The Wireless World AND RADIO REVIEW

VOLUME XXV

JULY 3rd—DECEMBER 25th. 1929

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INDEX—VOLUME XXV

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ILLUSTRATIONS

AUTHORS

BOOK REVIEWS.

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CONTENTS OF THIS ISSUE.

AMATEUR STATUS.

IN the leading article in our issue of June 19th we drew attention to the contrast in the treatment meted out to the amateur transmitter in Britain and in the United States of America. Here every effort appears to be made by the Post Office authorities to crush amateur activities and limit the number of amateur transmitters to a mere handful by imposing cumbersome and, we think, unnecessary restrictions, which even the Post Office officials themselves seem unable to interpret.

Something should be done, if only in the interest of the country generally, to revive the transmitting amateur and give him a reasonable place in the ether, a place at least comparable with the status enjoyed by American amateurs across the Atlantic.

U.S. Signal Corps Co-operation.

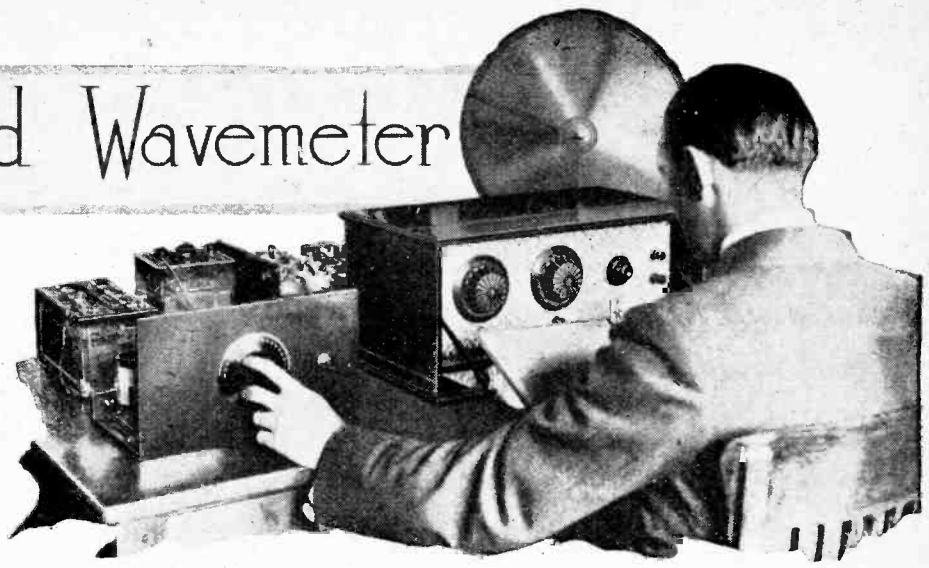
We pointed out in our leader that the Signal Corps in America co-operates closely with the transmitting radio amateurs and, amongst other things, undertakes to render "such encouragement and assistance as may be desirable to firmly establish and perpetuate the American amateur."

We do not want to lay the blame for the present position on the amateur himself, but we must confess that our feeling is that the amateur has permitted himself to be crushed without even showing the resentment of the proverbial worm. After the War, and for a number of years, the Radio Society of Great Britain was a very dominant factor in the affairs of the British amateur, and it was through the activity of that body that facilities for experimental work were wrested from the Post Office (for nothing was given away in those days, and every concession was fought for inch by inch). But to-day the Radio Society has, as far as the evidence goes to show, allowed the Post Office to deprive the amateur of a great deal which had been so hardly fought for and eventually won in the days gone by.

Is the Amateur Himself to Blame?

We do not wish in any way to criticise the work of individuals at present responsible for directing the destinies of the Radio Society, but we feel our suggestions will not be misunderstood if we say that looking into the present conduct of the Society as compared with past days, we think the trouble lies in the fact that the present executive is composed of individuals who are such enthusiastic transmitters and experimenters themselves that they have not the time, nor perhaps even the inclination, to be concerned with affairs of administration and the politics of wireless, and yet their very existence must depend on the way in which their Society and others connected with amateur activities handle the politics of the situation. Although the Radio Society may no doubt have gained in popularity amongst transmitting amateurs, we feel that it has lost something of its old reputation as a body prepared to fight to the bitter end, if necessary, for the rights of the amateur. Letters from readers indicate quite clearly that the necessary enthusiasm still exists which would ensure a success being made of the amateur transmitting movement, if it were not for the unreasonable attitude which has been taken up by the Post Office, an attitude which has so disheartened our best amateurs that many have given up their transmitting licences. The urgent need of the moment is for the transmitting amateurs to prepare a strong case to justify their existence, and proceed by every means to re-establish themselves with the authorities, and particularly gain the support of those branches of the services which are in a position not only to justify the amateur, but to make of the transmitting amateurs collectively a first-class national asset.

Modulated Wavemeter

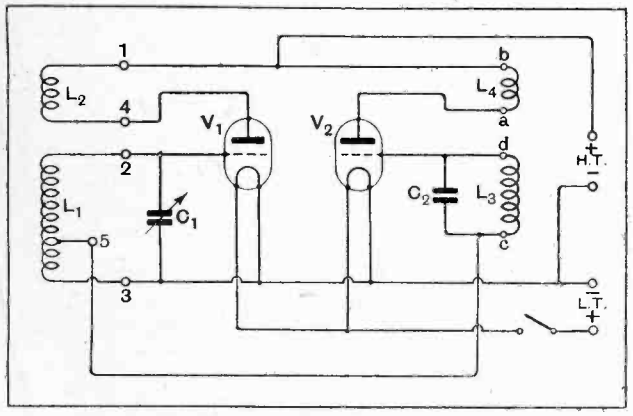


An Aid to Accurate Tuning and Distant Reception.

By H. B. DENT.

IN spite of what has so often been said to the contrary, there is, at the present time, much pleasure and enjoyment to be found in listening to distant transmissions; indeed, modern receivers, whether they have one or more H.F. stages, are quite capable of picking up and reproducing at comfortable loud speaker strength items broadcast from a source some thousand miles or so from the receiver. Such sets are naturally rather difficult to adjust to any desired wavelength, since a powerful signal on a near-by wavelength will act as a magnet to the operator, and weaker signals, possibly of greater interest if capable of accurate tuning in, will be overlooked or more likely swamped owing to the difficulty of isolating them from the giants of the ether.

Familiarity with the receiver will eventually overcome this difficulty, but it takes time; moreover, many experimenters' sets rarely live long enough for the owner to become really familiar with them. A good set capable of great things is more often than not modified owing to the tedium of adjustment, even though with all circuits correctly tuned surprising results can be obtained. A set which shows promise should not be relegated to the background before it has been given an opportunity to justify its existence, and if adjustment is critical, why not help things out by means of a wavemeter? The instrument which is to be described here should prove an invaluable accessory to all those indulging in long-distance reception, and while, perhaps, a little more ambitious than those generally used, will be found far more satisfactory, since it possesses a degree of selectivity extremely difficult to achieve—if at all possible—with the popular buzzer type. Briefly, the arrangement consists of a heterodyne wavemeter with a low-frequency signal superimposed on the H.F. oscillations.



Theoretical circuit. $C_1 = 0.0005$ mfd. $C_2 = 0.01$ mfd. V_1 and V_2 are general purpose valves.

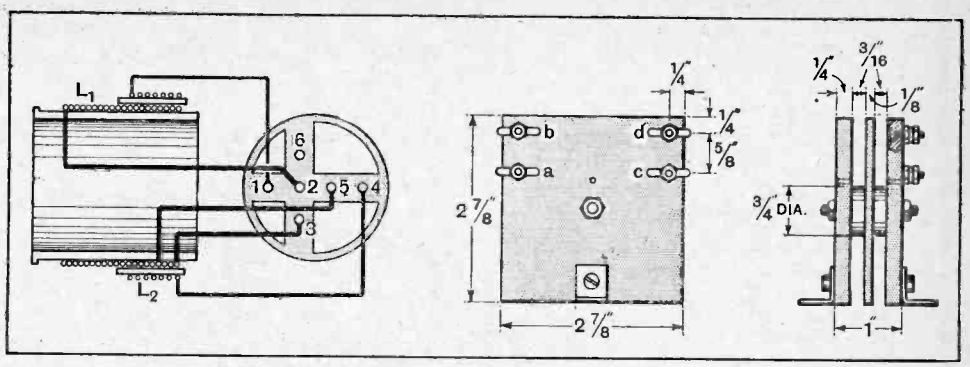
It possesses, therefore, the selectivity of the heterodyne type coupled with the advantages of the buzzer arrangement, since an audible signal can be heard in the loud speaker without causing the set to oscillate. Quite apart from the fact that a reradiating aerial is not in keeping with the courtesies of the ether, few modern sets fitted with real H.F. stages incorporate a reaction circuit.

