute, has this to say, in part, in his "Chronological History of Radio" (which, except for an odd date here and there, checks favourably with the bibliographical references available for this compilation): "Considering the inventions and research of previous years, it is with no great surprise that we determine that scientists of this era looked upon Marconi as an interloper and one of audacity. In 1895 Marconi conducted experiments with *Hertzian waves*, and was able to send and receive messages over a distance of a mile and a quarter.

(To be continued)



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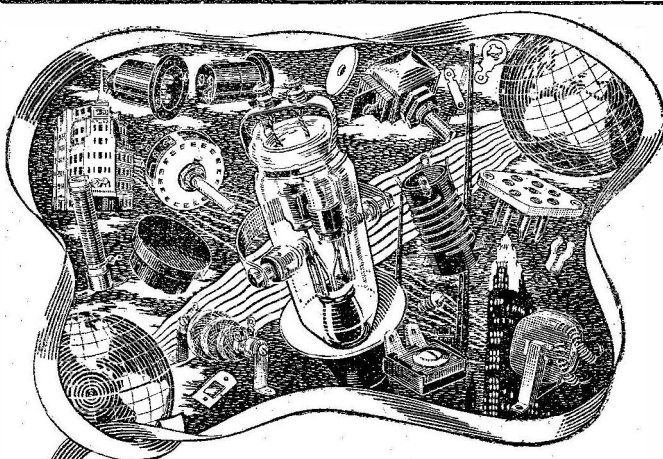
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# Dynamic Tester

By T. C. IRVING, A.I.P.R.E.

**T**HIS device is constructed from any old radio receiver, and will be found to cover a great deal of work the service-man of everyday servicing has to do. The old technique of voltage and resistance tests are often too slow or cumbersome, so by using a radio receiver, with leads coupled to the outputs of various stages to feed the signal into the receiver under test at the corresponding stage, faults can be traced to the

using a shielded test lead in applying it to the input of the detector under test. The output of the R.F. stage is also applied to the detector of the tester, making it in turn to the audio amplifier, audio frequency voltages are made available at P2 for grid drive of any output stage of the receiver on test, and at P3, the speech coil of the speaker.

A .0001 mfd. condenser is connected to the anode of

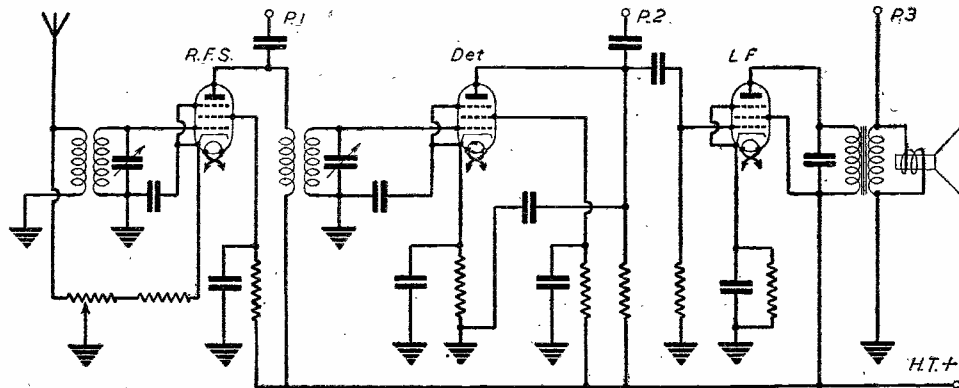


Fig. 1.—Circuit of modified receiver.

stages, signals can be inspected at any stage of the receiver under test. A service-man with a signal generator or an oscilloscope would not require a dynamic tester, but for those without or not wishing to spend the money, this is ideal.

## Circuit Details

I used a midget broadcast straight receiver for this, and added on a mixer-beat frequency oscillator. The diagram shows the idea of the device. A signal is picked up from a broadcast station with an aerial, and is amplified through the R.F. tuned amplifier to sufficient power to drive any detector.

Output can be obtained from P1 in the R.F. stage, by

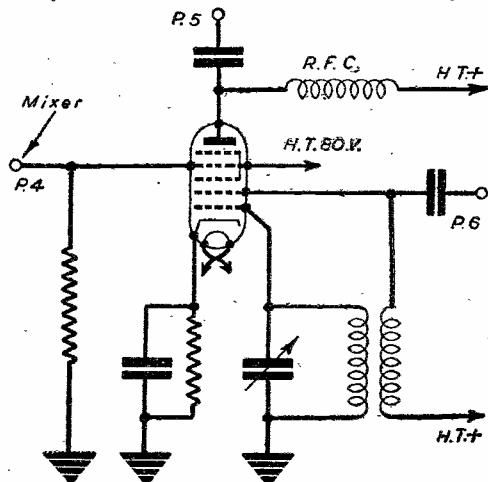


Fig. 2.—Mixer stage.

the R.F. stage, and the other side of the condenser connected to the plug P1, these plugs could be jacks, whichever are best suited, the ground for the shieldings of the lead from a point on the chassis. A 0.05 mfd. condenser between the anode of the audio amplifier and plug P2 supplies the audio signal, and P3 to one of the speech coil leads with the other at earth, supplies a signal to apply to a loudspeaker. This as it stands can be used for testing straight receivers.

## For Superhets

For superhets I added a 6A7G mixer-valve with the associated parts in its circuits. The best frequency oscillator for the production of modulated intermediate frequencies of any value, and in having this oscillator, it produces an I.F. the same as in the superhet under test, that is by beating with the incoming signal from the R.F. amplifier.

The coil and condenser for the grid circuit of the 6A7G comes from the superhet under test, in other words the grid circuit of the mixer in the set being repaired is used for the grid circuit of the mixer in the dynamic

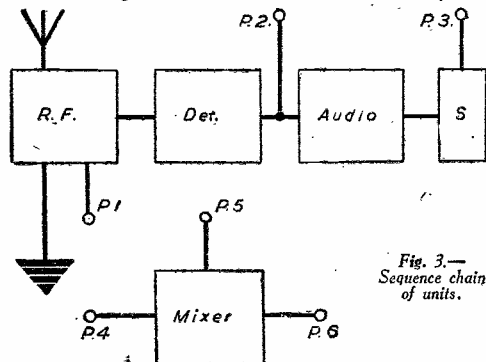


Fig. 3.—Sequence chain of units.

