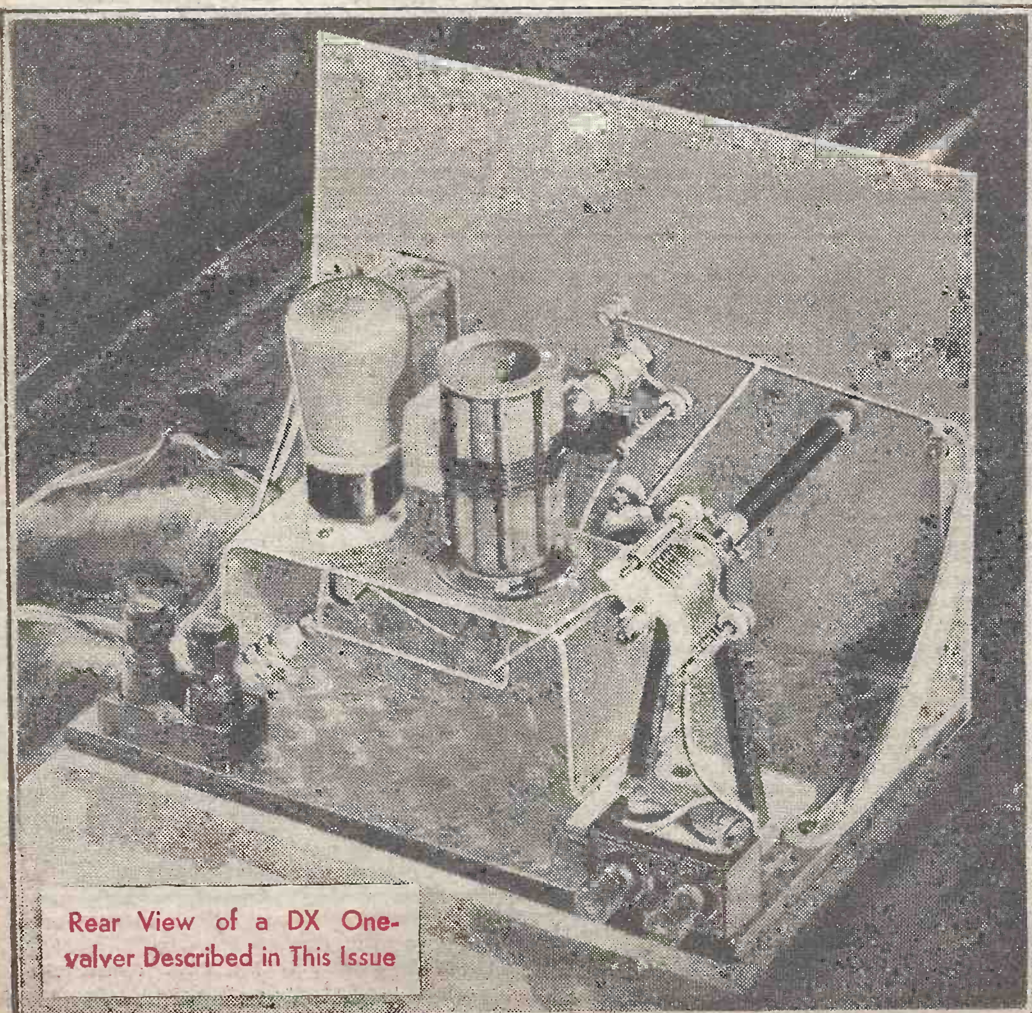
RADIOGRAM CIRCUITS

Practical Wireless 9D EVERY MONTH

Editor F. J. CAMM

Vol. 20 No. 461 NEW SERIES NOVEMBER, 1944



Rear View of a DX One-valver Described in This Issue

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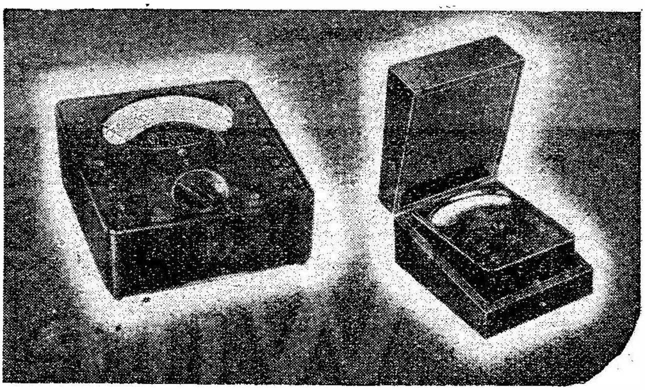

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Practical Wireless

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 battened 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 ægis. 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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Owing to the rapid progress in the design of wireless apparatus and to our efforts to keep our readers in touch with the latest developments, we give no warranty that apparatus described in our columns is not the subject of letters patent.

ROUND THE WORLD OF WIRELESS

Army Signals Exhibition

AN 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

SOUTH 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

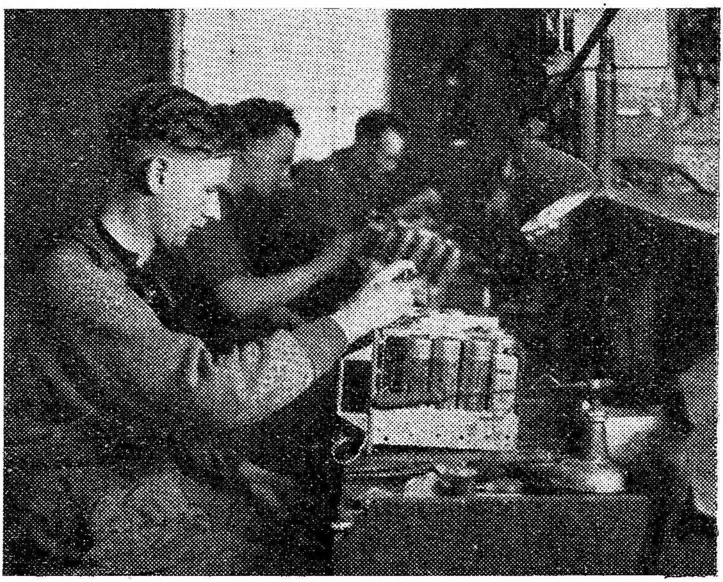
ACCORDING to a recent report from the United States, General Electric engineers have invented a remarkable electronic tube, now being used in war applications, which will enable the radio relaying of television programmes for quick expansion of the service after the war.

New Radio Drama Technique

UP 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 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.



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.

B.B.C. War Reporters

COVERING 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.

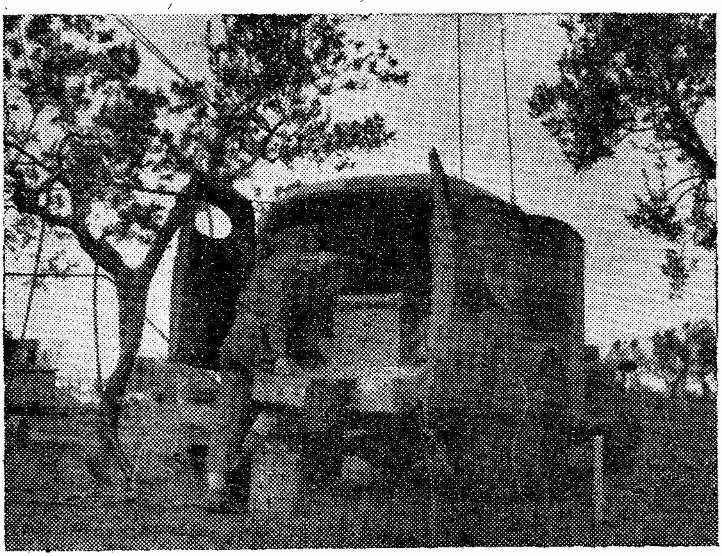
The name of this music club is "Music for All." It so happened that at the time Gillard was giving his description of it to the Music Department they were planning a new series of concerts of popular music to be given before a Forces audience, and could find no appropriate title. The idea behind the 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

MILLER 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 capacitative, 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—and 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

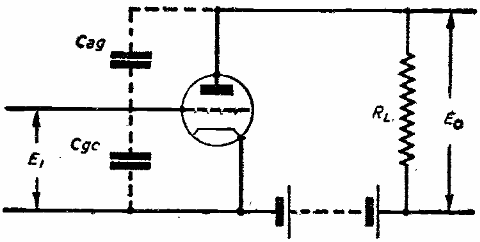


Fig. 1.—A triode valve circuit in which the capacities concerned are indicated and in which the anode load is resistive.

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.
Cag represents anode-grid capacity due to electrode structure.
Cgc represents grid-cathode capacity due to electrode structure.

The condensers Cag and Cgc 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 × voltage

The charge on the grid due to Cgc $= E_I$ Cgc

The charge on the grid due to Cag $= (E_I - E_O)$ Cag

$= [E_I - (-ME_I)]$ Cag

$= E_I (1+M)$ Cag

The total charge on the grid $= E_I$ Cgc $+ E_I (M+1)$ Cag

$= E_I$ [Cgc $+ (M+1)$ Cag]

The resultant effective input capacity = charge ÷ voltage

$=$ Cgc $+ (M+1)$ Cag 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

$= 6 + (80+1)\ 2$ 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 41MH 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

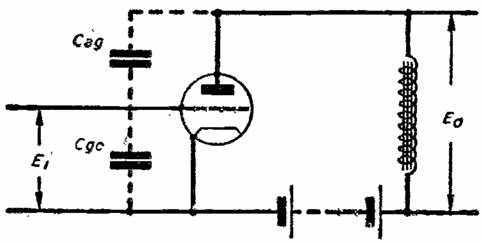


Fig. 2.—The anode load in this instance is an L.F. choke and is therefore reactive.

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

(12 Cgc + 2 valve-holder capacity + 6 wiring capacity) + (50+1) (5 Cag + 1 valve-holder capacity + 2 wiring 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

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

where μ represents the valve amplification factor.
R_L represents the load resistance.
and R_A represents the valve anode impedance.

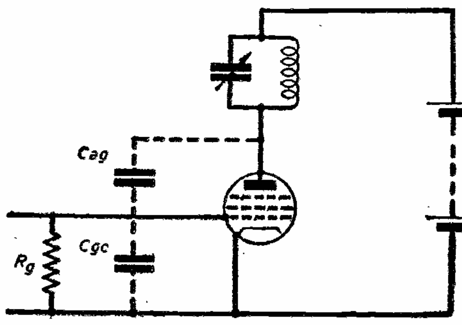


Fig. 3.—Method of varying the applied frequency.

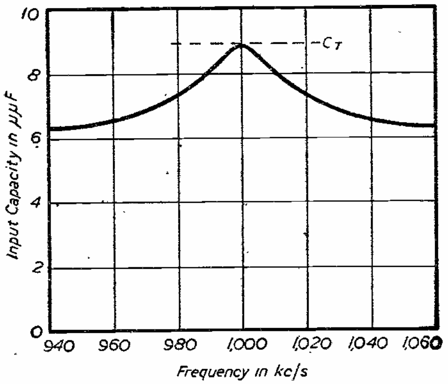


Fig. 4.—Input capacity variation as the applied frequency is varied above and below resonance.

It should, however, be borne in mind that though μ 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 capacitative 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

$$-\frac{1}{\omega \text{ Cag M} \sin \theta} \quad \ldots\ldots\ldots\ldots\ldots\ldots 3$$

Where Cag represents the anode-grid capacity
M represents the voltage gain of the stage
θ represents the phase angle of the anode load, being positive for an inductive load and negative for a capacitative 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 ωL where $\omega = 2\pi f$) θ the phase angle will be approximately 90 deg. and therefore $\sin \theta = 1$

$$\text{Hence } R = -\frac{1}{2\pi f \text{ Cag M}} \quad \ldots\ldots\ldots\ldots\ldots\ldots 4$$

When $\theta = 0$, i.e., when the load consists of a resistance, $\sin \theta = 0$ and therefore $R = -\frac{1}{0}$
= Infinity.
i.e., the grid input is purely capacitative 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 (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 capacitative, θ, 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.