Modulation by Additional Valve.

From the theoretical arrangement of the wavemeter, which is given in the circuit diagram, it will be seen that two valves are used. V_1 is an H.F. oscillator and V_2 a low-frequency modulator. A few may look askance at this, and regard it as somewhat extravagant, so perhaps it would be as well at the outset to state that any general-purpose type of valve, provided it is in reasonably good condition, can be used. The advent of the screen-grid valves must have displaced one or more three-electrode valves of the H.F. type, and since these are now probably decorating a shelf, here is a useful job for them to do before they come to an untimely end by being swept off during the bi-annual clean-up of the workshop

Modulated Wavemeter.—

The question of H.T. and L.T. need not be regarded as a serious drawback, because the spare accumulator can be pressed into service on the occasions the wavemeter will be required, and as for H.T., a 36-volt, small-size battery will suffice for the best part of a year. Most of the components can be salved from the spare parts box, but it would be advisable to use a really good logarithmic type variable condenser. This is the only item that need be purchased, provided that the other suitable parts can be found in the workshop. By fitting the same type condenser as used in the model illustrated much time will be saved in calibrating the instrument, since the curve given here can be redrawn on graph paper by shifting the condenser graduations right or left, as the case may be, after taking one or two check readings on some of the B.B.C. or Continental stations whose wavelength can be relied on.



Details of the two coils. L_3 and L_4 are wound on the two-slot former and each has 5,000 turns of No. 40 S.W.G. enamelled wire.

Air-core Audio Oscillator.

Now a word or two with regard to the modulator circuit. Originally a discarded L.F. transformer was tried, but subsequent tests proved this to be unsatisfactory, and finally recourse was made to air-cored coils. A modulating frequency of about 900 cycles was chosen, and this was found rather difficult to achieve with a transformer, although various types were tried.

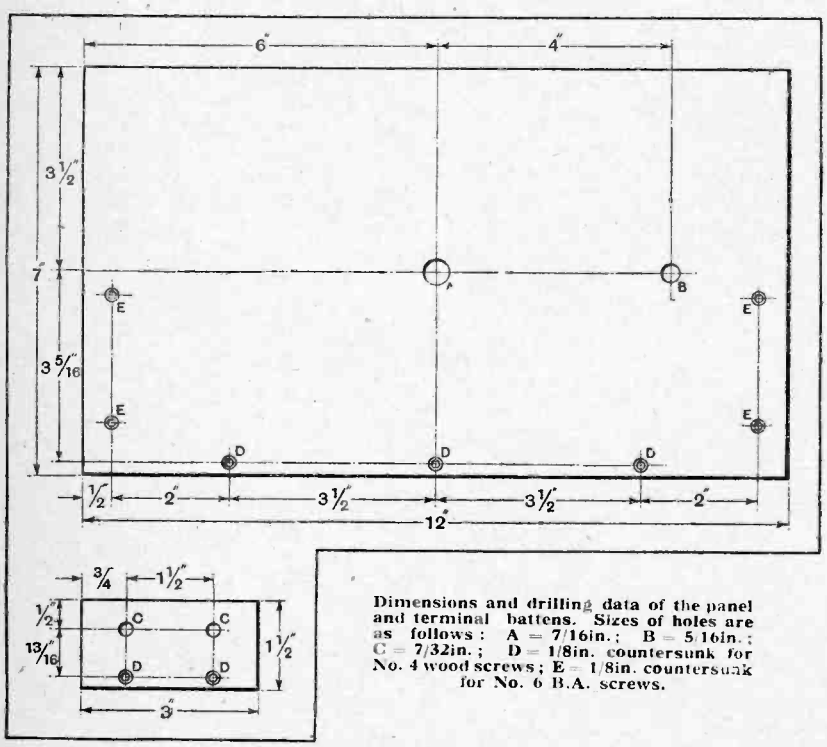
Possibly some readers may be more fortunate than the writer, so that, should it be decided to try out the idea, it is suggested that the arrangement which is most likely to be workable is that in which the primary is used as the tuned grid coil and the secondary as the reaction coil.

Modulation Method.

With a fixed condenser of 0.01 mfd., the grid coil will require an inductance of about 3 henrys to produce an audible note of the order of 900 cycles. The majority of old transformer primaries show a much higher inductance than this, especially as there is no D.C. through the coil which, by virtue of its effect on the permeability of the iron circuit, generally causes the primary to lose some of its henrys. However, the construction of the slab type inductances will be found reasonably simple, and probably lead to a considerable saving of time in the end.

The only other matter of interest that requires comment is the method of mixing the low- and the high-frequency oscillations. It was this, more than any other consideration, that led to the choice of two valves. A single valve oscillating at both frequencies could be made to work at times, but the arrangement was somewhat uncertain in its operation. The most serious snag of all, however, was met with in the mixing department, and although various arrangements were tried, no simple means of controlling the amount of L.F. modulation could be devised. A superabundance of L.F. leads to poor selectivity. The envelope of the H.F. oscillations must be very lightly modulated, otherwise the wavemeter becomes no better than one of the buzzer type.

The method chosen here offers one solution to the problem, although others may suggest themselves to the reader.



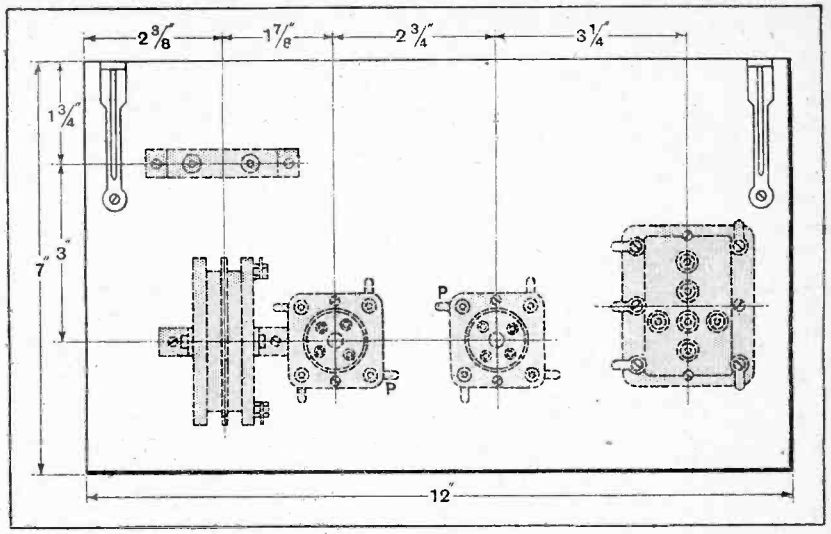
Dimensions and drilling data of the panel and terminal battens. Sizes of holes are as follows: A = 7/16in.; B = 5/16in.; C = 7/32in.; D = 1/8in. countersunk for No. 4 wood screws; E = 1/8in. countersunk for No. 6 B.A. screws.

Modulated Wavemeter.—

and enables the amount of L.F. energy introduced into the H.F. circuit to be varied within very wide limits. The low potential end of the modulator circuit, C_2, L_3, is connected to a tapping on the coil L_1 of the H.F. oscillator; this is taken out at the tenth turn from the filament end. The amount of L.F. mixing with the H.F. can be made greater or less by shifting the tapping nearer to, or away from, the grid end of this coil.

A plug-in H.F. oscillator, consisting of coils L_1 and L_2, wound on a Colvern six-pin former, is employed, since it renders the wavemeter flexible, and to extend its usefulness either to higher or lower bands suitable coils can be wound and plugged in when required.