## DYNAMIC TESTER (Continued)

tester. The beat frequency oscillator has a separate tuning control for the production of any I.F. valve needed for checking I.F. or second detector stages. This is modulated by the original signal when a link is made between P1 and P4 and made available through P5. The output of the B.F.O. from P6 can be used when testing local oscillator.

## Operating Test

Assume that a receiver is under test, and found to receive no signals. The tapping points P on the dynamic tester are applied to the set, R.F. or I.F. from the tester

to the set; if no signal is heard, the fault may lie in the power supply, detector or L.F. stage, but if a signal is heard, the fault will lie ahead of the stage tapped into. This piece of equipment can only be used to trace the stage at fault, but not the exact source of trouble, but once the stage is found, the ohmmeter and voltage test can be put into operation.

The dynamic tester can be constructed either battery or mains job, but with a mains tester and testing a battery receiver care must be taken to ensure that it is signal voltage that is being applied and not mains voltage. This of course is a point to be watched when taking the tapings at Points P on the construction.

# Barretters

By E. G. BULLEY

**T**HESE devices, sometimes known as ballast tubes, are designed solely for the purpose of regulating and controlling the current in any circuit in which they are connected, that is to say, their presence maintains a specified current over a fairly large voltage range. This is an advantage of the barretter, because, although the voltage rises within the specified range, the current will still remain constant.

The construction or design of any barretter varies, dependent upon the use or the work it will have to do; nevertheless, barretters closely resemble an electric lamp to look at, consisting of an iron wire filament mounted upon a small glass stem. This assembly is sealed into a glass bulb, and in turn is exhausted and filled with pure hydrogen. The presence of pure hydrogen is for cooling purposes only and is essential to the correct working of the barretter.

These devices are to be found in many experimental and development laboratories, as well as garages, radio shops and service stations, where they are used in battery chargers, radio receivers power packs and telephone circuits.

A typical circuit for battery charging is shown in

Fig. 2 and is simple and easy to construct, consisting of a transformer, gas-filled rectifier and a barretter.

Fig. 3 is another circuit which can be easily constructed and is suitable for the H.T. supply of a battery receiver where an eliminator is not available.

The barretters shown in Figs. 2 and 3 are centre tapped to give the required current rating, although other circuits can be easily designed in which a centre tap is not required.

Data and curves of barretters are given below and should prove useful to those engaged either in the practical side of radio and its allied subjects or those having dealings with radio development.

The data and curves are self-explanatory as they show the current maintained over the specified voltage ranges.

## Characteristics

Mean current, 0.3 ampere.

Type 301. Voltage range, 138-221. Dia. 64. O./L., 130.

Type 302. Voltage range, 112-195. Dia. 64. O./L., 130.

Type 304. Voltage range, 95-165. Dia. 64. O./L., 130.

Type 303. Voltage range, 86-129. Dia. 64. O./L., 130.

Cap., Standard Edison screw.

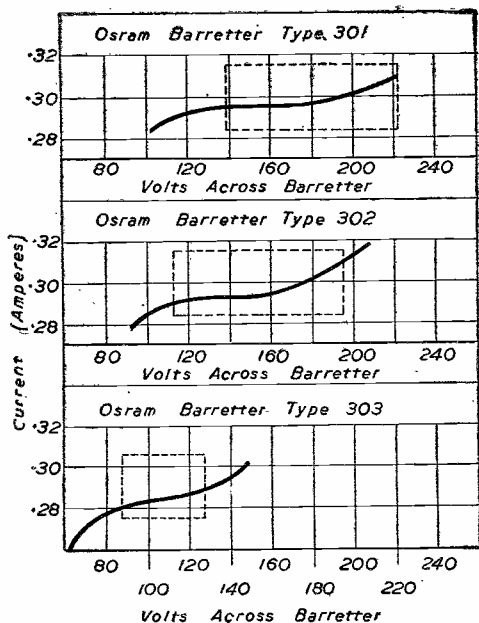


Fig. 1.—Group of barretter curves.

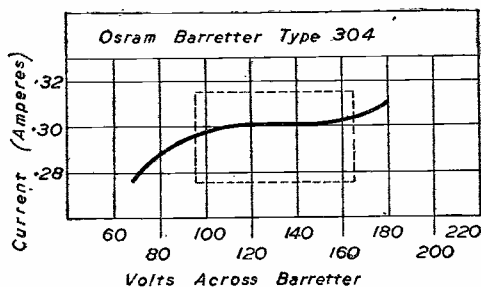


Fig. 2.

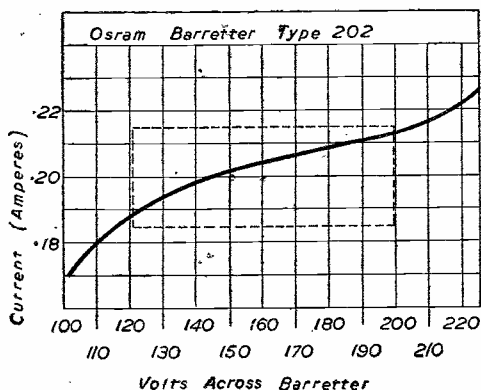


Fig. 3.

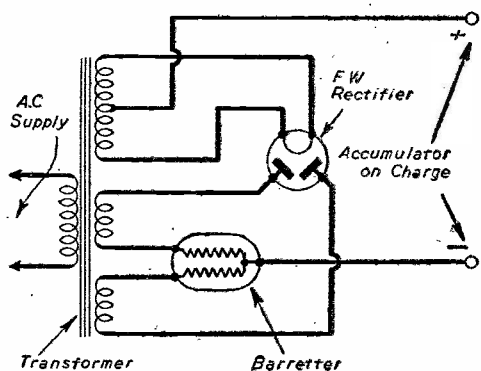


Fig. 2.—Typical circuit for battery charging.

**Characteristics**

Barretter, Type 202.  
Mean current, 0.2 ampere.  
Voltage range, 120 to 200.  
Overall length, 155 mm.  
Diameter, 65 mm.  
Cap, 4-pin.