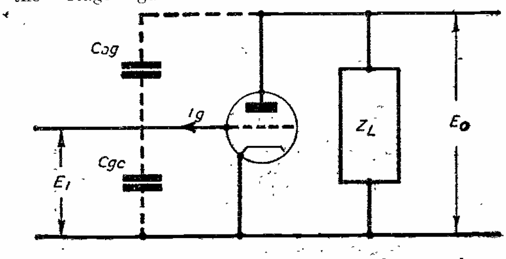


Fig. 6.—The triode circuit when the load impedance is inductive.

Assume $M = \frac{Eo}{EI} = 50$
Cag = 3 mmfd.
and Cgc = 12 mmfd.

The input capacity will be (from Expression **6**)
$12 + 3 (1 + 50 \cos 90°)$
$= 12 + 3 (1 + 50 \times 0)$
$= 15$ mmfd.
i.e., the input capacity becomes the same as for no load, Cgc + Cag.

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.

Assume Cag = .03 mmfd.
Cgc = 6 mmfd.
M = 100
$f_0 = 1{,}000$ kc/s = resonant frequency of tuned circuit
Q = 50

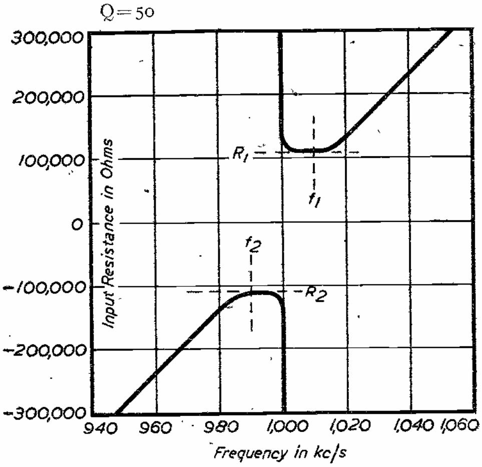


Fig. 5.—Input resistance variation as the input frequency is varied above and below resonance.

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, $C_1 = 6 + (101 \times .03)$ mmfd. (from Expression 1)
= 9 mmfd.

In Fig. 5 it may be shown that

R_1 (the minimum value of Rg) $= \frac{2}{\omega \text{ Cag M}}$

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

at frequencies $f_1 = f_0 + f_0/2Q$
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_L represents load impedence.
I_g represents A.C. grid current (i.e., the current through the condensers Cag and Cgc).

M represents stage gain $= \frac{E_O}{E_I}$

$\omega = 2\pi f$.

θ represents the phase angle of the voltage across Z_L (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 ωCgc 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

$$Cag = [E_I - E_O \cos(\theta + 180)] \div \frac{1}{j\omega Cag}$$

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

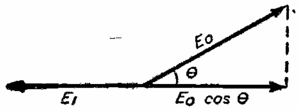


Fig. 7.—The vector diagram for EI, FO and EO cos θ.

the input voltage E_I is considered as being developed across a resistance, and that across Z_L 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 $E_O \cos\theta = 180$

∴ the voltage across $Cag = E_I - E_O \cos(\theta + 180)$

and the grid current due to $Cag = [E_I - E_O \cos(\theta + 180)]\ j\omega Cag$

∴ the total grid current $I_g = j\omega Cgc E_I + j\omega Cag [E_I - E_O \cos(\theta + 180)]$

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

Hence, $\frac{1}{\text{Grid input impedance}} = \frac{\text{Total grid current}}{\text{Grid input voltage}}$

i.e., $$\frac{1}{\text{Grid input resistance} + \frac{1}{j \times \text{grid input reactance}}} = \frac{j\omega\ Cgc\ E_I + j\omega\ Cag\ E_I[1 - \frac{E_O}{E_I}\cos(\theta + 180)]}{E_I}$$

$$= j\omega\ Cgc + jw\ Cag\ [1 - M \cos(\theta + 180)] \quad \ldots\ldots\ldots\ldots 5$$

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

Grid input reactance $= \omega Cgc + \omega Cag\ [1 - M \cos(\theta + 180)]$

Dividing by "ω"

Grid input capacity $= Cgc + Cag\ (1 + M \cos\theta)$ 6

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

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

$$\frac{1}{\text{Grid input resistance}} = -j\omega\ Cag\ M \cos(\theta + 180)$$

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

∴ Grid input resistance $= -\frac{1}{\omega\ Cag\ M\ \cos(\theta + 270)}$

But $\cos(\theta + 270) = \sin\theta$

∴ Grid input resistance $= -\frac{1}{\omega\ Cag\ M\ \sin\theta}$ 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.

Effective grid input capacity =
$Cgc + Cag\ (1 + M \cos\theta)$ 6

Effective grid input resistance $= -\frac{1}{\omega\ Cag\ M \sin\theta}$ .. 3

where Cgc represents grid-cathode capacity
Cag represents anode-grid capacity
θ represents phase angle of anode load
$\omega = 2\pi f$

M = stage gain $= \frac{\mu R_L}{R_A + R_L}$ 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 Cac 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_2 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 Cac are effectively in parallel with R_L (as Cc has negligible reactance and the impedance between HT + and earth may also be ignored) the effective impedance of the anode load of V_1 (assuming R_g to be much greater than R_L) $= \frac{R_L\ Xc}{R_L + jXc}$ where Xc is the reactance of the total shunt capacity from V_1 anode to earth. Thus when $Xc = R_L$ the anode impedance =

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

i.e., at the frequency at which $Xc = R_L$ 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

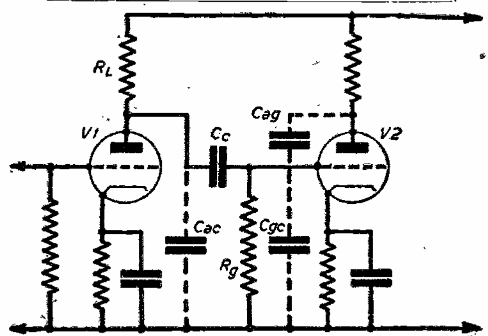


Fig. 8.—A typical resistance capacity coupled A.F. amplifier.

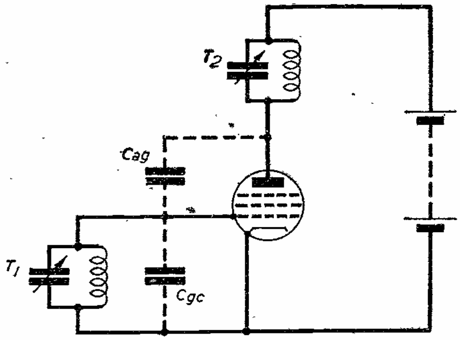


Fig. 9.—Amplifier grid and anode circuit employing a pentode.

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 Cag = .005 mmfd.
Cgc = 6 mmfd.
M = 200.
f_0 = 465 kc/s = resonant frequency of tuned circuit.
Q = 50.

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

Although Cag = .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

$$= \pm \frac{2}{\omega \, Cag \, M}$$

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

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

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. raction 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.

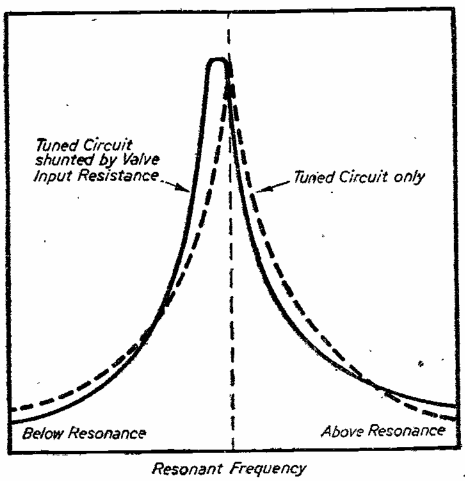


Fig. 10.—Response curve.

Sound Amplifying Equipment—3

Assembling and Wiring the Components in the Chassis

(*Continued from page 454, October issue*)

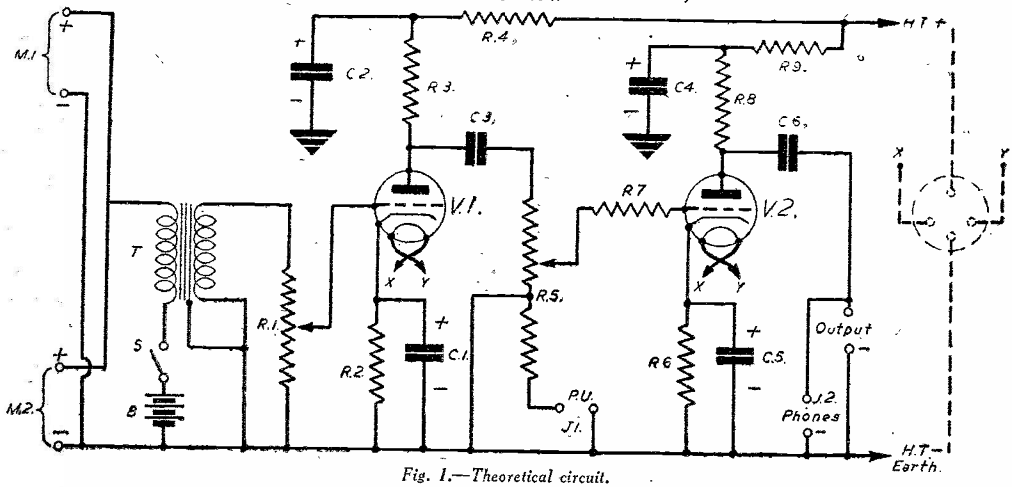


Fig. 1.—Theoretical circuit.

WHEN 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 flatting 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 41MH 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 condenser 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

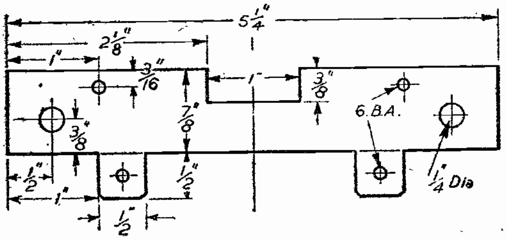


Fig. 2.—Base for condenser and resistor panel.

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 V1 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 V1) to pick-up and/or control the input of either to V2. 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 R7 is incorporated as a grid-stopper or decoupler, its value being 100,000 ohms. Bias for V2 is obtained by the normal cathode system, while anode decoupling is also provided for this valve by the resistor and condenser R9 and C4. The output is taken from the fixed condenser C6 (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 V2 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 R1, 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 R1, is located properly and not twisted round when the nut is tightened.

The microphone transformer, the switch, volume control and the grid circuit of V1 can now be wired. Note that the connection between the moving arm of R1 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, R5, and the two jacks J1 and J2 should next be fitted to the panel noting that J1 (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 C6 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 C3 to the anode pin of V1 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 1/4in. away from the body of the condenser. This extra wire or connection is needed for linking up with the anode load resistor R3.

Resistor Panel

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

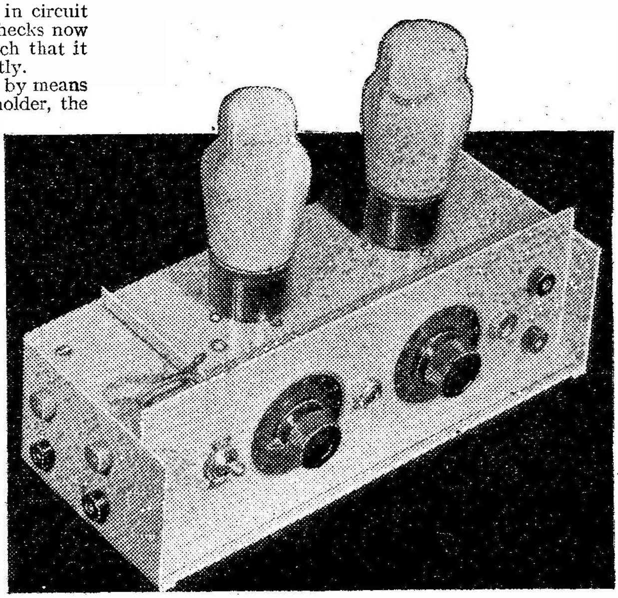


Fig. 3—View of the completed unit.