The construction is, relatively speaking, simple, and does not call for detailed description. Accordingly, this will be dealt with in the briefest manner possible. The panel and baseboard presenting no difficulties, attention will be directed to the two coils. The modulator coils, L_3 and L_4, will be taken first. As will be seen from the illustrations and drawings, both grid and plate coils are wound on a two-slot former built up from pieces of ebonite held together by a screw passing through clearance holes in the centre of each piece. Square cheeks have been used because this is the simplest form of construction and does not call for access to a lathe, as would be the case if a bobbin turned from a solid block of ebonite were employed.

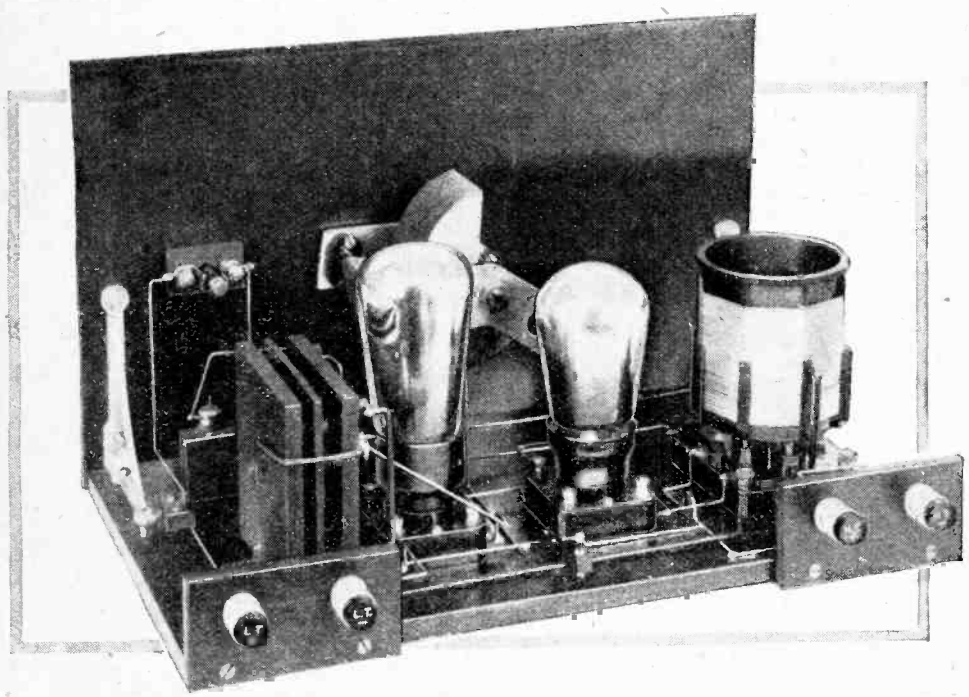


Baseboard layout. The modulator coils are shown on the left.

Having constructed the former in accordance with the details given in the drawings, the next step is to wind each slot with 5,000 turns of No. 40 S.W.G. enamelled wire. About 6oz. will be required. Both coils are wound in the same direction, the inners and outers being brought out to soldering tags fixed to one end-cheek. Wire of this fine gauge is easily broken where it passes through the small holes in the centre of the former, and it is recommended that a few turns of a stouter gauge wire, or preferably Litz if available, should be put on first, and the fine wire soldered to this. The same precaution can be taken with the finishing ends, although a break here is not so serious, since they are readily accessible.

When connecting the coil in the circuit it is necessary only to remember that if the outer of the grid coil goes to the grid of the valve, the inner of the reaction coil (anode coil) should be connected to the anode of the valve.

The H.F. oscillator coils are wound on a ribbed former, the grid coil being put on first and the reaction winding supported on $\frac{1}{8}$in. spacers over the low potential end. For the grid coil 70 turns of No. 26 S.W.G. D.C.C. will be required; this is close wound; while the reaction coil contains 12 turns of No. 34 S.W.G. D.C.C. wire spaced 16 turns to the inch. When winding L_1, a tapping should be made at the 10th turn from



Rear view of the wavemeter The right-hand valve is the H.F. oscillator and the modulator is on the left.

LIST OF PARTS.

1 Ebonite panel, 12 × 7 × $\frac{3}{16}$ in.
2 Ebonite terminal strips, 3 × 1½in.
2 Valve holders (Formo).
1 Variable condenser, 0.0005 mfd. Log. (Marconiphone).
1 Dial, 0–180°.
1 On and off switch (Bulgin).
1 Pair 3in. panel brackets (Camco).
1 former, 6-pin (Colvern Type R.P.).
1 Base, 6-pin, with terminals (Colvern).
1 Fixed condenser, 0.01 mfd. (T.C.C.).
4 Nickel-plated terminals (Belling-Lee).
6 ozs. No. 40 enamelled wire for modulator coil.
Quantity No. 26 and No. 34 D.C.C. wire, Sistoflex, ebonite, screws, etc.

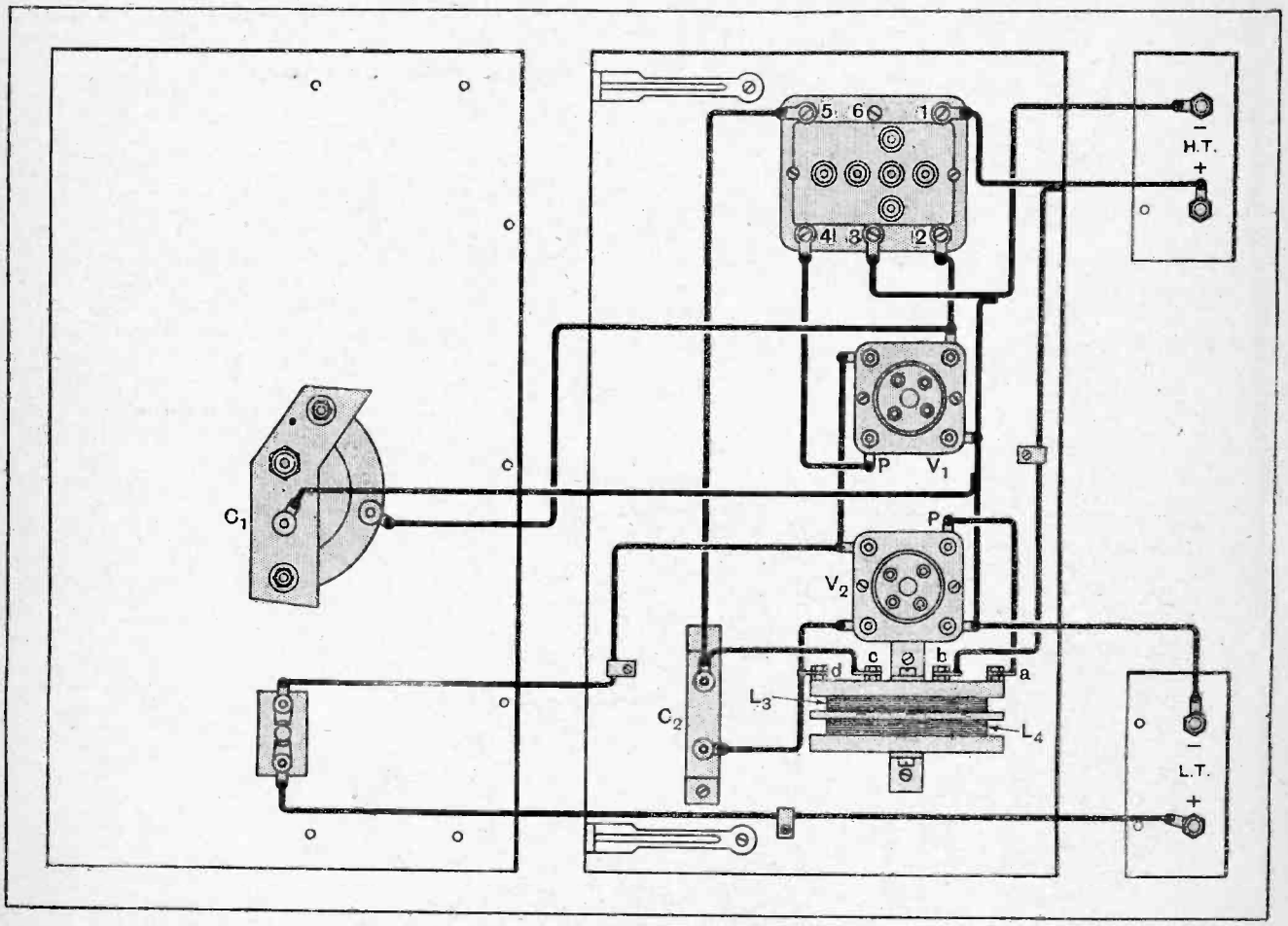
Approximate cost, excluding valves, £2 8s.

the L.T. negative end: that is to say, from the bottom of the coil in the physical sense. Both coils are wound in the same direction.