The operating conditions for the above barretters, namely the 301, 302 and 304, will regulate from three

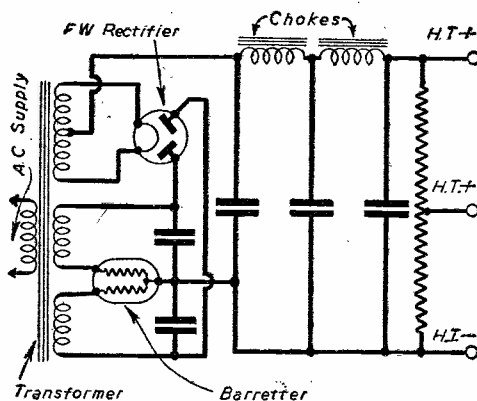


Fig. 3.—Circuit for H.T. supply of battery receiver.

to seven 0.3 amp. heaters respectively for a mains supply range from 190-260 volts.

In the case of the Osram 303, a small additional series resistance of 150 ohms is required when operated on a mains supply of 230 volts to 260 volts.

(The author is indebted to "The General Electric Co., Ltd.," for permission to use the data and curves set out in this article.)

## B.B.C. Winter Variety Plans

**J**OHNN WATT, B.B.C. Director of Variety, has planned a programme of autumn and winter entertainment which is a blend of the old and the new, the tried and trusty favourite and the experimental form. "Itma," of course, falls into the first category, so does "Monday Night at Eight," which came back on October 9th. This miscellany, which Harry Pepper has been putting together for seven years now, shows no signs of losing its public. Indeed, last season the listening figures were higher than ever before, only topped by those for "Itma."

Flotsam and Jetsam were such early broadcasters that they fall, by right of long usage, into the "tried and trusty" class. But it is some time since they were singing together, and the first time that they have had a series of programmes built round them. It is a short series and will be based on their journeys up and down the country, and their fellow travellers. The first programme, on October 6th, commenced in the train, and who should be in the carriage but Gwen Catley and Robb Wilton. Michael North, the producer, had given an assurance that Miss Catley would not, however, be called upon to sing accompanied by "train noises," but by the B.B.C. Revue Orchestra, who had also provided the musical background to the second and third programmes on October 13th and 20th.

Another singer who was apprenticed to the microphone years ago and is now a fully-qualified "household name" is Paula Green, and she commenced a new series of solo performances on October 11th.

An experiment with great possibilities is the teaming of Wilfred Pickles and Avril Angers in "Pickles' Party" on Wednesday evenings, which began October 11th. Wilfred is one of the most versatile of all broadcasters; news-reader, comedian, Children's Hour uncle, singer, compère, these are a few of his aliases. He is an old hand, and as popular in the south as he is north of Trent. Avril Angers is a versatile performer, too, but she is a new hand—in radio. Not in entertainment. No one who has travelled thousands and thousands of miles in

the Middle East and Africa for two years could be described as a tyro. It is a hard school but a rewarding one, cheering the troops far from home; Avril, with her fair hair, laughing eyes and gamine smile, is known from one end of the Mediterranean to the other, and she has every right to the Africa Star which she proudly wears on her lapel. She made a sensationally successful appearance in "Variety Band-Box" on coming home, and since then has also been heard—and hugely enjoyed—in "Atlantic Spotlight." It is rash to make prophecies about stardom in radio, but there is no doubt Avril Angers will make a bid for it. John Watt and Pat Hillyard are both highly enthusiastic about her personality at the microphone. These two, and Henry Reed, who is producing, are planning a revue-form for "Pickles' Party." There will be a Sherlock Holmes burlesque in an early programme, some of Henry Reed's "Æsop's Fables," and a weekly "potted" thriller. The friends who "drop in" to the party will vary from week to week.

Another experiment in atmosphere for a revue-type of show will be tried—"Houpla!" which that vigorous and all-embracing showman, Tom Arnold, is to present. Many of the stars whom he has helped to groom and build will appear, on Tuesday evenings, which began October 10th and as he has, in his time, produced anything and everything from Shakespeare and Tolstoy to pantomime, they should be a true "variety." The locale will be that of a fairground, with Freddie Forbes and Max Wall as "barkers," and Robb Wilton in the highly appropriate rôle of "complaints manager." These three will be residents in the show. In the various booths will be "Queens of Glamour," "Kings of Song," and so on, and the fair also has its theatre with guest stars each week. Richard Tauber will be a "King" in the first programme, and Polly Ward a "Queen," while Revnell and West will be appearing at the theatre. The fair will also have the assistance throughout of Gerald and his Orchestra, though it remains to be seen whether "Gerry" will attempt to imitate a callopie. Script by Max Kester, production Pat Dixon.

# Impressions on the Wax

## Review of the Latest Gramophone Records

### Columbia

**O**F the larger works by Delius, his Violin Concerto ranks as one of the most important. It was composed in 1916 and dedicated to that great violinist Albert Sammons, who gave the first performance of it in 1919. Delius does not follow the usual form of a great violin concerto, the composition being in one continuous movement, having what is best described as three sections. The solo violin takes the major part of the work, which consists of many varied applications of a number of short themes. As is well known, the composer was a poet and dreamer, and essentially a mystic, and these qualities or characteristics are evident in most of his works. The Violin Concerto takes one through all stages of emotion, and although the work is easily assimilated one becomes entranced by the great beauty of the delicate shades of tones and harmonies. As one would expect, the performance by Albert Sammons and the Liverpool Philharmonic Orchestra is superb. The recording is in six parts on three records *Columbia DX1160-1162*.

Much has been heard lately on the radio of André Kostelanetz and his Orchestra, and I am sure there will be a great demand for his latest recording on *Columbia DX1163*. For this, he has selected that old favourite of Liszt's "Liebestraum," and a work by the Czech composer Fibich entitled "Poem." In the roini. series, I find another by Frank Sinatra, accompanied by Harry James and his Orchestra, and for his latest release he has recorded "Here Comes the Night," and "From the Bottom of My Heart," on *Columbia DB2150*. Monte Ray has made two good recordings on *Columbia FB3043*, they are "The Echo of a Serenade" and "You Belong to My Heart." Felix Mendelssohn and his Hawaiian Srenaders, on *Columbia FB3041*, offer No. 5 of "Hawaiian Memories"—two parts—which introduces "Song of the Islands," "Love Song of Tahiti," "Aloha Oe," "Hawaii, Sing to Me," "Flowered Isles," and "Trade Winds." I place this recording as one of the best Felix has made in this series. Carroll Gibbons and the Savoy Hotel Orpheans have recorded two good numbers which I recommend for dancing. Both are foxtrots, their titles being "San Fernando Valley" and "Swinging on a Star," and they will be found on *Columbia FB3048*.