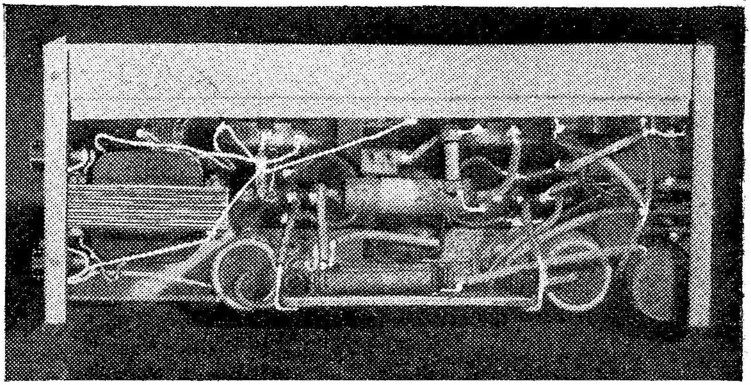


Fig. 4.—Underneath view.

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 ¼in. holes, one at each end of the strip, are for the fixing of the Dubilier electrolytic condensers C1 and C5, 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 R2 and R6 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 R4 and R9 together, connect R8 to R9, and R3 to R4, and solder on leads of tinned copper wire to the anode ends of R3 and R8. Now bolt the panel to the metal strip bracket and, after placing C4 in position, i.e., under J1 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 C2. A word of warning regarding earthing the chassis. It is best for the contact to the chassis to be made near V1, 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.

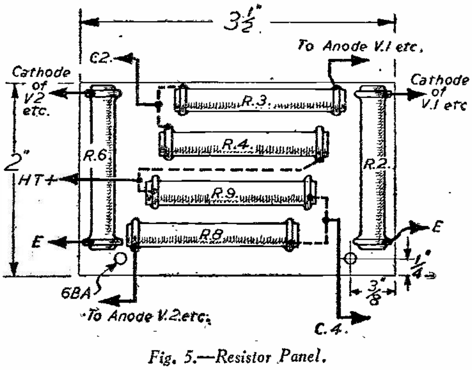


Fig. 5.—Resistor Panel.

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. Hunts. (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, ½ 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 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-amps.—not in terms of watts.

In order to convert apparent power in volt-amps

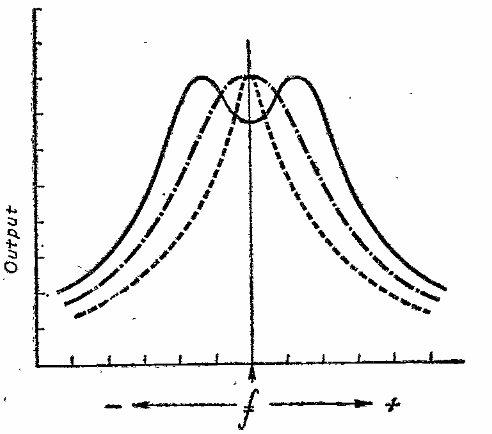


Fig. 1.—Different types of resonance curves for tuned circuits. That shown by a broken line is for a sharply tuned or loose-coupled circuit, that in a chain line is for a critically tuned circuit, while the double-humped curve shown as a full line is the result of the coupling being too tight.

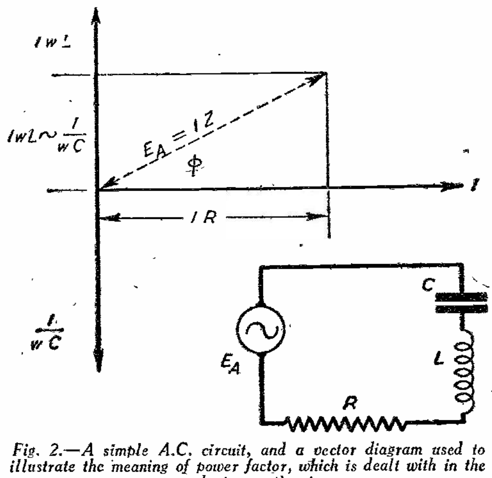


Fig. 2.—A simple A.C. circuit, and a vector diagram used to illustrate the meaning of power factor, which is dealt with in the reply to question two.

to actual power in watts we must use a conversion factor. This is described as the power factor, and it varies in magnitude according to the constants of the circuit involved. One method of stating power factor is by the fraction R/Z (resistance divided by impedance).

In Fig. 2 a series circuit is shown, where a condenser, inductance and resistance are connected in series with an alternator. Also, in Fig. 2 is a vector diagram which relates the various factors in the circuit. Inductive and capacitive reactance are measured upward and downward from the horizontal ordinate, as are the corresponding voltages, shown as IωL and 1/ωC. Since the two oppose, their difference is taken and measured off to a convenient scale on the vertical ordinate. Next, the apparent voltage IR is measured off along the horizontal ordinate. By drawing horizontal and vertical lines to complete a rectangle, we can find the true voltage (E_A) by drawing a diagonal and measuring its length to the same scale used before.

It can now be seen that the power factor is equal to IR divided by IZ, or R/Z. Another name for power factor is cos ϕ, where ϕ is the angle shown; the cosine of this angle is found by dividing the base of the right-angled triangle by the hypotenuse.

3. Noise Suppression

A noise suppression circuit for use after the second detector of a superhet is shown in Fig. 3, where V1 is the second detector, and V2 is the diode noise suppressor. In the absence of noise suppression, the low-frequency amplifier would be fed from the top of the load resistor marked R1; the usual feed point is indicated by a broken line.

For so-called noise suppression we require a circuit arrangement which will prevent any sudden surges—of the kind resulting from strong "noise," such as static or powerful interference—from being passed on the L.F. amplifier. We, therefore, feed the output from V1 on to the anode of V2, though a suitable D.C. "stopping" condenser, and apply a small anode voltage to V2, so that it will conduct. This voltage, normally between about 20 and 30, is obtained through the potentiometer marked R4 and the cathode resistor R3.

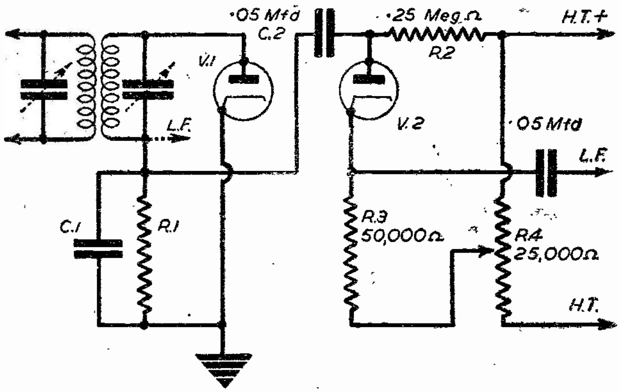
Assume that the anode voltage has been so adjusted by setting R4, so that the diode V2 will continue to conduct at all required signal-voltage levels from V1. Now the application of a high negative surge voltage, due to strong interference surges, to the anode of V2 will "over-ride" the steady D.C. anode voltage, with the result that the anode will become negative in respect of the cathode. In that condition the valve will not conduct, and therefore there will be no transfer of signal from the anode to the cathode. Since the lead to the L.F. amplifier is taken from the cathode, the input to the amplifier will be discontinued, and the "noise" will not be heard. As soon as the "noise" ceases the suppression valve will again conduct, and the output from V1 will be passed on to the L.F. amplifier.

4. Secondary Emission

When electrons strike the positively biased anode of a valve they do so at a very high velocity. In striking it they tend to "knock out" other electrons. It is the latter which are described as secondary electrons, the electrons flying to the anode from the cathode being described as primary electrons.

In the ordinary course of events the secondary electrons would soon return to the anode because of the relatively high positive potential on it. But if there were another nearby electrode with a positive potential equal to that of the anode the electrons may well be attracted to that.

This can occur with a screen-grid valve when the anode voltage is below or not greatly in excess of the screen voltage. This explains why, for example, the anode current of a screen-grid valve falls as the anode voltage is increased from zero to a figure equal to rather less than the screen voltage. Further increases in anode voltage produce an increase in anode current. Because of this the valve will operate correctly as long as the anode voltage is in excess of the screen voltage. It must be remembered, however, that even though the steady D.C. anode voltage is suitable, the actual voltage may be swung by a strong signal. If it should be swung sufficiently low for secondary electrons to be attracted to the screen serious distortion will occur.



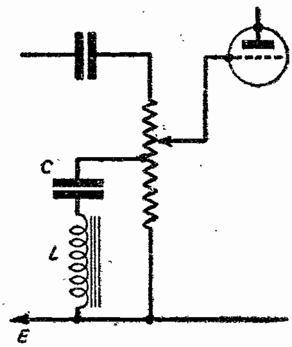


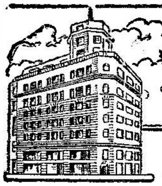
Fig. 3. (Left).—A noise-suppression circuit used between the second detector (V.1) and L.F. amplifier of a superhet receiver. Fig. 4 (Right).—A simple tune-connected audis volume centre consisting of a condenser C and choke L connected in series between a tapping on the volume control potentiometer and the earth line.

5. Volume Control and Tone Control

It has been noticed by everyone that reproduction tends to become "thin" as the volume is reduced by turning down the volume control. This is because there is a certain amount of attenuation of both the higher and lower audio frequencies. The attenuation is more apparent than real, and is due to the characteristics of the human ear, which is less sensitive to the upper and lower frequencies.

To overcome the loss of "richness" of reproduction it is often desirable to combine a tone control, or rather a tone-correction device, with the volume control. There are various methods of doing this, but perhaps the simplest is by incorporating a tone filter in a simple circuit arrangement of the kind illustrated in Fig. 4. It will be seen that a condenser and a choke are wired in series and connected between a tapping on the audio volume control potentiometer and earth.

If the filter is made to resonate at a low frequency it will give a certain amount of bass boost. It could, however, be designed to give boost to the treble, whilst if it resonates at about 1,000 cycles per second it will tend to give a certain amount of boost to both bass and treble.



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-cored 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 Paree! Ici Radio Paree!
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."

Our Roll of Merit

Readers on Active Service—Forty-seventh List

K. Hanson (R.A.).
J. Phillips (Cpl. R.A.F.).
T. A. Palmer (R.A.F.).
J. Hodgkins (Pte. R.A.).
J. Tonkin (Cpl. R.A.F.).
W. Foyle (L.A.C. R.A.F.).
G. Clark (AC/1 R.A.F.).
A. H. Gardner (A.C. R.A.F.).
J. 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 ½in. 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.

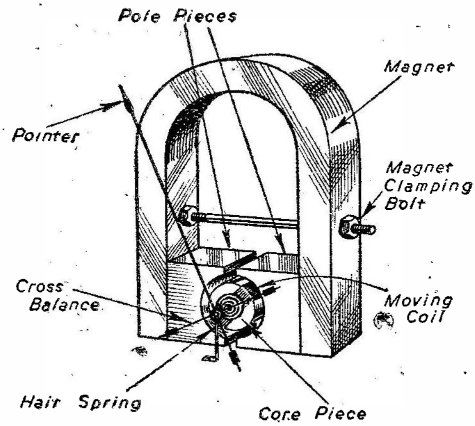


Fig. 1.—Diagrammatic view of a moving coil meter.

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 1in. A 2in. long pointer will need to turn through approximately 50 deg. for a 1¾in. deflection; if the pointer is lengthened to 4in. it only need turn through 35 deg. for a similar deflection of 1¾in. With the instrument mentioned, a deflection of 4in. 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.