It was mentioned earlier that a 36-volt battery will be required; actually the working H.T. voltage is slightly less than this, and will probably vary with different valves. The original model was fitted with a Marconi Osram H.L.210 as H.F. oscillator, and a Mazda G.P.210 as modulator. This arrangement worked very nicely with 24 volts H.T. If the modulator part of the unit is functioning correctly, it will be possible to hear the modulating frequency by connecting a pair of telephones, or a loud speaker, between the H.T. positive terminal and the high-tension battery, or between pins 3 and 5 on the coil base.

The calibration of the wavemeter will be a tedious job, unless a logarithmic condenser is fitted, but it can be achieved by making use of the measured wavelengths of some of the more important B.B.C. and Continental stations published from time to time in these pages.

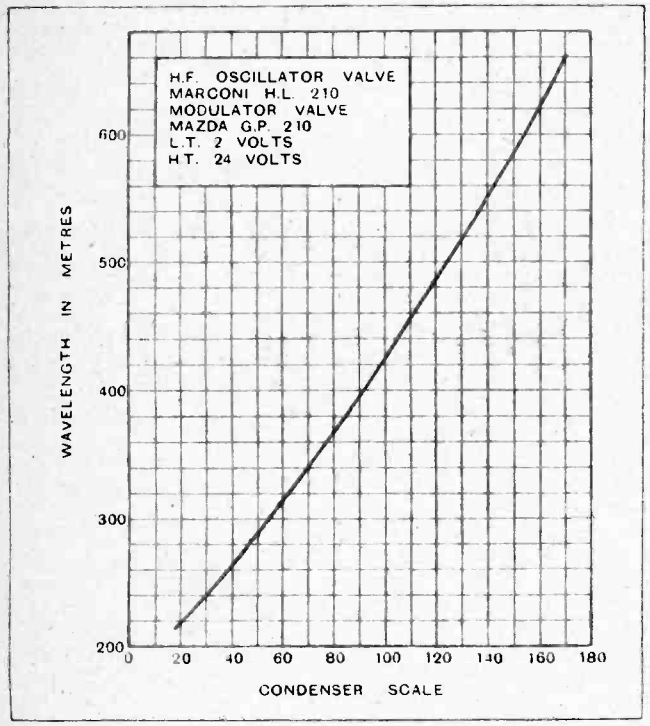
A logarithmic condenser of the type used in the model, however, solves all our difficulties, since it is possible to redraw the calibration chart given by making one check reading on a station whose wavelength can be relied on, and engraving a short line on the panel as an



Wiring plan of the baseboard and panel.

Modulated Wavemeter.—

indicator. For example, 358 metres (2LO's wavelength) corresponded to the 76-degree mark on the condenser dial of the model. A 0-180 scale is adopted. Another check wavelength would be 482.3 metres (5GB); this corresponds to the 118.5-degree mark on the condenser dial. The procedure is as follows.



Calibration chart taken from a standard wavemeter and using the valves and condenser mentioned in the text.

Calibration by Station Settings.

Accurately tune-in whichever station is the most convenient, and strictly limit the input to the set, either by means of a series condenser or a short indoor aerial. Wait until an interval occurs in the transmission, and then take a "snap" reading with the wavemeter. Refer to the chart and mark a line, lightly at first, on the panel, so that this corresponds with the dial setting for the particular wavelength chosen; the chart should be prepared beforehand, of course. The following table has been prepared, since it may be difficult to reproduce the chart from the one given here, owing to the small scale.

Condenser divisions on a 180° dial.	Wavelength (metres).
20	218
40	261
60	315
80	368
100	425
120	488
140	551·5
160	622

Before engraving the line deeply, it would be wise to take one or more check readings on stations of known wavelength and make certain that the wavemeter is in agreement.

TRANSMITTERS' NOTES.

Russian Stations.

Mr. A. Lambourne has kindly sent us a further list of Russian stations in the first district, from which we give the following, which have not yet appeared in the Radio Amateur Call Book :—

EU 1AL (ex 14RB), M. Smirnovsky, Omsk.
EU 1AM (ex 27RB), M. Kotelinokov, Novosibirsk.
EU 1AN (ex 30RB), M. Pavlyucheiko, Habarovsk.
EU 1AO (ex 72RB), M. Solomin, Biysk.
EU 1AQ (ex 29RW), M. Selezner, Tomsk.
EU 1AR (ex 60RW), M. Pivovarov, Omsk.
EU 1AS M. Sheptunov, Novosibirsk.

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Belgian Transmitter.

ON4HL, M. H. Thomas, is transmitting from 16 Boulevard des Martyns, Ghent, with a Mesny circuit, and an input of 8 watts, and will welcome reports from B.R.S. stations, which should be sent to him direct to save time.

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Nationality Prefixes.

With reference to the note on page 613 of our issue of June 12th, our correspondent in Ceylon now informs us that the postal authorities have allotted amateur stations in that country the prefix VS, followed by the figure 7 to distinguish them from stations in the Malay States, which have the same prefix.

The following nationality prefixes should be added to the list previously published :—

RW—Persia (in place of RV), **ZK**—Cook Island **ZM**—Samoa, **ZP**—Paraguay.

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Temporary South African Call-Sign.

Mr. T. M. Yule (ZU6C) is temporarily in Rhodesia, and has been allotted the call-sign VQ2ND; his address is c/o Anglo-American Corporation, N'dola, Northern Rhodesia.

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New Call-signs and Stations Identified.

G2AW (ex 2AHX), W. F. C. Geraghty, 5, Benson St., Norton, Stockton-on-Tees.
G2CJ S. Townsend, Barnwood House, Gloucester, transmits on 7,000 kC. band and will welcome reports.
G2NM G. Marcuse, Dunedin, Caterham Valley, Surrey. (Change of address.)
G5NC H. Osborne, 77, Barrett Rd., London, E.17.
G5PO H. J. Pollard, c/o 35, Beresford Ave., Bebington, Cheshire. (Change of address.)
G5SL (ex 2AZD), W. H. Slough, 46, Station Rd., London, N.3.
G5ST R. R. Morrison, Spring Grove, Kilbarchan, Johnstone, Renfrewshire. (Returns to old address.)
G6KA K. F. Hardie, 117, Evering Rd., London, N.16. (Change of address.)
G6QF A. M. Robertson, The Tower, 5, Burford Rd., Whalley Range, Manchester.

BOOKS RECEIVED.

The Admiralty List of Wireless Signals, 1929, including direction-finding stations, land stations communicating with ships and aircraft, wireless beacons and fog-signals, meteorological and time signals, with extracts from the General Regulations under the International Convention of Washington, in so far as they are applicable to ships and aircraft, and from the special regulations affecting warships issued by various foreign governments. Compiled by the Hydrographic Dept., Admiralty. Published by H.M. Stationery Office and sold by J. D. Potter, 145, Minories, E.C.3. Price 6s. 6d. net.

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Wireless Echoes of Long Delay, by Prof. P. O Pedersen, Principal of the Royal Technical College, Copenhagen. Pp. 48, with 12 diagrams. Published (in English) by A. F. Höst and Sön, Copenhagen. Price Kr. 2.40.

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On the Lichtenberg Figures, Part III, The Positive Figures, by Prof. P. O. Pedersen. Pp. 137, with 36 diagrams and 28 plates. Published (in English) by A. F. Höst and Sön, Copenhagen. Price Kr. 10.