Another fine record for dancing is *Columbia FB3046*, on which Victor Silvester and his Ballroom Orchestra have made a fine recording consisting of "Star Eyes"—slow foxtrot—and an old favourite, "Reconciliation" waltz.

### H.M.V.

**A**T the risk of rekindling the controversy "What is light music?" I strongly recommend *H.M.V. DB6171* to all those who enjoy good music possessing delightful melodies, plus the thrilling charm of a symphony orchestra under the baton of such a maestro as Toscanini. All these qualities will be found on the record quoted above, as it offers a superb recording by the N.B.C. conducted by Toscanini, of Johann Strauss's Blue Danube Waltz, the full title of the record being "On the Beautiful Blue Danube (Op. 314)." There is no need for me to say anything about the composition, but I can say that Toscanini and the N.B.C. Symphony Orchestra add to it that masterly perfection which leaves nothing to be desired.

As a composer, Georges Enesco is best known by his Rumanian Rhapsodies, and this month *H.M.V.* has released an exceptionally fine recording of his "Rumanian Rhapsody No. 1, in A Major, Op. 11," performed by Eugene Ormandy and the Philadelphia Orchestra. It is in two parts on *H.M.V. B6130*, and the work is melodiously vigorous. D

For lovers of the pianoforte, there is another treat in store this month, and it takes the form of that great artist, Solomon playing Brahms' "Rhapsodie in G Minor, Op. 79, No. 2," and the same composer's "Intermezzo in B Flat Minor, Op. 117, No. 2." The former is a good example of Brahms' dramatic style, while the latter is almost fairy-like with its simple, delicate theme. Solomon does full justice to both of these exacting pieces in performances which reveal his great understanding and perfect technique.

Of the vocal records, I recommend *H.M.V. C3405*, on which Heddle Nash—Tenor—has made a first-class recording of "The Flower Song," from Act 2 of Carmen, and "All Hail Thou Dwelling," from Act 3 of Faust. He is accompanied by Dr. Malcolm Sargent and the Liverpool Philharmonic Orchestra, and as mentioned above, the complete performances are delightful.

Maggie Teyte—Soprano—has recorded, in French, "Elégie" and "Obstination," which she sings with that perfect ease and technique which makes her performances so delightful. She is accompanied by Gerald Moore at the piano, and, during "Elégie" also by James Whitehead, whose rendering of the cello obbligato is, in itself, exquisite. Two fine recordings, *H.M.V. DA1847*. Here are three good dance records. Eric Winstone and his Band playing "Time Alone Will Tell" and "Long Ago (And Far Away)," both foxtrots on *H.M.V. BD5857*. Glenn Miller and his Orchestra on *H.M.V. BD5854* presenting "Sold American" and "Moon Love," which, incidentally, is adapted from Tchaikowsky's 5th Symphony, two good foxtrots, and, finally, Joe Loss and his Orchestra on *H.M.V. BD5855* playing "I'll Be Seeing You," and "If Ever You Go to Ireland," foxtrot and waltz respectively.

"Hutch" sings about "Sophisticated Lady" and "Till Stars Forget to Shine," on *H.M.V. BD1087*.

### Parlophone

**R**ICHARD TAUBER is well on form in his latest recording on *Parlophone R020531*, for which he sings "When Love Has Gone" and "For Love Alone." Both are in English.

Geraldo and his Orchestra, on *Parlophone F2035*, play "Someday I'll Meet You Again" and "I'll Be Seeing You," both foxtrots, well presented and orchestrated. "Because I Love You" and "Brown Eyes" are the titles of two good numbers played by the No. 1 Balloon Centre Dance Orchestra, on *Parlophone F2037*.

"Tin Pan Alley Medley No. 64" is on both sides of *Parlophone F2034*, and Ivor Moreton and Dave Kaye, on two pianos with string bass and drums, make a very pleasing record of it. Joe Daniels and his Hotshots in "Drumnastics" on *Parlophone F2038* record "Alike as Two Peas" and "Shandy," which they put over in their own inimitable style.

### Regal

**H**ERE is another of Gene Autry's records. This yodelling cowboy has recorded "Darling, How Can You Forget So Soon" and "When the Swallows Come Back to Capistrano." These are on *Regal MR3738*.

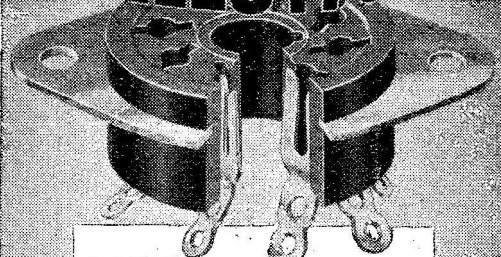
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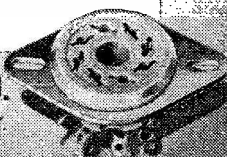
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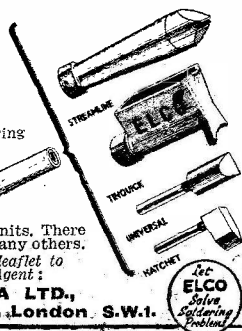
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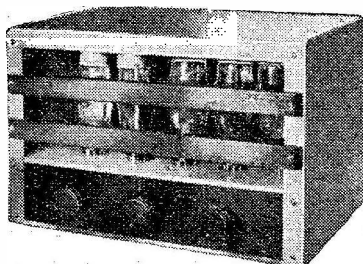
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# Open to Discussion

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).