Practical Hints

Handling Thin Strip Solder

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

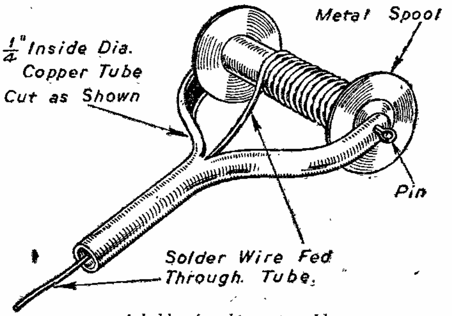
A wooden or metal spool, such as a roll-film spool, is fitted with a tubular guide formed by splitting a piece of copper or brass tubing lengthwise, as shown in the sketch. Two holes are drilled through the ends of the split tube, and a pin is inserted through the spool and the holes in the tube. When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

THAT DODGE OF YOURS!

Every Reader of "PRACTICAL WIRELESS" must have originated some little dodge which would interest other readers. Why not pass it on to us? We pay £1-10-0 for the best hint submitted, and for every other item published on this page we will pay half-a-guinea. Turn that idea of yours to account by sending it in to us addressed to the Editor, "PRACTICAL WIRELESS," George Newnes, Ltd., Tower House, Southampton Street, Strand, W.C.2. Put your name and address on every item. Please note that every notion sent in must be *original*. Mark envelopes "Practical Hints."

SPECIAL NOTICE

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



A holder for thin strip solder.

A Continuity Tester

THE 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 4½ 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.

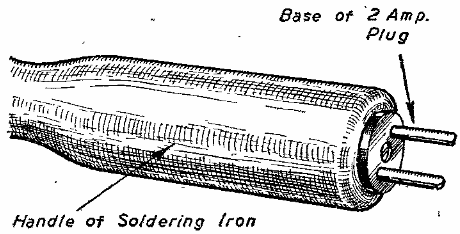
A switch was included in the circuit so that the battery would not run down if the test prods were accidentally short-circuited and three other terminals were connected to those of the voltmeter for battery testing. The completed instrument was mounted on a cigar box about an inch deep, with the battery fixed underneath.—R. L. STOKER (Market Harborough).

Improved Connection for Soldering Iron

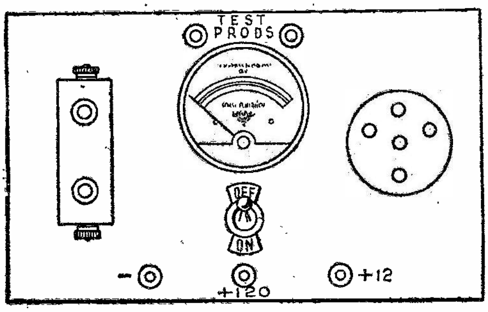
A GREAT deal of trouble can be experienced in repairing the connections to an electric soldering iron. I am using a very simple dodge which makes the only repairs necessary outside the handle of the iron. I have attached to the handle of the iron a 2-amp. 2-pin plug, and to the mains lead a 2-amp. socket.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

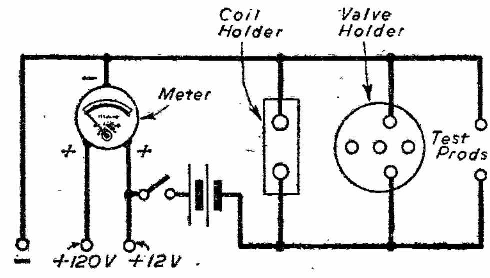
Extension Speakers

DURING 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 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).



A handy method of connecting an electric soldering iron.





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 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.

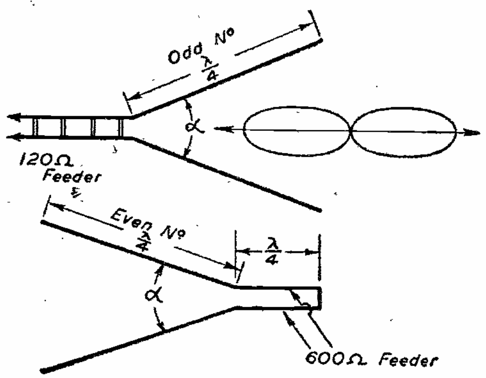


Fig. 1.—Details of the "V" type of bi-directional aerial. Two different methods of feeding it (according to whether the arms are an even or odd number of quarter-waves long), and inset is shown the form of the horizontal polar diagram.

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 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 (λ), and the angle between the arms (α) 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

eference 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)

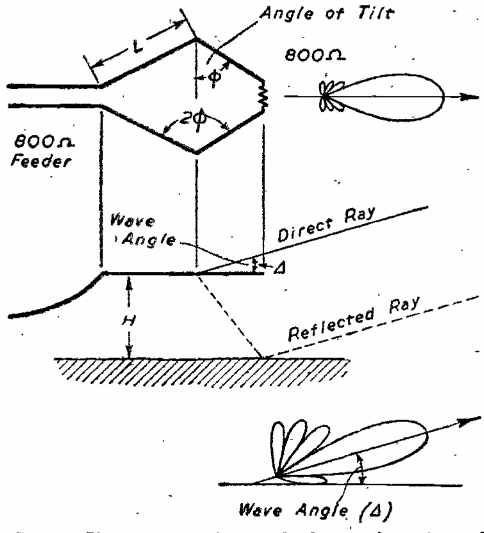


Fig. 2.—These diagrams show a rhombic aerial in plan and elevation, whilst the horizontal and vertical polar diagrams indicate the general radiation pattern.

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

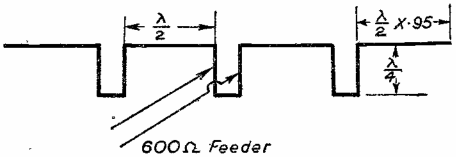


Fig. 3.—A four-section co-linear broadside aerial with quarter-wave matching stub.

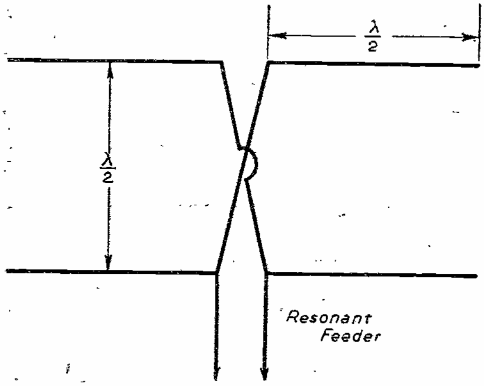


Fig. 4.—The "Lazy-H" broadside aerial array.

(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 ovious that both " V " and rhombic aerials 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.

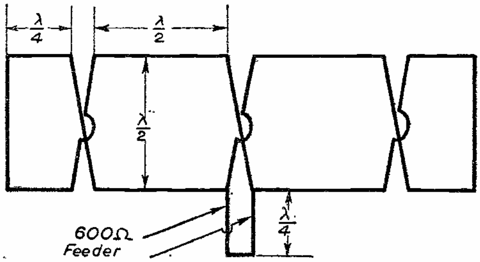


Fig. .. —The Sterba aerial. Its directivity can be increased by the use of additional half-wave sections. A reflector may be placed a quarter-wave behind the aerial to render the system uni-directional.

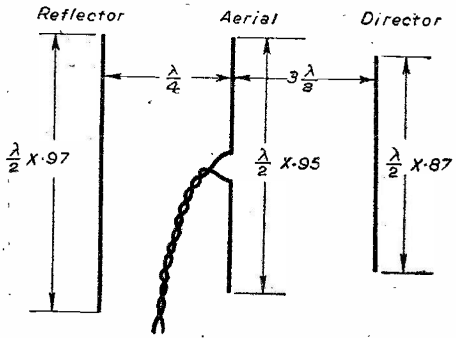


Fig. 6.—Details of a simple Yagi aerial having only one director. The beam angle may be reduced—and the aerial gain increased—by the use of additional directors.

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 aerials 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

THE 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 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 ⅛in. 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.

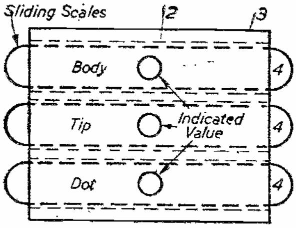
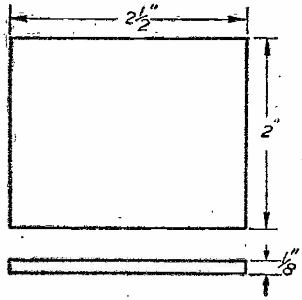
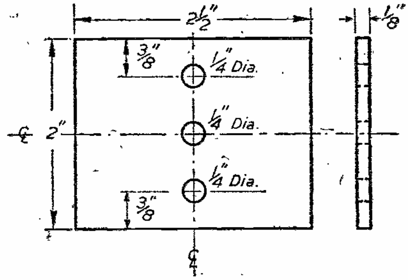


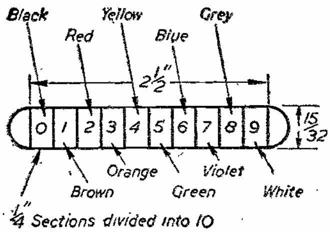
Diagram of Completed Device.



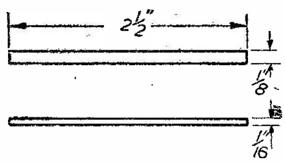
Part No. 1 (1 off).



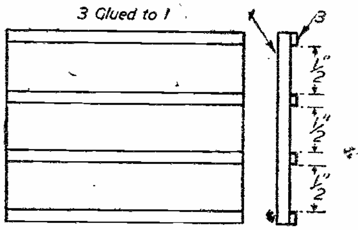
Part No. 2 (1 off).



Part No. 4 (3 off).



Part No. 3 (4 off).



Assembly of Part Nos. 1 and 3.

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 ?

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 12ft. 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.

Amplitude Modulation Systems

An Explanation of Some of the Most Satisfactory Methods of Obtaining Amplitude Modulation with Low-power Transmitters

SO much has been written and spoken during the past few years about frequency modulation that serious attention has often been diverted from amplitude modulation. Despite the advantages which frequency modulation possesses, especially on very high frequencies, there is little doubt that amplitude modulation will remain in use for many more years. And if one is to obtain a clear understanding of the advantages offered by frequency modulation, it is necessary first to have a clear impression of the process of amplitude modulation, as well as of the practical application of the system.

One of the chief advantages of amplitude modulation is that transmissions can be received with the type of receiver which is standardised to-day for both broadcast and short-wave reception in this country; to receive F.M. transmissions it is necessary to employ a receiver with a different type of detector—or de-modulator, as it can more properly be called.

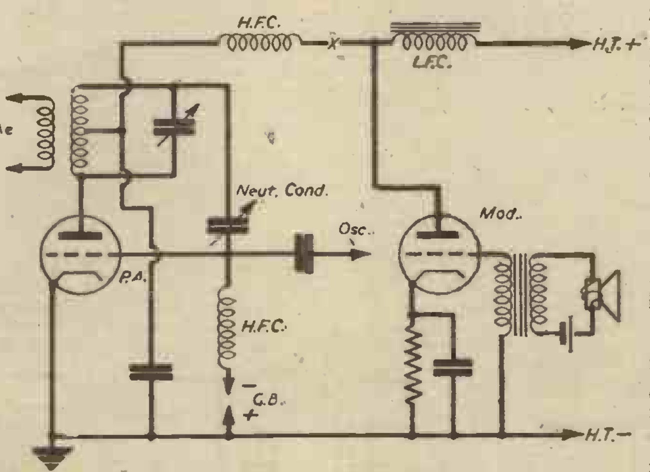


Fig. 1.—Simple anode or choke modulation of a Class C R.F. amplifier.