With any new development a high standard of perfection is not expected at the onset. To accomplish the aim while giving even crude results is an achievement that must be encouraged and heralded with appreciation.
From this standpoint technical progress in the field of both television and picture telegraphy has been carefully recorded in these pages, rigidly avoiding prejudice on the one hand, yet on the other distinguishing between extravagant claims and well-founded inventions that will bear scientific investigation.

TELEVISION by the Mihály System

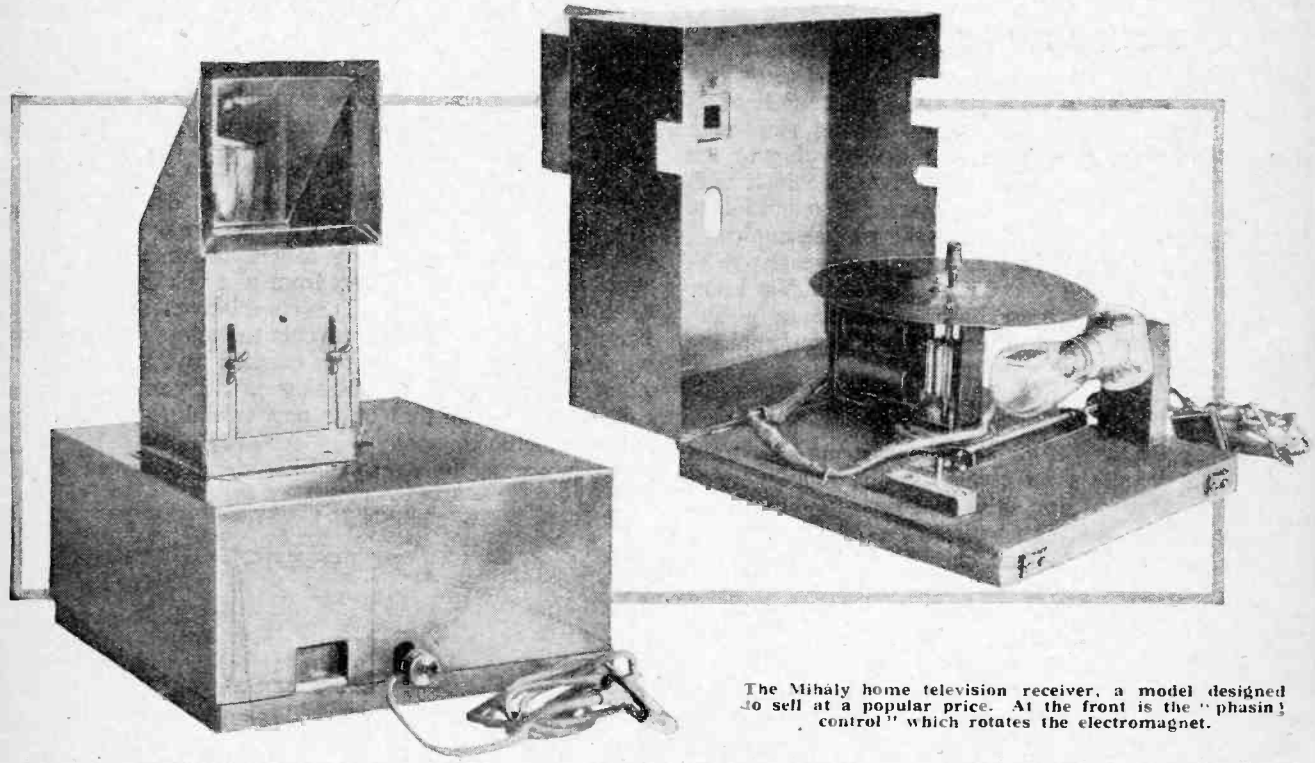
First Description of a New Receiver Shortly to be Seen in this Country.

AS long ago as March, 1924, there appeared in *The Wireless World* a detailed description of the research work then being conducted towards the achievement of a practical system of television by Denes von Mihály. His experiments dated back to 1913, and he claimed his first success in June, 1919. Much has been heard from Germany during recent months concerning this system of television which, it is claimed, possesses commercial potentialities. It is through the courtesy of the inventor that the writer has been privileged to examine the receiving equipments of this system and which Herr Mihály described and discussed in every detail. We have seen that after close investigation support has been given to the Mihály inventions by the German Post Office, and by their co-operation television transmissions have been taking place from the 4 kW. broadcasting station at Witzleben.

Television methods, as we know them to-day, are extremely simple compared with the complex conditions which the radio amateur is called upon to study in the use of valve receiving sets. For the moment we are interested only in the television receiving apparatus.

Scanning Disc and Neon Lamp.

As with other systems, this depends upon a rotating disc with holes near its edge arranged as a single turn of a spiral. Readers are familiar with the purpose and design of such a disc. The holes are viewed through an aperture roughly equal in width to the arc between successive holes, the depth of the aperture being the difference in radius between the hole nearest the circumference and that nearest the centre. Immediately behind the disc and coinciding with the outline of the aperture is the cathode plate of a neon tube. This plate is caused to glow with varying luminosity by the changing currents of the output of the receiver. Thus,

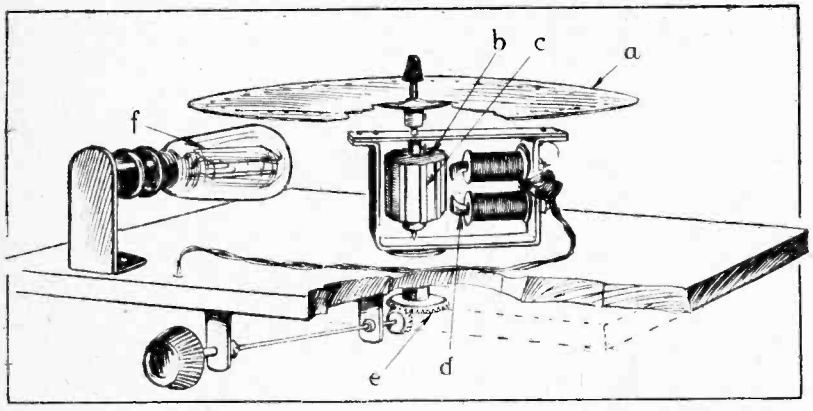


The Mihály home television receiver, a model designed to sell at a popular price. At the front is the "phasing control" which rotates the electromagnet.

Television by the Mihály System —

when the cathode is viewed through the holes in the rotating disc, a picture is formed by the process of causing the cathode to glow when the holes take up positions representing the white portions of the image.

Without describing the precise form of apparatus used at the transmitter, it is obvious that the object must be "scanned" and analysed into small areas, the light values of which are eventually conveyed to the neon tube at the receiver. The extreme sensitiveness of the modern photoelectric cell has removed many of the difficulties met with in the design of the transmitter, and for the Mihály system it is claimed that the transmitting equipment functions with normal conditions of lighting. Photocell and neon lamp having reached a state of perfection permitting of the conveying of the light values from transmitter to receiver, we look with critical interest in any proposed system of television to the methods employed for causing the picture analysing apparatus of the transmitter running in close step with the picture assembling disc at the receiver. We know how these difficulties have been overcome in photo-telegraphy, and it is in the merits of the synchronising gear that television succeeds or fails.



Constructional details of the receiver. (a) Ebonite disc with 30 holes forming a single spiral, (b) drum carrying 10 iron segments (c), (d) electromagnet energised from 50 cycle A.C. supply mains, (e) phasing correction control, (f) neon lamp deriving current from a rectifying valve connected to the output of the radio receiver.

Mains Synchronising Unsatisfactory.

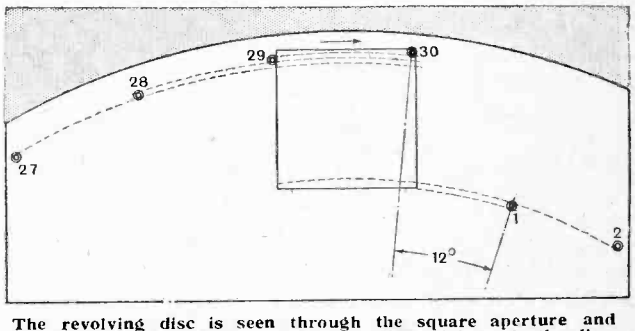
In the apparatus before us the revolving disc must be run at a definite speed related to the rotating parts at the transmitter. For this purpose a cylinder has been mounted on the shaft beneath the disc. It carries ten iron bars which, when rotating, move before the poles of an electromagnet which is energised from the alternating current supply mains. A 50-cycle supply would thus energise the magnet one hundred times a second, and in attracting the bars would revolve the disc at a definite speed, depending upon the frequency of the supply and the number of bars, giving in this case ten revolutions a second. This arrangement of synchronising was described in the Mihály system of 1924 and, known as the phonic wheel method, it has appeared in modified form in many systems of picture telegraphy.