## An Electric Soldering-iron Hint

**SIR**,—I think most of us at some time or other have gone into the workshop the next day to find the soldering iron beautifully red-hot; an aggravation, besides the danger from fire and waste of electricity. I cured myself by the following simple method:

Fix in series with the iron lead a flashlamp bulb of a type depending on the wattage of the iron as a warning light; in my case I put a 5A extension plug with a miniature bulb-holder between.—FRANK WALTER (Bexhill).

## Call Signs—Confirmation Wanted

**SIR**,—Since I last wrote to you I have become indebted to G8RF and L.D. Colley for the interesting information they give regarding the stations I mentioned.

Can any short-wave fan confirm that the call sign of AFHQ is THD (Algiers)? I have recently added to my log: ICD, WKS, WQR, AFHQ/THD, CUD<sub>2</sub>, HVJ (in morse!), "ORA de SUC", "WC15 de YVR", WQF, vvv de FYJ, "HB" stations, FZT, JCYN, American telephone and telegraph station ("Magnetism is a Quality of the Atom"), MSA39, GFN9, GYZ69, VER, CNR<sub>2</sub>, GYA18, "JNJ de HDL4", "vvv vvv de JEK" and aeroplanes above 50 metres.

Will G8RF please write? In my opinion, Miss Priscilla Tryphena Smart ("Telling Us Off," July) is a perfect example of an attempt to be funny.

I was keenly interested in the article on sidebands in your August number, and I support Thermion on his ideas about crooners and slush.—G. C. BAGLEY (Ironbridge).

## Universal 2-valve Midget

**SIR**,—Having seen no reports by any constructor on the "Universal 2-valve Midget," described in the April issue of PRACTICAL WIRELESS, I venture to recount some of the experiences I have had with this particular model.

My greatest difficulty was in obtaining the necessary components, especially the electrolytic condensers. Eventually I had to content myself with a 20 mfd. and a 12 mfd. to make up C14. As I could not get a 5 mfd. for C7 I successfully substituted a 25 mfd.

I was not too fond of the tuning by switched pre-set condensers, so I utilised a tiny two-gang variable taken from a discarded American midget, small trimmers being placed across the coils. I also decided to incorporate a reaction circuit, and for this I am partly indebted to the designer, 30 turns of 36 s.w.g. d.s.c. wire were wound round the secondary of the H.F.T. and controlled by a 0.0001 variable condenser; this valve will be found sufficient if the bypass, C3, is omitted—it was not necessary on my set. Reaction added to anode-bend detection is, admittedly, unusual, but in this case it worked extremely well, and fully justified the trouble taken over it.

As a result of using many non-midget components, coupled with the various additions described, it was not possible to construct a receiver to go with the original size of cabinet. My set, however, occupies only a space of 6in. x 5in. x 4½in., which should be small enough for anyone.

One other point: my mains voltage is high, and I found it desirable to use 650 ohms of line cord (tapped 350 ohms down) in order to prevent overload of the rectifier.

As to results, smoothing is of a very high order, only the faintest trace of hum being heard. With 15ft. of

fine copper flex as a throw-out aerial I can, in this remote corner of North Ireland, receive all the Home and Forces programmes, together with the overseas M.W. broadcast and some continentals. My local Home and Forces come in at great strength, although I am 70 miles from the nearest transmitter. These results are made possible only by the use of reaction, but I have no doubt that, were conditions more favourable, reaction could be dispensed with.

Altogether, the designer is to be congratulated on introducing a set that is not merely a novelty but a fully practical proposition.—W. JAMES (Enniskillen).

## Portable Three

**SIR**,—I recently constructed "A Portable Three," described in the June issue of PRACTICAL WIRELESS. I obtained excellent results with this set; the Home Service and Forces come in at full L.S. strength. After dark several other stations can be picked up. Not having all the parts at hand, I made a few variations to the values of the components, using .1 (paper) condenser for the .03 (mica), .01 (paper) for .01 (mica), 1 mfd. for two .5 (51,000 ohm for 50,000, 33,000 ohm for 30,000).—A. A. WISEMAN (Southampton).

## Crystal Sets

**SIR**,—I heartily agree with J. H. Woodward in his suggestion that we should have more about "the old crystal set." Although I have never had much success with them myself, I, too, would like to hear of other people's experiences on the subject, their successes and failures, and also about crystal sets in the far-off days of 2LO, when we younger members of the community were not there to see for ourselves.

I am at the moment experimenting with a "portable radiogram," although I have got very little farther than putting in the gramophone turntable and fixing the pick-up, etc., but I will write to you again when it is further advanced.

Please keep PRACTICAL WIRELESS at the same handy size after the war. I am one of the many who appreciate it as it is now: it is easier to carry about and bind. Congratulations on a very fine piece of work.—DAVID BARTON ELLIS (Lyne Regis).

## Data Sheet 129: Correction

**SIR**,—In case it has not already been pointed out to you, I should like to point out the errors in PRACTICAL WIRELESS (September number) concerning Octal Brimar Valve data on page 436.

The first 10 valves on this page are all right. The remainder should read as follows: 6N6G Double Output Triode, 6N7G Double Triode, 6P8G Triode Hexode F.C., 6Q7G D.D.T., 6R7G D.D.T., 6U7G H.F. Pen., 6V6G Power Pen., 6X5 Car Radio Rectifier, 6ZY5G F.W. Rect., 25A6G Power Pen. (two sets of characteristics), 25L6G Power Pen., 25Z4G H.W. Rect., 25Z6G F.W. Rect.—M. BROWN-GREAVES (Horsham).

## Economy DX Three

**SIR**,—I am afraid that I am not an old hand at wireless, but I should like to compliment F. G. Rayer through your magazine for the splendid performance of the Economy DX Three. I have just completed this set and it's the first short-waver that I have constructed that gives really good results. I have also received the station with the call sign "Sabu." This station gives out the latest news headlines in English at approximately 1400 hours B.S.T. As I have no means of calibrating



my tuning control I should say this station is on the 25 metre band. Also, to finish, may I compliment you on your splendid magazine. I have been a constant reader now for the last 12 months and nothing will tear me away from PRACTICAL WIRELESS once I have settled down to read it.—C. BLAIR (Farnham).