It is not proposed to go fully into the principles of modulation because they have often been explained in these pages before. Instead, it is proposed only to consider the methods by which a transmitter may be amplitude-modulated. It is, however, necessary to bear in mind that the requirement is that a sine wave representing the carrier wave of the transmitter shall be varied in amplitude at an audio-frequency. Thus, the oscillator or R.F. amplifier (the latter is to be preferred in most instances) shall have fed into it a voltage which alternates at an audio-frequency. The audio-frequency voltages are added to, or subtracted from the radio-frequency or carrier-wave voltages according to the momentary phase relationship between them. The modulation should be applied in such a manner that the mean output of the transmitter rises with the modulation. The output does not rise in direct proportion to the modulation power, but the ratio between modulated and unmodulated output, for 100 per cent. modulation, is 1.5 : 1. For other precentages of modulation, the ratio can be found from the simple equation: Ratio, Modulated power : Unmodulated power $= \frac{(1 - m^2)}{2} : 1$.

Change in Aerial Current

As aerial current is generally used as an indication of power output (and it can be used correctly for this purpose provided that the radiation resistance of the aerial circuit is known) it is better to express the ratio in terms of current. This can be done simply by taking the square root of the expression inside the brackets above. It will then be found that for 100 per cent. modulation the ratio between the aerial currents for modulated and unmodulated output is 1.23 : 1.

At this point it is necessary to explain that the term m in the above equation is not the precentage modulation, but the modulation index. In other words, it is the percentage expressed as a decimal fraction; for example, 50 per cent. modulation is the same as a modulation index of .50; or 75 per cent. modulation is equivalent to a modulation index of .75.

It is fairly evident that, in order to obtain modulation, it is necessary to vary the output from the transmitter at an audio- as well as a radio-frequency. This can be done by applying an audio-frequency voltage to the cathode, grid, anode or suppressor grid of the oscillator or R.F. amplifier valve. We can see how it is possible to provide modulation by each of the methods mentioned. In doing this it will be assumed that we are to modulate a Class C R.F. amplifier (often called the power amplifier or P.A.) rather than the oscillator. This, in any case, is to be preferred.

Anode Modulation

Anode-modulation is probably the simplest, and one method of applying this is illustrated in Fig. 1. It will be seen that an audio-frequency choke is included in the H.T. positive lead to the P.A. valve, and that this carries the H.T. current for both the modulator and P.A. stages. The choke acts as the anode load for the modulator, and so the A.F. current fluctuations through it cause an audio-frequency voltage to be developed between its ends. This is impressed on the otherwise steady anode voltage applied to the amplifier.

In many cases, the modulator valve requires to have a higher H.T. voltage than the amplifier if anything like 100 per cent. modulation is to be obtained. This is because the output from the modulator would be much less than the H.T. voltage. To overcome this difficulty, it is necessary to include a voltage-dropping resistor, with by-pass condenser at the point marked with a cross in Fig. 1. The value of the resistor is so chosen that the anode voltage applied to the P.A. is equal to the maximum A.F. voltage provided by the modulator. A suitable value for the by-pass condenser would be about .1 mfd.

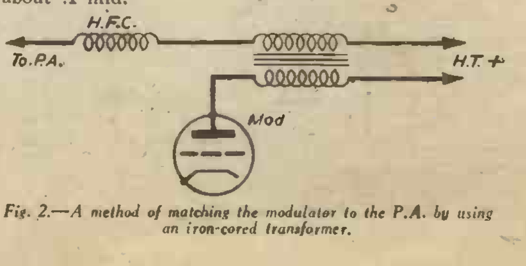


Fig. 2.—A method of matching the modulator to the P.A. by using an iron-cored transformer.

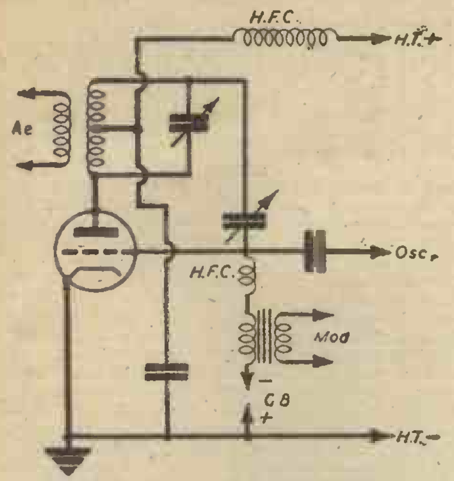


Fig. 3.—A grid-bias-modulated R.F. amplifier.

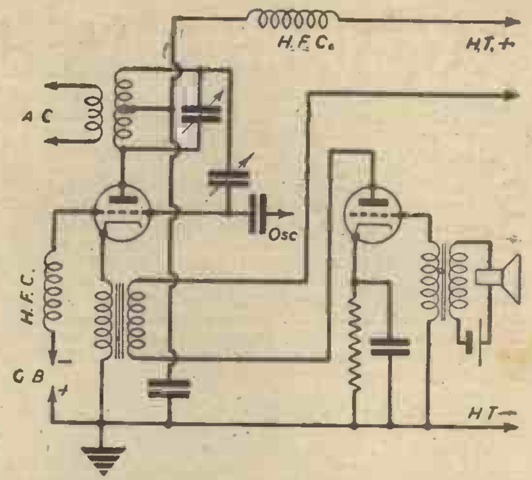


Fig. 4.—Cathode modulation. The modulator output is used to vary both grid bias and anode voltage.

Correct Matching

It will be seen that there is no provision made in the circuit in Fig. 1 for the matching of the modulator to the amplifier. Full efficiency cannot be obtained unless the two are matched together, in the same way that the anode load of an ordinary L.F. amplifying valve must be suitably chosen to suit the anode resistance of the valve. Matching can be obtained by replacing the iron-core choke by a transformer or tapped choke (which can be used as an auto-transformer). The connections are shown in Fig. 2, and the correct ratio for the coupling transformer can easily be found if the anode resistance, or the optimum load, of the modulator is known, and also the working characteristics of the amplifier. Assuming that the modulator is a triode, the optimum load may be taken as twice the anode resistance. The working impedance of the amplifier is best found by dividing the applied anode voltage by the anode current (when unmodulated). It is then possible to calculate the optimum ratio for the transformer by dividing the working impedance of the amplifier by the optimum load of the modulator, and taking the square root of the quotient; this is the same method as that used for determining the ratio of an output transformer for coupling a receiver to a speaker.

It will be evident that an ordinary low-frequency transformer would seldom be of any use in a circuit of the kind under consideration because the windings (and the core) would be totally unsuitable for the far heavier currents being used. In general, the most suitable type of valve for use as a modulator is one with a low anode resistance; this means, in effect, a good low-resistance power valve. This, incidentally, emphasises the desirability of using a matching transformer.

Grid Modulation

Grid modulation, or grid-bias modulation, as it is often called, is illustrated in Fig. 3. The modulation from the single- or multi-valve modulator is applied to the grid circuit of the amplifier through a transformer which is isolated from the R.F., also applied to the

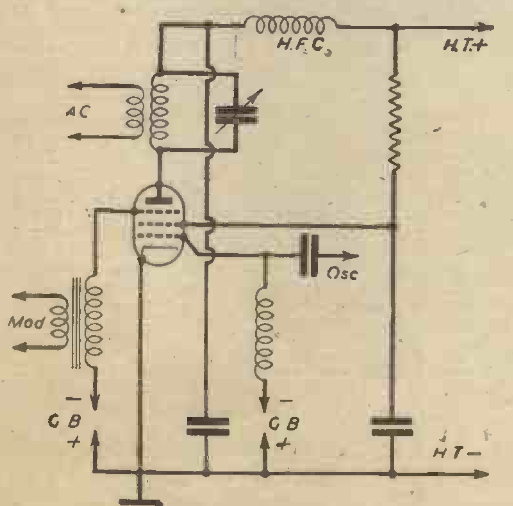


Fig. 5.—How suppressor-grid modulation may be applied to an R.F. amplifier.

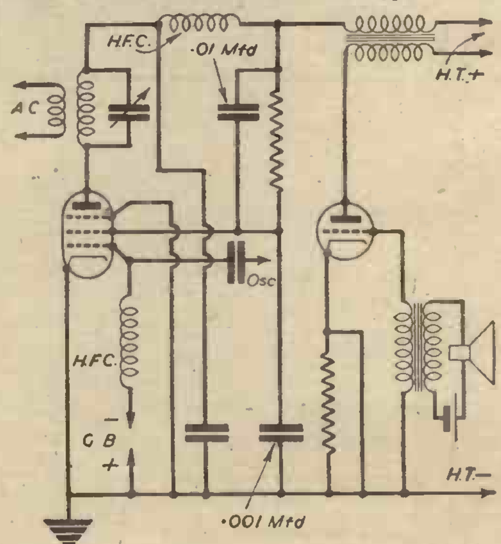


Fig. 6.—Combined anode and screen modulation of an R.F. pentode. The two condensers in the screen circuit form an A.F. potentiometer; values assigned are very approximate.

amplifier grid from the oscillator, by means of an H.F. choke. This system of modulation is not normally to be recommended, partly because difficulty is experienced in setting up the transmitter to avoid distortion, and partly because it is not very efficient. The reason for the relatively low efficiency is that the anode voltage of the amplifier remains constant; to provide increased power output on modulation the valve must be adjusted to operate inefficiently when unmodulated or on low modulation voltages. On the other hand, the system has the advantage of requiring a low modulation input, since the modulation, being applied to the grid, is amplified at the same time as the R.F. by the normal action of the valve.

Cathode Modulation

Cathode modulation is really a combination of grid and anode modulation. This is because, the audio-voltage being applied in the cathode lead, both grid-bias and anode current are varied by the application of the modulation. A circuit is shown in Fig. 4, where it will be seen that the secondary winding of the modulator output transformer is inserted in the cathode lead of the amplifier; a separate lead is taken from the amplifier grid to a source of grid-bias. This is normally necessary because for class C amplification a high bias voltage is required to bias-back the amplifier well beyond the cut-off point when it is unmodulated. This arrangement combines the advantages and disadvantages of both grid- and anode-modulation, and often provides a satisfactory compromise.

Suppressor-grid Modulation

Suppressor-grid modulation of a pentode R.F. amplifier is illustrated in Fig. 5. It has the advantage of requiring very little audio-power for its operation; in fact, if the suppressor grid remains negative throughout modulation the power requirement is nil. In that case, only audio-voltage is required. In addition, this form of modulation is very nearly distortionless, and the circuit can easily be set up. Among the disadvantages are the relatively low efficiency of the amplifier itself and the inability of the system to take deep modulation except when use is made of special pentodes with particular suppressor-grid characteristics. The requirement is that the suppressor voltage-anode current curve shall have a long straight operating portion. The suppressor-grid voltage should be such that it is half-way along the straight portion of the curve in the absence of modulation.

A Double-modulation Method

Another method of modulating a pentode is that in which modulation is applied simultaneously to both the anode and the screening grid. One simple manner in which this can be done is shown in Fig. 6. It will be seen that the circuit closely resembles that for a transformer-coupled anode modulated triode, with the addition of a feed from the "anode" end of the transformer secondary to the screening grid—through a suitable voltage-dropping resistor. There are no particular virtues in the system, but it is clear that the audio output required from the modulator is somewhat less than that required for plain anode modulation.

Throughout this article the modulator has been illustrated as a single valve. In practice, it would generally consist of an audio-amplifier of two or three stages. The amplifier would, in fact, be of the same type as that used with a receiver. The output required from it would depend entirely on the unmodulated output from the R.F. amplifier and upon the system of modulation employed; as already stated, a lower audio-power is required for grid and for suppressor-grid modulation than for, say, anode modulation.

Quench-operated Receivers

The Principles of Super-regenerative Receivers

THE principles upon which quench-operated receivers work are interesting, and well worth study. This class of receiver (also called super-regenerative) has suffered a partial eclipse, but there can be no doubt that when hostilities end and amateur activity starts up on the ultra-short wavelengths, it will be in great demand. On the U.S.W. it offers many advantages, such as the ability to "hold" a station whose frequency is not quite steady. This combined with great amplification makes the super-regenerative receiver the ideal simple set for use at very high frequencies, though of course it can be worked on ordinary short waves and even on medium waves as well. For these reasons the study of the somewhat complicated technique of the quench-operated receiver can profitably be undertaken.