For television broadcast, phonic wheel synchronising is unworkable owing to discrepancies in the frequency of the supply. This is at once appreciated by considering the effect on successive holes as they cross the aperture in forming a single image, assuming an error in the supply frequency as small as 2 per cent. In this case where each transverse line on the object is traversed in $\frac{1}{300}$th second a single hole of a 30-hole disc will have crossed the aperture in $\frac{1}{10.2 \times 30}$ seconds. A 30-hole disc sweeps an angle of 12° between successive holes, but with the 2 per cent. error an angle of 12.24° will be traversed at the receiver corresponding to 12° at the transmitter. In the passing of 30 holes, therefore, the 2 per cent. error still remains and gives the cumulative error of 367.2° rotation in place of 360°. An image 12° in width therefore possesses a displacement error of no less than 7.2° in a single revolution, or in the space of time $\frac{1}{10}$th second. Before a single image is completed its square formation becomes spread out to a wide parallelogram, and in the course of a second the ten images have become spread out in the form of a spiral extending over nearly quarter of the rotation of the disc. This point has been explained at length to show conclusively that the small errors met with in supply frequencies rule out this method, excepting, perhaps, where transmitter and receiver have mains common to them both. Even in these circumstances a synchronising frequency of 50 cycles is too low to be usefully employed.

"Inter-line" Synchronising.

In a small booklet which is issued, describing the Mihály apparatus, it is stated that where supply mains are not available a tuning fork synchroniser is provided intended for working from a 4-volt accumulator or three primary cells. The cumulative error arising from local synchronising prevents the adoption in home equipment of the simple fork control, and as this proposal was described by Mihály many years ago, we can safely assume that he is now turning his attention to new methods.

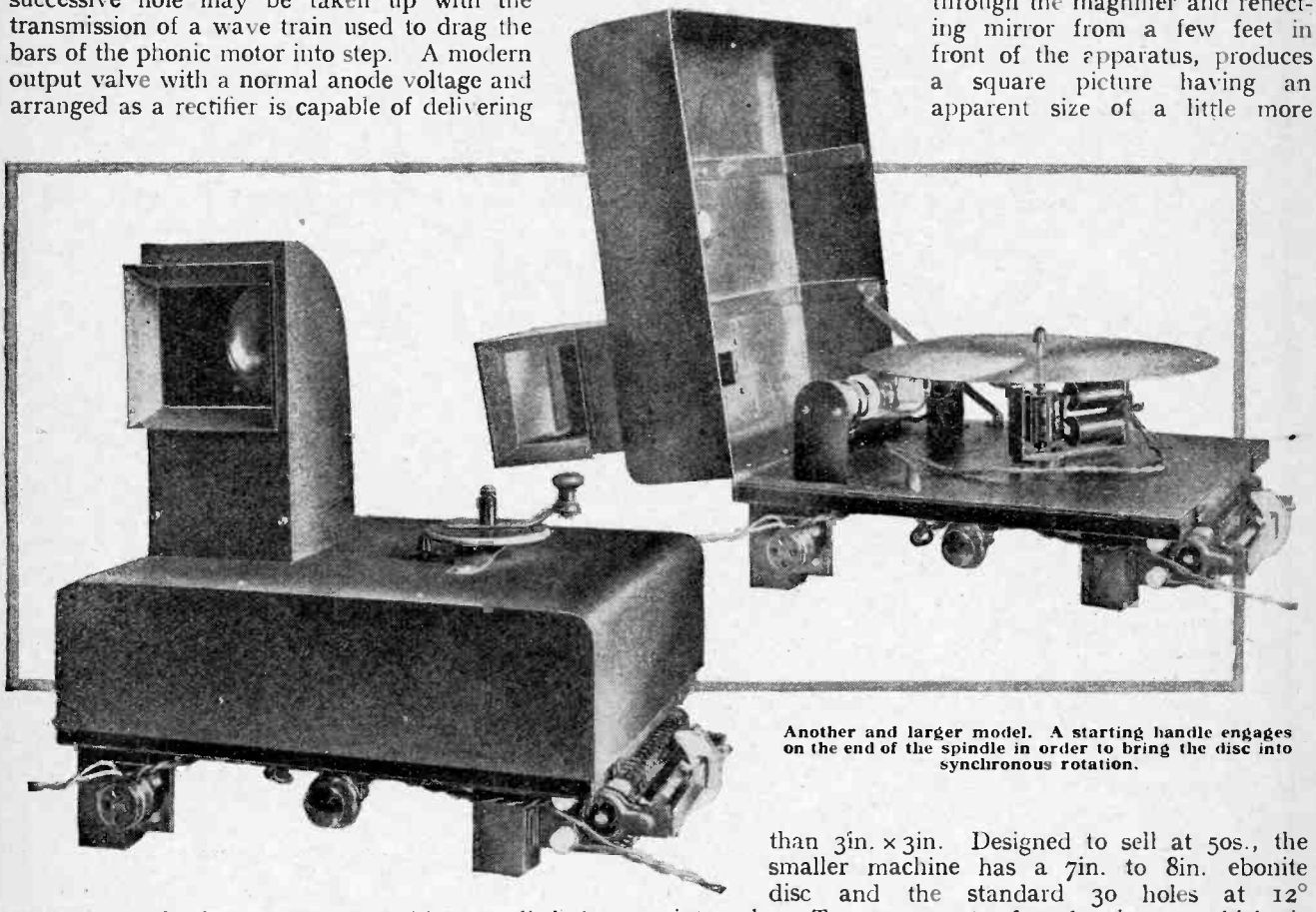
To interpose the synchronising signal between each



The revolving disc is seen through the square aperture and immediately behind is the neon tube. With 30 holes in the disc, the image is divided into 900 points of varying light value.

Television by the Mihály System.—

successive traverse of the object at the transmitter is a logical suggestion. With the 30-hole scanning disc and its 12° image, some 3° or 4° rotation between each successive hole may be taken up with the transmission of a wave train used to drag the bars of the phonic motor into step. A modern output valve with a normal anode voltage and arranged as a rectifier is capable of delivering an output of almost a watt, which applied intermittently for 25 per cent. of the time of rotation would, no doubt, alone serve to keep the almost frictionless mounted disc in rotation.



Another and larger model. A starting handle engages on the end of the spindle in order to bring the disc into synchronous rotation.