**SIR**,—I have built F. G. Rayer's DX Economy Three. Although the valves are different from those specified (a W21 in the H.F.) the results are good. So far I have identified the following stations: WCBX, WCRC, WLWK, WLWO, WBOS, WOOC, WOOW, WGEO, WNBI, DXJ, DJA, DGC, DXU9, DXR7, PRL8, FZr, Radio Tokio, 19 m.b., Radio Metropole 31.65 m., United Nations Radio, All-India Radio, Leopoldville 19.78 m. and 25 m.b. and 31 m.b., Radio Shonan and many point to point transmitters, plus scores of unidentified stations.

Can any reader tell me where Radio Metropole is situated? I express my thanks to your journal as it is my only way of keeping in touch with radio.—J. M. EALEY (Swindon).

### "Licences for Service Engineers"

**SIR**,—I have read with interest the letters in PRACTICAL WIRELESS, one from Serviceman, Barrow, in August issue, and from E. A. Street of London, September issue, regarding the proposed licensing of radio servicemen. I have done service and radio repairs since 1935 at this address. During this time I have had a good deal of repairs that so-called radio dealers have been unable or unwilling to do.

In a good many cases where these firms have done a repair and the set has afterwards packed up again, and been brought to me, I have found the only replacement that has been put in has been a small resistance or tubular condenser; for this I have known of cases where over 30s. has been charged.

I shall continue to carry on repair work if I am allowed to do so, and do my best in the future as in the past, to give every one of my customers a square deal.—B. DANN (Cottenham).

**SIR**,—F. J. Grant's letter in the October copy of PRACTICAL WIRELESS entitled "Licences for Service Engineers" revives my own problem which briefly is this: I am a member of the regular Air Force and my engagement of six years is now completed and, in view of this, demobilisation should follow soon after the "Cease Fire." I am mustered in the trade of Wireless Operator Mechanic and have had a pretty wide experience of radio maintenance and repair, mainly of service pattern. To augment my R.A.F. training I have taken correspondence instruction in City and Guilds Radio Communication and having so far been successful, I hope to make the Final Grade next year. So far so good, but in the view of many people, including our friend F. J. Grant, these things count for nothing when it comes to obtaining employment in "civvie street." And I'm told it's best not to mention "Service" experience as a prospective employer would laugh at the idea of a R.A.F. trained wireless mechanic trying to get a job in the trade. Even at best, can I hope for nothing better than £2 6s. a week to keep my wife and children on? Or shall I cut all the expense and hours of studying and take a course of bricklaying, which I'm sure must be a dead "cert." Of course, I can always sign on for 24 years in the R.A.F.—P. D. VICKERS (Farnborough).

**SIR**,—After reading the concluding remarks of F. J. Grant's letter in the October issue of PRACTICAL WIRELESS, I venture to suggest that his design for a valve tester would be welcomed by many readers.

Being the designer of the instrument published in PRACTICAL WIRELESS of September last year, I am well aware of the difficulties, not to mention the pitfalls, in designing such apparatus, and I, for one, would be extremely interested to see Mr. Grant's arrangement.

Any new ideas on this subject are, I think, always welcome.

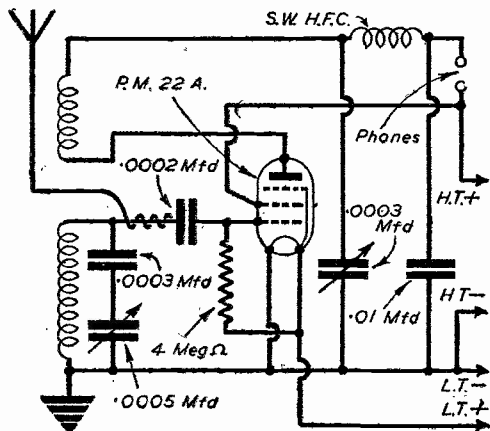
Regarding S. B. Hawkes's letter, also in the October issue, I fail completely to understand his remarks re the "Rapid Two." Perhaps other readers can suggest a diagnosis of this unusual discovery.—STANLEY BRASIER (Stroud).

### Midget A.C./D.C. Receiver

**SIR**,—Re "Midget A.C./D.C. Receivers," by L. C. Marshall (Whitehaven), in the September issue, assuming there is the usual metal chassis, he has made a direct earth connection to the chassis and not through a fixed condenser, as is the usual practice in these type of sets. The filament circuit drawn shows an obvious short to earth when switched on. Even when using an indoor aerial most people would require an earth connection; although the aerial condenser is partly a safeguard, the earth end is not, and as I have built several of this type of set, also serviced many, and will probably build this circuit, I shall put a condenser from chassis to earth. The condensers .001 mfd. and .0005 mfd. are, or should be, safe even if connected to the chassis, as the circuit is at present, but I submit that the earth sides of the electrolytic condensers are at direct earth connection and not through the usual fixed condenser. The cathode of V2 is also in direct contact with earth, also the screen is getting direct connection to earth through resistance 600 ohms of V3 cathode bias. Of course, the simple insertion of a condenser of high working peak voltage cures all the faults indicated. I have shown circuit to my friend, whose opinion I can vouch for, and he is of the same opinion as myself over the circuit.—W. H. WILLIAMS (Llandudno).

### One-valve Short-waver

**SIR**,—I have constructed a one-valve short-wave set which to me is very satisfactory. I give the circuit, and it will be seen that it uses throttle control. The main details are taken from the May, 1942, issue of PRACTICAL WIRELESS. The valve is a Mullard pentode P.M.22A, and the aerial is connected to a piece of bare wire which is twisted two or three times round the coil-grid condenser lead. I used the .0005 mfd. tuning condenser as I had not a .00016 mfd., but the .0003 fixed condenser connected in series is a good substitute.



One-valve short-waver. J. H. Woodward (Stoke-on-Trent).

I have not checked the majority of stations received yet, but here are a few: TAP, 31.7 m.; WRC, 25.3 m.; PRL8, 25.6 m.; Brazzaville, 25.06 m.; WOOC, 19.75 m.; Delhi, Berne, United Nations Radio, Algiers, Moscow, and a host of others. I use a 35ft. long indoor aerial.

I have made the midget one-valve set described in the October, 1943, issue of PRACTICAL WIRELESS; this is also very satisfactory. I have just received my September copy of PRACTICAL WIRELESS; it sure does "Beat the Band."—J. H. WOODWARD (Stoke-on-Trent).