The mode of operation is to make the set oscillate

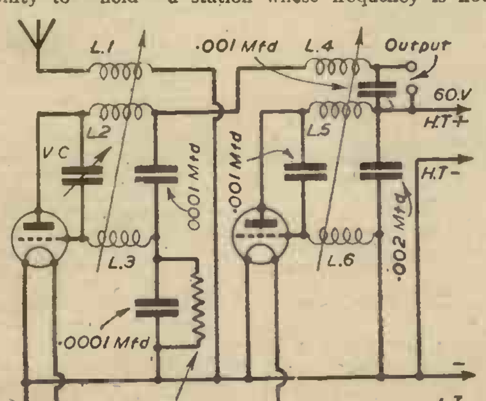


Fig. 1.—Quench-operated circuit for U.H.F.

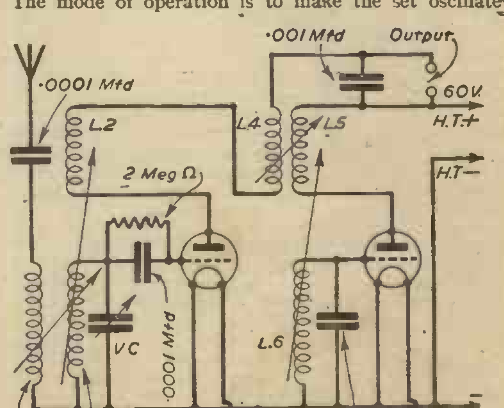


Fig. 2.—Circuit for short and medium waves.

and then introduce intermittent damping into the circuit. This damping prevents oscillation, and since the damping is intermittent the periods between the damping action are periods when a large amount of reaction can be used.

In the ordinary regenerative circuit a reaction coil is linked to the grid coil, and as the coupling between the two coils is increased so also is the signal strength increased. There is a definite limit to the amount of amplification which can be obtained in this way, however, for if the coupling is made too tight the valve begins to oscillate; this causes a howl, and the signals also become distorted. By means of another set of oscillations at a different frequency, however, damping is introduced. or, in other words the resistance of the circuit can be controlled. As the resistance of the circuit is varied about a particular critical value, so will the current in the circuit change.

Reaction

The use of ordinary reaction or regeneration is equivalent to reducing the effective resistance of the

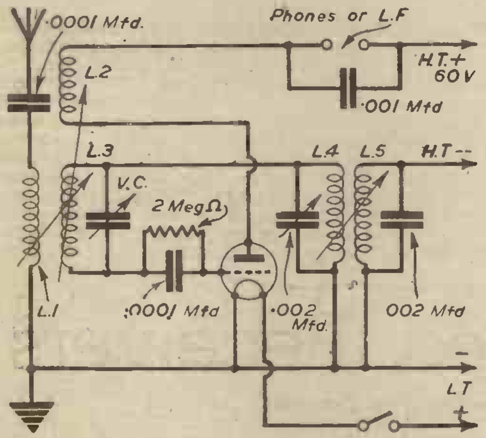


Fig. 3.—Single valve quench-operated receiver.

input circuit. When the receiver is brought to the oscillation point the effective resistance is zero, and the generation of continuous self-oscillations is possible. When oscillations have just commenced they are very small in amplitude; with further increase of reaction oscillations build up to a larger amplitude, and while they are building up the effective resistance is negative.

The special feature of super-regenerative receivers is that the effective resistance is deliberately varied at some chosen frequency, so that it is alternately positive and negative. In other words, the energy fed into the circuit by reaction is caused to be alternately greater and less than the amount required to overcome the damping losses in the circuit, the negative resistance being alternately greater and less than the positive.

Before going on to describe the operation of a quench receiver in greater detail, it may perhaps be as well to introduce a practical circuit so that the various details may be followed with greater lucidity. Fig. 1 is the circuit of a quench-operated receiver. This is by no means an ideal circuit for the purpose, but for the purposes of explanation it is admirable. The circuit associated with V1 is of the direct grid excitation type, the coils L1, L2 and L3 being of a nature suitable for the waveband to be covered. The coils L2 and L3 are connected in the right relationship to produce oscillations, L1 being the aerial coil. The circuit is tuned to the frequency of the incoming signal by the condenser, VC.

Modulation

In addition, a separate oscillatory circuit of identical type is maintained in oscillation at a supersonic frequency by means of V2, and is coupled by the coil L4 in the anode lead of V1. In consequence of this arrangement, the anode voltage of V1 is modulated at the frequency of the V2 circuit, and alternates above and below the mean value of the H.T. voltage by the amplitude of the supersonic E.M.F. in the anode lead. The frequency of oscillation in V2 is round about 20,000 c/s, and this can be achieved by making L5 and L6 sufficiently large (about 1,000–1,200 turns).

Since the effect of the supersonic frequency generated by V2 is to alter the anode voltage of V1, the mutual conductance of V1 is increased as the anode voltage is increased. Thus the supersonic variation of anode voltage produces a supersonic variation of negative resistance above and below the positive resistance of the circuit, and therefore to make the effective resistance alternately positive and negative at the supersonic frequency.

It is important to remember that the amplitude which the free oscillation (as distinct from the forced oscillation, i.e., the incoming signal) during any one period of negative resistance is allowed to attain is proportional to the amplitude of the incoming signal at the beginning of that period. This depends on the fact that the free oscillation is quenched before its amplitude nears the condition when the valve is saturated. Also that the free oscillation must be completely quenched during the period of positive resistance. If there is a residual free oscillation the mean audio frequency variation of the current in the oscillatory circuit would be different from the modulation of the incoming signal. This is not likely to happen on wavelengths lower than 100 metres (signal).

Amplification

The actual amplification attained depends upon the ratio of the final amplitude of the free oscillation to that of the forced oscillation at the beginning of the period of effective negative resistance and this may be very large. Unfortunately, other impulses besides the wanted signal, such as an interfering signal, atmospherics, or even a local disturbance such as that caused by irregular filament emission or a bad cell in the H.T. battery, will initiate free oscillations if it occurs during such a period. The forced oscillations due to such disturbances form a background of mush, and the weaker the signal the more noisy will be the background. This is not so serious as it appears, on the U.H.F. at any rate, and it is as well to use a H.T. battery which is comparatively new for this class of work.

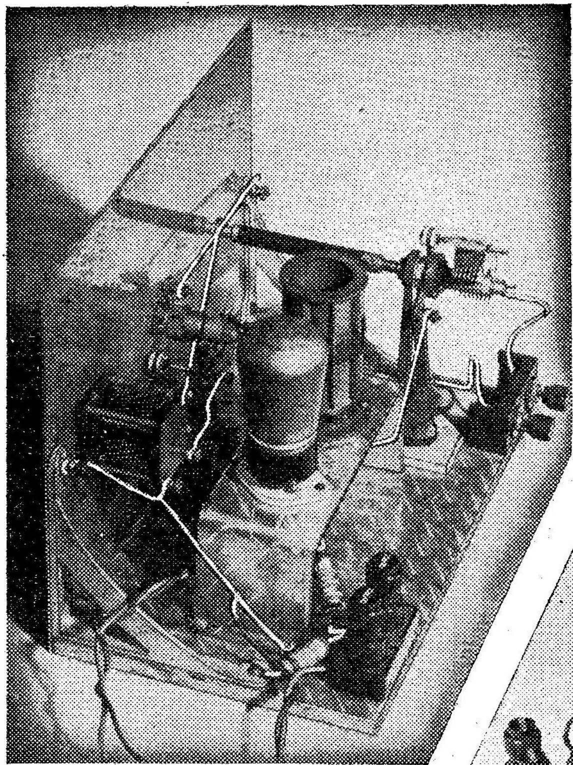
Mention has been made of 20,000 c/s as a suitable quenching frequency. It will be interesting to see why 20 kc/s is considered suitable. In the first place, 20 kc/s is above the limit of audibility for the average person. Reduction of the quenching frequency, i.e., the frequency with which the circuit varies between a positive and negative value, could only be made at the expense of quality.

It has already been remarked that the circuit "gathers" a lot of mush, and if quenching were to take place at an audible frequency of, say, 5,000 c/s, the continuous noise produced would be sufficient to drown the incoming signal. For this reason, among others, a quenching frequency of supersonic nature is utilised. It must not be too high, however, or the great amplification will not be obtained. The higher the quenching frequency, the less time there is for free oscillations to build up and die away. Hence the smaller is the final amplitude reached in each burst of self-oscillation, and the smaller the amplification.

Fig. 2 is a circuit in which the more ordinary tuned-grid mode of operation is employed. All that has been said as regards Fig. 1 holds for this, the only difficulty being that it may not be possible to make V1 oscillate satisfactorily below 10 metres. From 15 metres up, however, it will be satisfactory.

Finally, Fig. 3 shows how it is possible to dispense with a separate oscillating valve.

In all cases, the easiest way of controlling the oscillation is to have the coils movable. Only the reaction coil need really be movable.

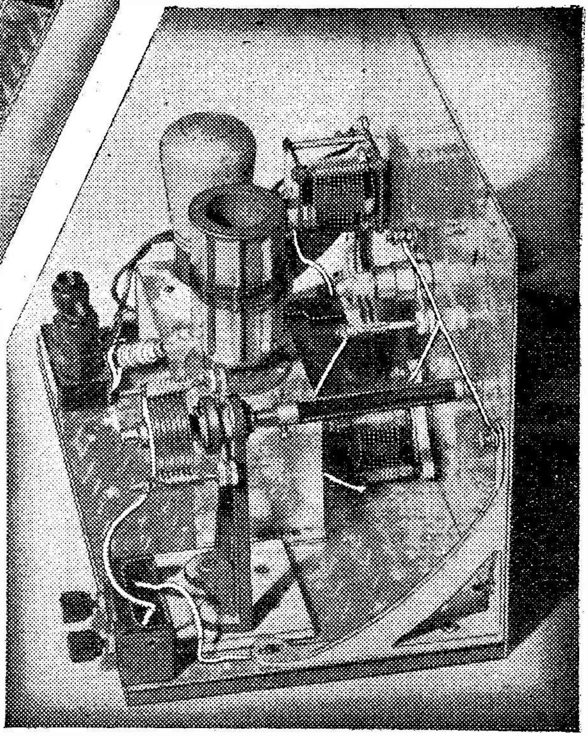


Short-wave Radio—3

Local Conditions. Planned Listening. Constructing a DX One-valver.

By 2CHW

Continued from page 469, October issue.)



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

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.

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 three hundred yards—can be responsible for some most weird results.

In case the would-be s.w. enthusiast forms erroneous conclusions from the foregoing, and is beginning to think that the reception of s.w. transmissions is a matter of pot-luck, I would say that a great deal depends on himself. For example, if haphazard listening is undertaken, the results may be good, but they are more likely to be bad. We have seen that much depends on the time of day and the month of the year, but there is also another item, and that is the frequency of the transmission, and the serious amateur will soon begin to find that certain wavelengths are best received during fairly constant well-defined periods of the 24 hours, and that these, in turn, will vary slightly according to the season. It is therefore necessary to try and arrange the hours of listening to suit the wavelength of the signals to be recieved, and if for the start the beginner tries the main bands—say, 40, 30, 25 and 15 metres—each session at the receiver, and makes a detailed log of the results, he will soon gain the experience and information which will allow "planned" listening to produce satisfaction.