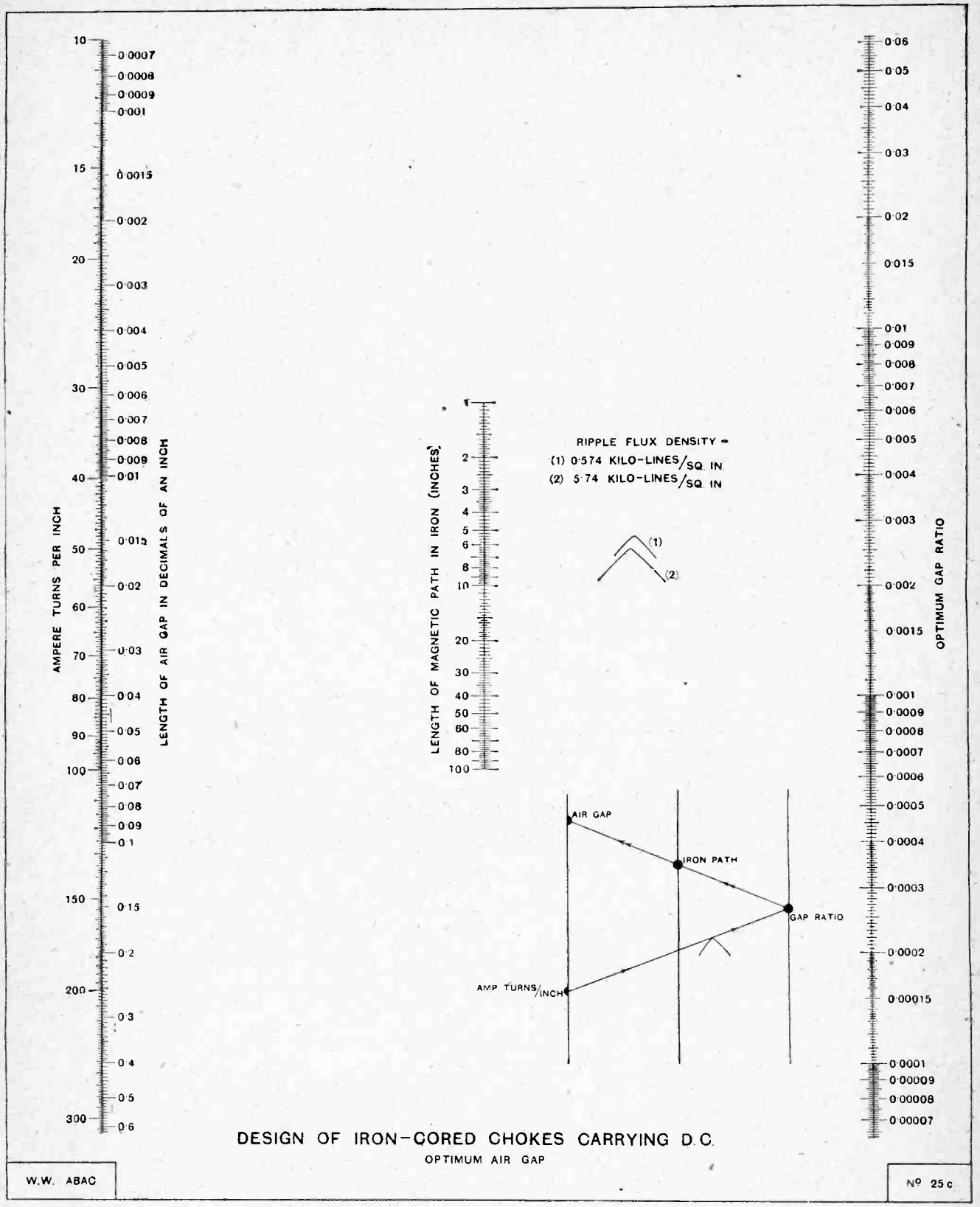
Neon Lamp Problems.

We now turn to another problem, that of the neon lamp which is required to glow to full brilliancy with the energy available in the anode circuit of an output rectifying valve. No great difficulty is experienced, assuming the use of a L.S.5 type with its associated high voltage anode current supply. In the Mihály system an important claim is made to the production of a new lamp capable of working when the available anode voltage does not exceed 150 and taking a current of only 5 mA. Attention might also be given to that property of the neon lamp in which the potential across the electrodes required to produce the glow may be appreciably higher than that at which the glow ceases. This property has no doubt received attention in the design of the lamp and by creating non-linear conditions in the associated circuit.

In the television receiver machines, shown in the accompanying illustrations, of which there are two types following in detail the description given here, magnifying lenses are fitted giving an enlarged virtual image. With the larger model a 30-hole disc gives an image a little over 1in. square. This, when seen through the magnifier and reflecting mirror from a few feet in front of the apparatus, produces a square picture having an apparent size of a little more than 3in. × 3in. Designed to sell at 50s., the smaller machine has a 7in. to 8in. ebonite disc and the standard 30 holes at 12° intervals. To compensate for the image which is formed behind a smaller aperture, greater magnification is provided so that the image appears similar in size to that of the larger type apparatus.

Because a phonic motor is not self-starting, a friction drive is fitted to the cover of the larger model, while with the smaller machine a knurled knob provides for rotating the disc up to a speed where the motor can drop into step with the supply frequency. Another control, acting through bevel pinions or worm wheel, swings the magnet about the motor axis. This, the "phasing control," brings the disc into correct relationship with regard to the aperture, so that the formation of each single picture starts simultaneously with each complete analysis of the object of the transmitter. A rheostat to be seen on the large instrument is for the purpose of accommodating the magnet winding to the mains voltage.

As it is understood that the Mihály system is considered to be sufficiently advanced for a broadcast television service, it will be possible to give more details when the complete equipment makes its appearance in this country. In the meantime we await with interest the results of a demonstration. F. H. H.



USEFUL DATA CHARTS (No. 25c). The most satisfactory width of air gap for an iron-cored choke can be obtained from this abac. For further explanatory notes reference should be made to last week's issue

DESIGNING THE L.F. AMPLIFIER

The Input to the Power Stage.

By T. R. LUPTON, M.Sc.
(of the Ferranti Radio Research Laboratories).

(Concluded from page 666 of previous issue.)

WE now come to the consideration of the input of the power stage. The writer prefers transformer as against resistance coupling, the main reason for this being, theoretically, that large transients including atmospherics, etc., can choke up the grid condenser, and this may last sufficiently long to be annoying to the critical ear. In practice, resistance capacity is not quite so foolproof as transformer coupling for getting best results, although by judicious design it can certainly be very excellent; for the description of an ambitious resistance amplifier with a good measured characteristic the reader should refer to an article entitled the "All Electric Amplifier" which has recently been published in *The Wireless World*.[1] Let us assume, therefore, that we intend using transformer coupling to the power valve. If push-pull has been decided on, then, without doubt, transformer coupling is the most convenient. For this a transformer having a centre-tapped secondary is the best thing to use.

An ordinary transformer can be furnished with an artificial centre tap by placing across its secondary two equal grid leaks in series, the centre point being taken to the grid bias as shown in Fig. 2. This, however, is not advisable for the following reason. The secondary of a good transformer has an enormously high impedance. When one places across it even such a high resistance as a grid leak, and when the secondary has an e.m.f. induced in it, the grid leaks will take a small amount of current. This current is certainly very minute, but the fact that it flows through the enormously high impedance of the secondary means that there is a voltage drop, i.e., the voltage applied to the grids of the power valves is not as high as the e.m.f. generated in the secondary.

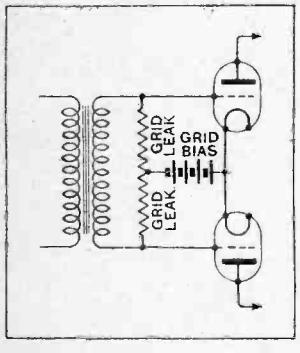


Fig. 2.—A means of obtaining an electrical centre tap to an untapped intervalve transformer. Amplitude distortion may arise from loading the secondary.

This in itself is not a disadvantage, but the trouble is that the current through the grid leaks varies according to the voltage across the transformer, so that the voltage drop in the transformer secondary varies also. Thus the output voltage becomes non-proportional to the input voltage across the primary, setting up what is strictly an amplitude distortion. A practical objection to this method is that if one buys two grid leaks of nominally the same value it is very unlikely that they will be exactly similar, hence one power valve grid has much more voltage applied to it than the other, with the result that full advantage is not obtained from the use of two valves.

[1] *The Wireless World*, June 19th, 1929.

A Plea for Calculation of Grid Swing.

In the penultimate stage, in spite of what many people have thought, even a small power valve is not necessary. Assuming as before that two PX.650 valves are being used in push-pull, which requires twice as large a grid swing in order to overload than does either a single valve or valves in parallel, we will consider grid swings, and by dint of ordinary multiplication

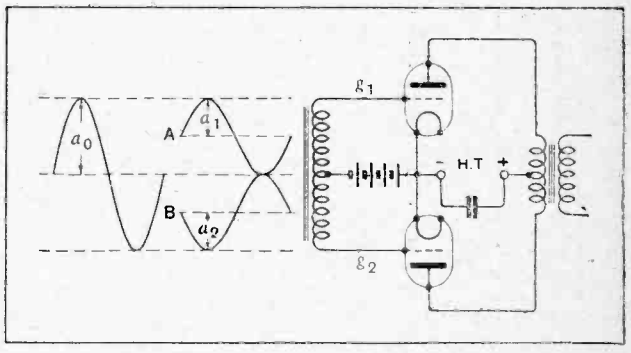


Fig. 3.—Graphical representation of the application of a signal grid swing to two valves in push-pull.

or division prove that the power valve is not necessary in the previous stage. With 200 volts on the anodes two PX.650 valves in push-pull will need a grid bias of −40 volts. Now it must be borne in mind that the centre-tapped secondary transformer performs the function of splitting the signal into two halves, as shown diagrammatically in Fig. 3, one half being applied to one valve as at A, while the other is applied to the other valves as at B. Thus in order to overload the valves a total peak swing, shown as a_0 in Fig. 3, which will just overload the valves, equals 80 volts.