### Station Identified

**SIR**,—In reply to the letter of B. C. Biddulph (Dawley), whose letter appeared in the October issue of PRACTICAL WIRELESS, I would like to submit the following information.

The station WCBX, together with WCRC and WCDA, belong to the Columbia Broadcasting System of 485, Madison Avenue, New York, all operating on the following bands given in metres: 49.5, 49.02, 48.62, 31.2, 31.09, 25.36, 19.65, 16.83, 13.94, 13.91.

The transmissions are beamed to various countries, not always the same call sign being given.

The usual wavelength for reception in this country is the one in the 25 metre band.—H. D. LOCKWOOD (Halifax).

**SIR**,—In the October issue of PRACTICAL WIRELESS B. C. Biddulph asks for information regarding WCBX. If you would please be so kind as to forward this on to him he may find what he requires here.

WCBX is located at Brentwood, Long Island. Of its power I am not sure. When it was at Wayne, New Jersey, it only used, to me, 10 kw., but I believe it is now from 50/100 kw.

It is operated by the Columbia Broadcasting System, 485, Madison Avenue, New York.

WCBX works from 04.00 G.M.T.—07.00 G.M.T. on 6,170 kc/s, 48.62 metres; 11.00 G.M.T.—15.00 G.M.T. on 15,270 kc/s, 19.65 metres; 19.45 G.M.T.—21.00 G.M.T. on 15,270 kc/s, 19.65 metres.—R. ALLEN (Sydenham).

### "Shady Dealing"

**SIR**,—I should like to pass a few remarks upon Mr. P. H. Beales's letter published in October issue.

I have been established 18 years, and am still dealing with customers who patronised me 18 years ago.

It appears that when Mr. Beales received his set from the shady dealers it worked quite satisfactorily for six weeks, but after that time it failed again; but I fail to see that the repair had not been properly carried out, as, upon taking the set back, he is informed that another valve and condenser had broken down; and, if he has sufficient knowledge (and test gear) to test this set, he should know what condensers have been replaced.

I quite agree that there is a great deal of shady business going on in the radio trade; and I think it would help matters a lot if dealers gave back to the customers any dud condensers, valves, etc., taken from their sets, and let customers see the chassis before and after the repairs are carried out.

My workshop is open to the customers all day; and if there is any question of price they are taken in, and the job is explained to them, and it is then up to them to decide if the job shall be carried out.

Of course, there is always the customer who thinks he is being done, because many years ago he built a two-valve set, and cannot realise the time taken in locating faults, and the expense of instruments and knowledge of how to use them.

I have repaired many sets which, after a few weeks, even days, have broken down again, due either to faulty valve, resistance, or condenser other than those that have been replaced by me; and, in a case like this, I explain to the customer, and only make a nominal charge plus the cost of the components replaced. I also explain to the customer, when the job is finished and working perfectly, it is quite possible for another component to break down.

As the majority of sets have been in use not less than five years, and, in my opinion, have had more use than

in peacetime, there is considerably more wear taking place.—R. H. PETTIT (Essex).

### "Examination Fees"

**SIR**,—Regarding letters concerning the licensing of repair depots, may I quote one instance.

A few weeks ago an American midget was brought to me for repair. The owner explained that he had taken it to several shops, with invariably the same answer. When he called back a few days later, he was told, "Sorry," that it was impossible to repair it. In at least two cases a charge of 10s. was made—a so-called examination fee.

Examination immediately produced the following: One 3525 broken down cathode-heater insulation; one smoothing condenser connected between heater tap and "earth"; one volume control faulty; one line cord short by 200 ohms.

On remedying the above, set went without any trouble.

Incidentally, quite a few dealers in this area absolutely depend on part-time servicemen for their repairs.—RALPH J. BEAVER (Bristol).

### An Appreciation

**SIR**,—I have been a keen reader for the past twelve years and would like to say that in wartime as in peace it has been kept up to the highest standard. It was from your first editions that I became familiar with this great era in radio.—WM. WHITE (R.N.).

### A.C./D.C. Midget

**SIR**,—In the September issue of PRACTICAL WIRELESS a circuit of an A.C./D.C. midget, on page 432, is shown. As other readers will note, there is no connection to the screen of the 43 valve, though obviously the screen is connected on the smoothed side of the 2,000 ohm field.—BASIL CUTNER (Clapton).

### "That Slowing Down"

**SIR**,—In reply to S. B. Hawkes's letter to your "Open to Discussion" column, I wish to say that if he read his "Radio Times" he would find that at the time mentioned the news is read at dictation speed for the benefit of the Forces newspapers overseas. As to such a thing as an automatic speed control on a receiver, as a young radio engineer, I think such a thing would be impossible.—ENGINEER (Penrith).

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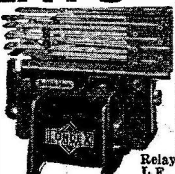
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(Continued top of next column.)

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PW48

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F. J. Camm's Silver Souvenir (HF  
Pen, D (Pen), Pen) (All-Wave  
Three) ..

PW49\*

Cameo Midget Three (D, 2 LF  
(Trans)) ..

PW61\*

1936 Sonotone Three-Four (HF  
Pen, HF Pen, Westector, Pen)  
Battery All-Wave Three (D, 2 LF  
(RC)) ..

PW53\*

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The Tutor Three (HF Pen, D, Pen)  
The Centaur Three (SG, D, P) ..

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PW62

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Cl. B) ..

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PW17

Fury Four Super (SG, SG, D, Pen)  
Battery Hall-Mark 4 (HF Pen,  
D, Push-Pull) ..

PW34B  
PW34C

"Aume" All-Wave 4 (HF Pen, D  
(Pen), LF, Cl. B) ..

PW83\*

The "Admiral" Four (HF Pen,  
HF Pen, D, Pen (RC)) ..

PW56\*

F. J. Camm's "Admit" All-Wave  
Four (HF Pen, D, LF, P) ..

PW67\*

## Mains Operated

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(D, Pow) ..

PW16\*

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PW23\*

D.C. Ace (SG, D, Pen) ..  
A.C. Three (SG, D, Pen) ..