It is the failure to observe these simple conditions, and to put them into practice, which causes so much

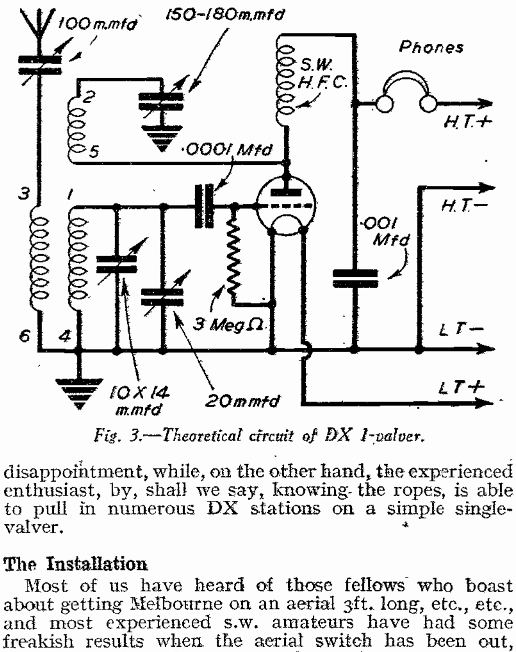


Fig. 3.—Theoretical circuit of DX 1-valver.

disappointment, while, on the other hand, the experienced enthusiast, by, shall we say, knowing the ropes, is able to pull in numerous DX stations on a simple single-valver.

The Installation

Most of us have heard of those fellows who boast about getting Melbourne on an aerial 3ft. long, etc., etc., and most experienced s.w. amateurs have had some freakish results when the aerial switch has been out, and so on, but these strange happenings must not be taken as being indicative of general practice. A *good* aerial—and this does not necessarily mean one of great length—is a valuable asset, as it is far better to use an efficient aerial system and, say, three valves than a poor aerial and four or five valves. The requirements are good signal to noise ratio, selectivity and freedom from interference. For a powerful signal, a high, long aerial seems to be the obvious solution, but, unfortunately, there would be the risk that the signal to noise ratio would suffer, therefore the net result would not be too good. As regards interference—and in this instance this means man-made static—no hard and fast advice can be given, as so much depends on the form of interference, local conditions and the space or facilities available at the receiving station.

Aerials (see "Aerial Pointers," July issue, and the new series, "Aerial Principles and Practice," which commenced in the August issue) call for as much consideration as the design of the receiver, and in view of the above references, I will only say pay particular attention to insulation, height and the distance away from earthed objects. For a simple receiver of the o-V-1 (detector and L.F. stage) type I prefer an aerial of the inverted "L" type, having an overall length of, say, 50 to 60ft., including the lead-in, as the use of an aerial arrangement designed to resonate within the wavebands to be covered, will impose a heavy load on the single tuned circuit at its resonant frequency, or, of course, its harmonics. If interference is bad a di-pole system is usually helpful.

A good earth connection is really essential. This point should be remembered when selecting the site for the receiver, as it is advisable to keep the lead as short as possible. Insulated wire should be used between the earth terminal and the earthing point and its gauge should be in the region of 3/22's.

A Receiver

Bearing in mind the object of this series, it is natural for the range of designs which will be described to commence with the humble but very useful single-valver. Owing to the simplicity of a receiver of this class, it is often treated with disdain by some folks who only seem able to secure a decent log by using a multi-valve superhet, but all genuine S.W. amateurs will vouch for the fact that a o-V-o or a o-V-1 can rope in an amazing number of DX stations, and that such an arrangement forms the best type of receiver for the beginner's initiation to S.W. operation. To get the best out of a single-valver, the components and their layout must be good, the aerial and earth, and the overall installation need to be as efficient as possible, and, finally, the operator must possess that "touch," skill and patience which are essential qualities of all S.W. enthusiasts. If, therefore, the amateur graduates from a o-V-o upwards, and if he s able to compile a decent log with such a receiver, then it is certain that a sound foundation has been laid which will prove invaluable as time goes on.

The receiver illustrating this article represents a typical form of single-valver, and one which is capable of giving first-class results on headphones. In its present form it is designed for battery operation, but little modification would be required to enable it to be used in conjunction with the L.F. portion of an A.C.-operated receiver, or a separate amplifier.

It will be noted that the layout follows recommended practice, inasmuch that all essential connections, i.e., the tuned circuit, grid and anode wires, are kept reasonably short and well spaced. Band-spread tuning is used, thus simplifying tuning and allowing thorough exploration of each band in small sections. Capacity controlled reaction. Reinartz system is used, while the aerial is inductively coupled to the grid coil, the aerial loading being varied to secure smooth reaction at all frequencies and improved selectivity, by means of a low capacity variable condenser connected in series with the aerial input. To reduce the possibility of hand capacity effects, a metal panel carries the tuning and reaction controls; body capacity troubles are eliminated by the inclusion of an H.F. choke and a small fixed condenser in the anode headphone circuit.

The theoretical circuit is shown in Fig. 1, which also shows the value of the components, and constructors are advised to adhere to the specified values, particularly if the recommended coils, namely, Eddystone 6-pin are used.

Construction

A plan view of the completed receiver is shown in Fig. 2, the point-to-point wiring being clearly indicated, and, owing to its simplicity, no difficulties should be experienced in carrying out this part of the assembly. It is always wise, and for the beginner, instructive, to compare the wiring plan with the theoretical diagram when doing the wiring, as this acts as a check, and also makes one familiar with rapid interpretation of the theoretical symbols.

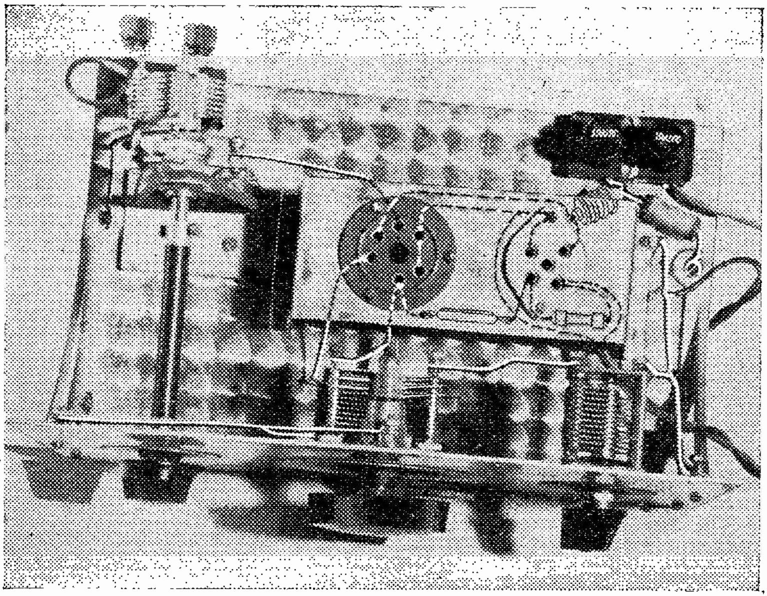


Fig. 4.—Top of chassis view of DX 1-valver.

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.×2⅝in. After squaring off the strip, mark lines parallel with the narrow sides, ¼in. and 2¼in. in from each end. These form the bending lines for the ¼in. 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 1½in. in from the top edge of the platform for the coil holder and 1¼in. in from the opposite edge for the valve holder. The diameter of the holes is 1¼in. 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 component 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 ¼ 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 that the average amateur is not aware that it is possible to reproduce records in this manner.

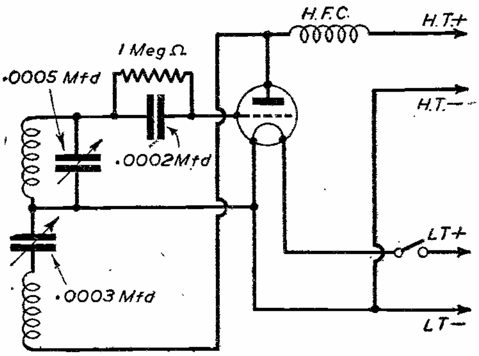


Fig. 1.—Oscillating Triode.

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 gramo. 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 gramo. 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.

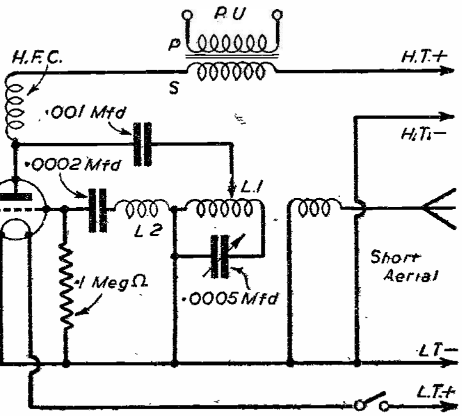


Fig. 3.—Simple tuned anode transmitter.

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 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.

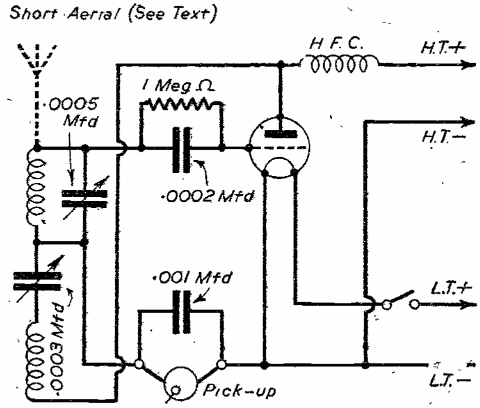


Fig. 2.—Circuit shown by Fig. 1 with pick-up connection added.

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 gramo. 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 gramo. 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 tappings so that the degree of coupling 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 diamater 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.

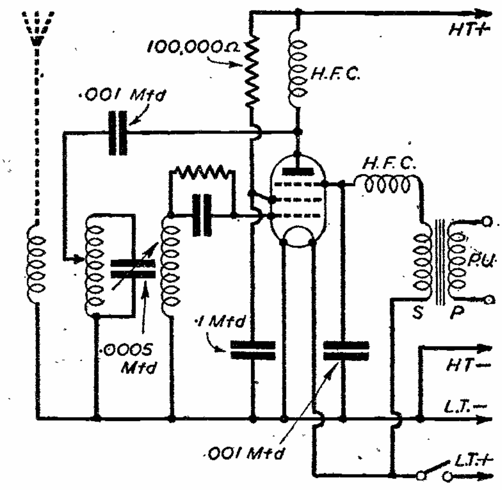


Fig. 4.—Suppressor grid modulation.

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 æsthetic reasons it is not advisable to sing an accompaniment to the records unless one can be certain that the microphone, and incidentally the singer's voice, will do them justice!

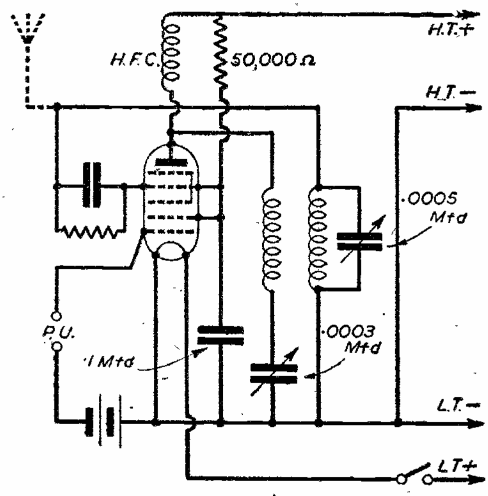


Fig. 5.—Circuit employing a heptode.

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

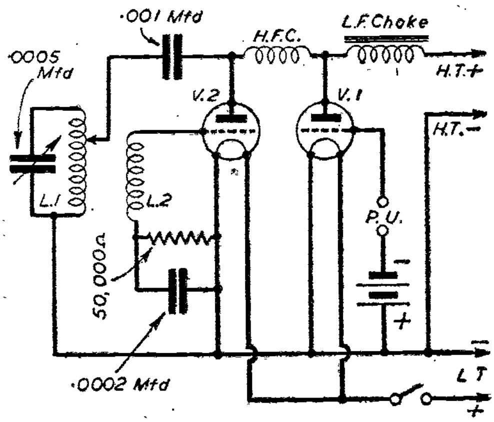


Fig. 6.—Circuit suitable for pick-ups with small output.

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

AN 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 Vo will always be slightly *less* than the original signal Eg 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 Eg to be 1.0 volt, and a voltage gain of exactly unity so that Vo is also 1.0 v., then if R is, say, 1,000 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, ra, 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/gm, where gm is the valve *mutual conductance*, expressed in *amperes per volt*. Thus, taking gm = 2 mA/V. = 0.002 *ampere* per volt, the impedance is 1/0.002 = 500 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 gm as

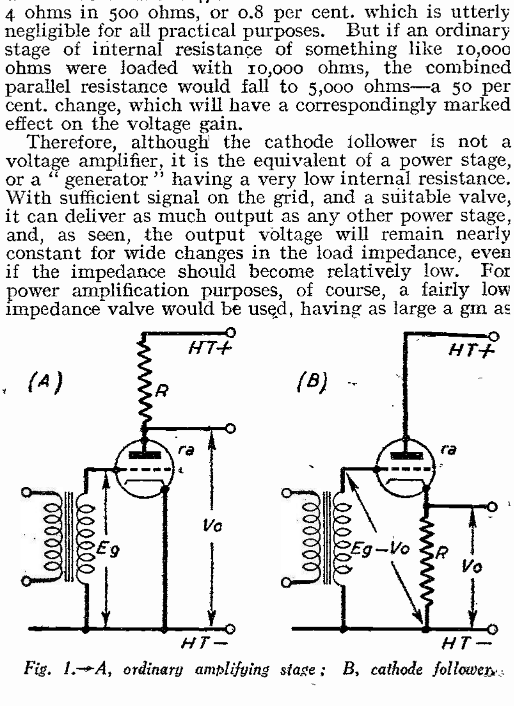


Fig. 1.—A, ordinary amplifying stage; B, cathode follower.

practicable to give the low output impedance. The load would be "matched" to the ra 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 Vo is being fed back in a negative sense, i.e., in direct opposition to the signal Eg. 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 Eg itself, but (Eg–Vo). The overall stage gain thus falls to a figure representing a much smaller effective signal on the grid. In fact, Vo will be something like 0.8Eg, which leaves us with an effective signal voltage of only 0.2Eg—or 20 per cent. The power output can be increased by applying a larger Eg, 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. Vo must be less than the original signal Eg, for the simple reason that (Eg–Vo) 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 Vo. But this means less negative feedback, and consequently an increase in the effective grid e.m.f. (Eg–Vo). 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 ra 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 ra for minimum internal loss is not affected by the negative feedback.

History and Development of Radio Science

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

BIBLIOGRAPHICAL 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 *electrum.* 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 Melanchton 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 Dufray, 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 Musshenbroek, 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 *electro-magnetic 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)

Dynamic Tester

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

THIS 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 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.

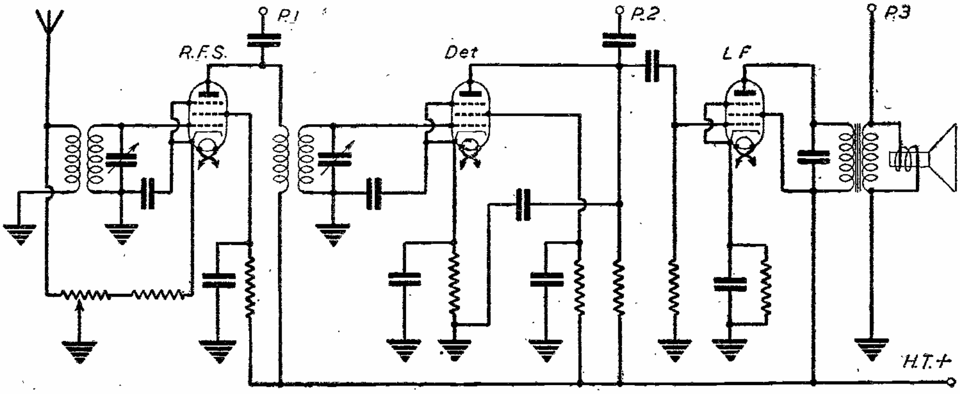


Fig. 1.—Circuit of modified receiver.

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 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 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.

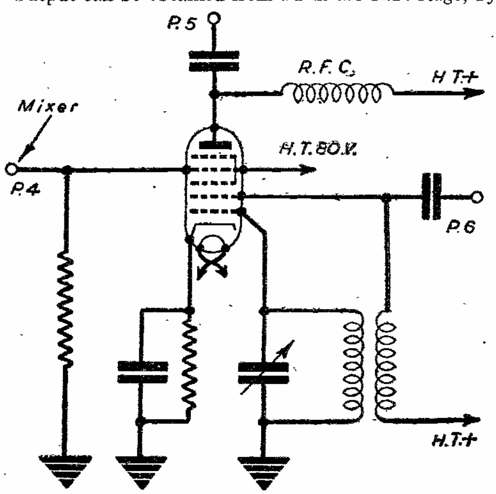


Fig. 2.—Mixer stage.

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

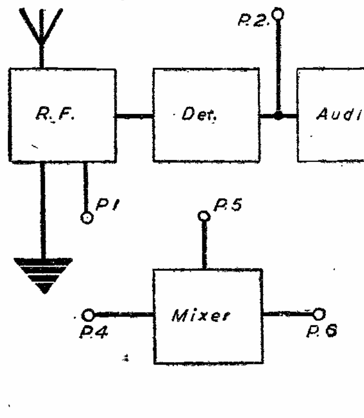


Fig. 3.—Sequence chain of units.

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 tappings at Points P on the construction.

Barretters

By E. G. BULLEY

THESE 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.

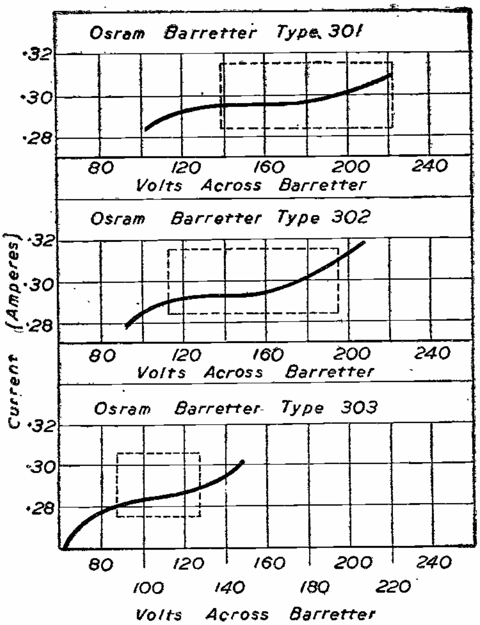


Fig. 1.—Group of barretter curves.

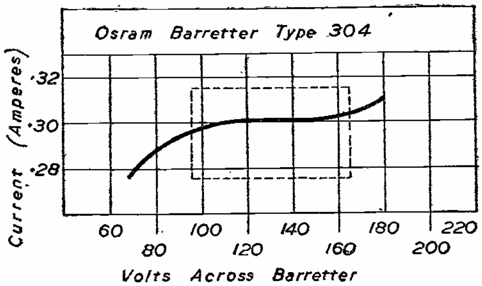


Fig. 2.

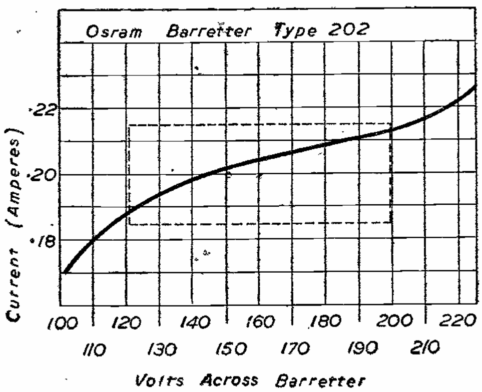


Fig. 3.

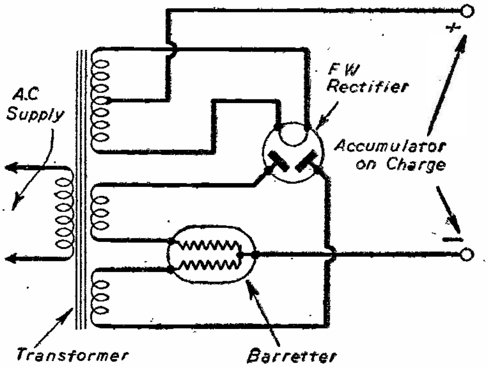


Fig. 2.—Typical circuit for battery charging.

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

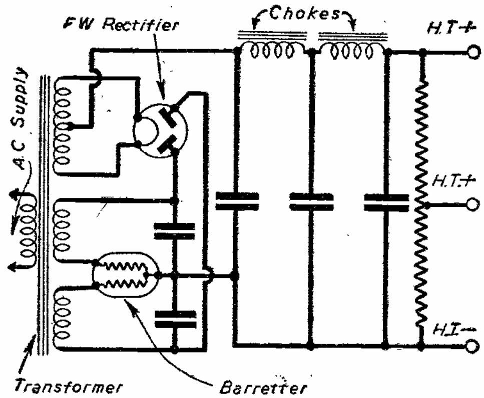


Fig. 3.—Circuit for H.T. supply of battery receiver.

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

JOHN 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 gamin 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 Geraldo and his Orchestra, though it remains to be seen whether "Gerry" will attempt to imitate a calliope. Script by Max Kester, production Pat Dixon.

Impressions on the Wax

Review of the Latest Gramophone Records

Columbia

OF 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 DX*1160-1162.

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 DX*1163. For this, he has selected that old favourite of Liszt's "Liebestraum," and a work by the Czech composer Fibich entitled "Poem." In the 10in. 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 DB*2150. Monte Ray has made two good recordings on *Columbia FB*3043, they are "The Echo of a Serenade" and "You Belong to My Heart." Felix Mendelssohn and his Hawaiian Serenaders, on *Columbia FB*3041, 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 FB*3048.

Another fine record for dancing is *Columbia FB*3046, 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.

AT the risk of rekindling the controversy "What is light music?" I strongly recommend *H.M.V. DB*6171 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. D B*6130, and the work is melodiously vigorous.

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. C*3405, 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. DA*1847. 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. BD*5857. Glenn Miller and his Orchestra on *H.M.V. BD*5854 presenting "Sold American" and "Moon Love," which, incidentally, is adapted from Tschaikowsky's 5th Symphony, two good foxtrots, and, finally, Joe Loss and his Orchestra on *H.M.V. BD*5855 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. BD*1087.

Parlophone

RICHARD TAUBER is well on form in his latest recording on *Parlophone RO*20531, for which he sings "When Love Has Gone" and "For Love Alone." Both are in English.

Geraldo and his Orchestra, on *Parlophone F*2035, 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 F*2037.

"Tin Pan Alley Medley No. 64" is on both sides of *Parlophone F*2034, 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 F*2038 record "Alike as Two Peas" and "Shandy," which they put over in their own inimitable style.

Regal

HERE 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 MR*3738.

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, CUD2, HVJ (in morse!), "QRA 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, CNR2, GYA18, "JNJ de HDL4," "vvv vvv de JEKF," 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 (Lyme 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, PLR8, FZ1, 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 WIRLESS 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.

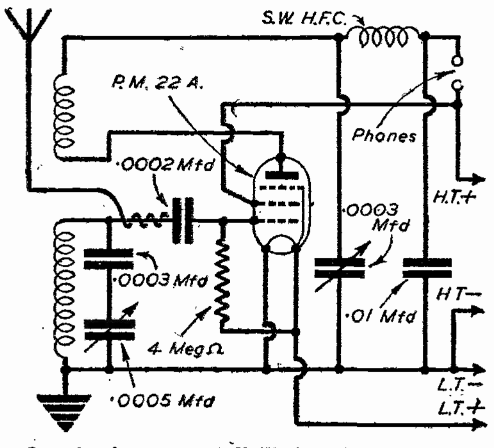
Regarding S. B. Hawkes's letter, also in the October issue, I fail completely to understand his remarks *re* the "Rapid Two." Perhaps other readers can suggest a diagnosis of this unusual discovery.—STANLEY BRASIER (Stroud).

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 .00005 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. PETTITT (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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The index letters which precede the Blueprint Number indicates the periodical in which the description appears: Thus P.W. refers to PRACTICAL WIRELESS. A.W. to *Amateur Wireless*, W.M. to *Wireless Magazine*.

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