PW25\*  
PW29

A.C. Leader (HF Pen, D, Pow) ..  
D.C. Premier (HF Pen, D, Pen) ..

PW35C\*  
PW35B\*

Unico (HF Pen, D, Pen) ..  
F. J. Camm's A. All-Wave Silver  
Souvenir Three (HF Pen, D, Pen)  
"All-Wave" A.C. Three (D, 2  
LF (RC)) ..

PW36A\*

A.C. 1936 Sonotone (HF Pen, HF  
Pen, Westector, Pen) ..

PW50\*

Mains Record All-Wave 3 (HF  
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PW54\*

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PW56\*

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Push-Pull) ..

PW70\*

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Push-Pull) ..

PW34D  
PW45\*

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PW40  
PW52\*

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PW43\*  
PW42

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Two-valve: Blueprints, 1s. each.  
Midget Short-wave Two (D, Pen)  
The "Fleet" Short-wave Two  
(D (HF Pen), Pen) ..

PW88\*  
PW38A\*  
PW91\*

Three-valve: Blueprints, 1s. each.  
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(SG, D, Pow) ..

PW30A\*

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Trans)) ..

PW63\*

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(HF Pen, D (Pen), Pen) ..

PW68\*

## PORTABLES

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F. J. Camm's L.F. Three-valve  
Portable (HF Pen, D, Pen) ..

PW65\*

Parvo Flyweight Midget Portable  
(SG, D, Pen) ..

PW77\*

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(Pen)) ..

PW56\*

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45 5s. Three De Luxe Version  
(SG, D, Trans) ..

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AW435\*

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Pen) ..

WM271  
WM327  
WM337

"W.M." (1934 Standard Three  
(SG, D, Pen) ..

WM351\*

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1935 6s. Battery Three (SG,  
D, Pen) ..

WM384  
WM371

PTF Three (Pen, D, Pen) ..  
Certainty Three (SG, D, Pen) ..

WM389\*  
WM393

Minitube Three (SG, D, Trans) ..  
All-wave Winning Three (SG, D,  
Pen) ..

WM386\*  
WM400

Four-valve: Blueprints, 1s. 6d. each.  
65s. Four (SG, D, RC, Trans)  
Self-contained Four (SG, D, LF,  
Cl. B) ..

AW370  
WM331

Lucerne Straight Four (SG, D,  
LF, Trans) ..

WM350

25 Is. Battery Four (HF, D, 2LF)  
The H.K. Four (SG, SG, D, Pen)  
The Auto Straight Four (HF, Pen,  
HF, Pen, DDT, Pen) ..

WM381\*  
WM384

Five-valve: Blueprints, 1s. 6d. each.  
Super-quality Five (2 HF, D, SG,  
Trans) ..

WM404\*

Class B Quadrazone (2 SG, D, LF  
Class B) ..

WM320

New Class B Five (2 SG, D, LF  
Class B) ..

WM344  
WM340

## Mains Operated.

Two-valve: Blueprints, 1s. each.  
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Economy A.C. Two (D, Trans) A.C.  
Three-valve: Blueprints, 1s. each.  
Home Lover's New All-Electric  
Three (SG, D, Trans) A.C.  
Mantovani A.C. Three (HF, Pen,  
D, Pen) ..

AW403  
WM286

415 15s. 1936 A.C. Radiogram  
(HF, D, Pen) ..

AW383\*

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Harris' Jubilee Radiogram (HF,  
Pen D, LF, P) ..

WM401\*  
WM329

WM326\*

## SPECIAL NOTICE

THESE blueprints are drawn full size. The issues containing descriptions of these sets are now out of print, but an asterisk beside the blueprint number denotes that constructional details are available, free with the blueprint.

The index letters which precede the Blueprint Number indicate the periodical in which the description appears: Thus P.W. refers to PRACTICAL WIRELESS, A.W. to Amateur Wireless, W.M. to Wireless Magazine.

Send (preferably) a postal order to cover the cost of the Blueprint (stamps over 6d. unacceptable) to PRACTICAL WIRELESS Blueprint Dept., George Newnes, Ltd., Tower House, Southampton Street, Strand, W.C.2.

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The Request All-Waver .. WM407

Main Sets: Blueprints, 1s. each.  
Heptode Super Three A.C. .. WM359\*

## PORTABLES

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Holiday Portable (SG, D, LF,  
Cl. B) .. AW393

Family Portable (HF, D, RC,  
Trans) .. AW347

Tyers Portable (SG, D, 2 Trans) .. WM387

## SHORT-WAVE SETS. Battery Operated

One-valve: Blueprints, 1s. each.  
S.W. One-valver for America .. AW429\*  
Roma Short-Waver .. AW452

Two-valve: Blueprints, 1s. each.  
Ultra-short Battery Two (SG, det  
Pen) .. WM402\*

Home-made Coil Two (D, Pen) .. AW440

Three-valve: Blueprints, 1s. each.  
Experimenter's 5-metre Set (D,  
Trans, Super-regen) .. AW438

The Carrier Short-waver (SG,  
D, P) .. WM390\*

Four-valve: Blueprints, 1s. 6d. each.  
A.W. Short-wave World-beater  
(HF, Pen, D, RC, Trans) .. AW436\*

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

Superhet: Blueprint, 1s. 6d.  
Simplified Short-wave Super .. WM597\*

## Mains Operated

Two-valve: Blueprints, 1s. each.  
Two-valve Mains Short-waver (D,  
Pen) A.C. .. AW453\*

Three-valve: Blueprints, 1s.  
Emigrator (SG, D, Pen) A.C. .. WM352

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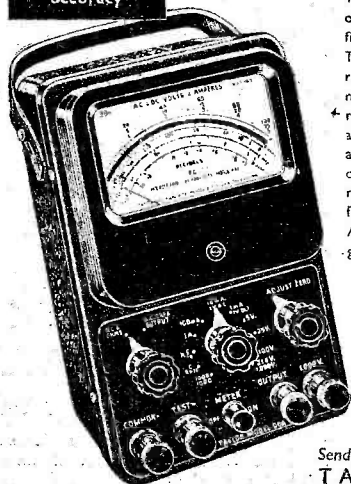
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