Assuming a transformer ratio of $3\frac{1}{2}$, then the voltage across the primary of the input transformer will be 80 divided by $3\frac{1}{2}$, that is, approximately 23 volts. Now suppose that in the penultimate stage we place an ordinary L.F. valve of a type with an impedance of 7,500 ohms. This valve with a good transformer will give a very flat curve for practically the whole of the normal audible range, so that we can say that it is quite an orthodox type of valve for this position. Such

Designing the L.F. Amplifier.—

a valve will have an amplification factor of 15. Thus in order to produce 23 volts across the primary of the transformer in its anode circuit a voltage of $23 \div 15$ would have to be applied to its grid, that is, approximately 1.7 volts. Normal conditions for this valve would be 140 to 150 volts H.T., with a grid bias of -3 volts. Thus there is ample margin of safety against overloading this valve, and the desirable condition would be reached of the output stage overloading long before there was any such tendency with the penultimate stage. The word "desirable" is used here advisedly because in a quality set it is practically imperative to use a milliammeter in the output stage in order to keep a check on the emission of the power valves, and since the set has been designed so that this is the point where overloading first occurs, the milliammeter by the movement of its needle shows immediately when overloading is present.

Choice of Detector.

Having therefore decided upon the valve which will perform the dual function of accepting the large available grid swing, whilst at the same time not overloading the transformer, or, in other words, not reducing the primary inductance of the transformer by virtue of saturating magnetically the iron core, we can proceed to a study of the first valve in the low-frequency chain, that is, the detector valve together with its coupling to the succeeding valve. The two popular methods of rectification are (a) cumulative grid, and (b) anode bend.

Discussions have in the past been numerous as to which of these two types is the "better." Without going deeply into the subject the "pros and cons" may be summarised thus. Cumulative grid rectification is very sensitive, and is useful, in fact, it is almost indispensable to the man who is building a set which is intended for the reception of distant stations. For really good quality of telephony reception a cumulative grid rectifier must have a comparatively critical value of voltage applied to its grid. On the other hand, anode bend rectification dispenses with the grid condenser and leak, thus saving the constructor a matter of four or five shillings. It is normally styled an inefficient method of rectification. This is very true for small grid swings; in fact, signals which are inaudible with an anode bend rectifier can be made quite audible by using grid leak rectification.

If a comparatively large signal is fed to the grid of an anode bend rectifier, rectification becomes very good, and there are other advantages which can most easily be discussed by referring to the valve characteristic shown in Fig. 4. This is the one usually included with the valve, where anode current is plotted vertically, grid voltage being plotted horizontally, the curve being taken for a stated value of anode voltage. In order to obtain anode rectification, the grid bias would be set at a value which would bring the initial condition of the valve down to the point X on the curve. Now suppose that a *small* signal is applied to the grid (as in Fig. 4 (a)), this would vary the grid voltage between the limits A and B. There would thus be an increase of current from a value C to D, and during the negative half-cycle a decrease from C to E. The mean increase would then be of some such value as F. It must be noted that, owing to the curvature about X, rectification has occurred, i.e., there has been an increase in the mean current to the anode of the valve, but the positive half-cycles have not been very much greater than the negative half-cycles.

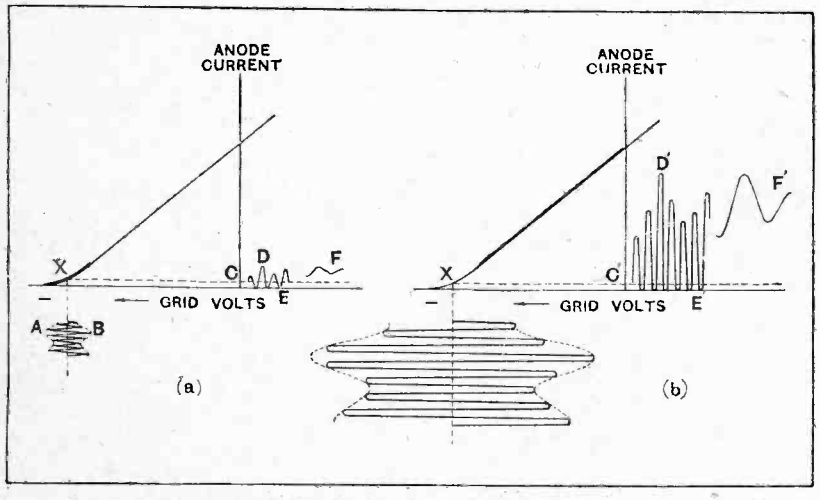
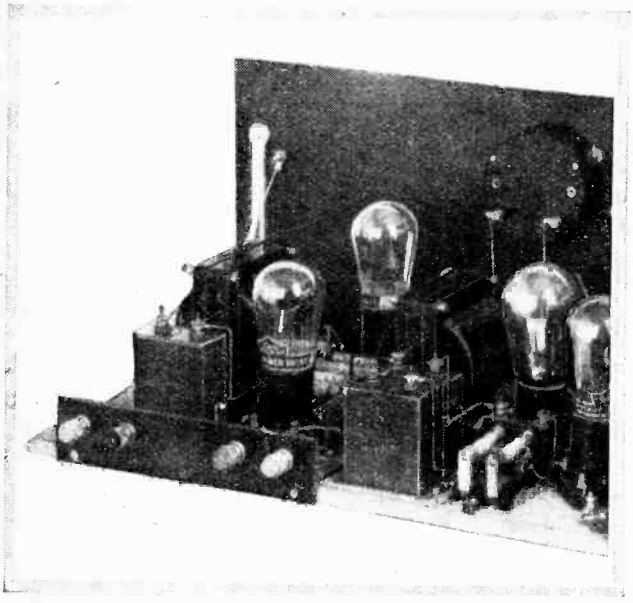


Fig. 4.—In (a) the application of a weak signal to the bend in the anode characteristic is shown. When a large signal is applied to an anode bend detector, the modulated envelope is applied to the straight part of the characteristic as in (b).

In the next place, let us assume that either more high-frequency amplification has been added, or, alternatively, a stronger station has been tuned in, resulting in a large input to the detector shown in Fig. 4 (b), where the same valve characteristic is repeated. The initial point is still X, but now the positive half-cycles raise the anode current to a point D', whereas the negative half-cycles can only result in a minute diminution to E'. There is thus a very large difference between the increases and decreases of current, or, in other words, a good efficiency of rectification, resulting in a change of mean anode current to a value F'. This is not the only advantage accruing. With the small input signal, the signal oscillated round the bend, which is shown thickened. This bend is such that the valve impedance is very much greater than that stated on the leaflet supplied with the valve, and care therefore is required in the choice of the coupling unit to be used in the anode circuit of the valve, but when a large signal is used, as in Fig. 4 (b), the crests of the high-frequency positive half-cycles enclosed by the dotted line envelope occur solely on the straight part of the characteristic (again shown thickened), so that the variation due to modulation is traversing the characteristic where the valve has nearly its normal impedance.

Designing the L.F. Amplifier.—

In this case one's choice of a coupling unit is not limited as previously. In addition, the output, even for comparatively large modulations, is proportional to the input, whereas, due to the curvature, this was not so in the case of the small signal.



The output stage of a receiver incorporating two valves in transformer push-pull.

It is thus seen that the choice of rectifier depends upon the magnitude of signal which can be applied to the grid of the detector, but there is no doubt that for quality work the anode bend method is far more popular.

Coupling between Detector and First L.F. Valves.

The limitations of resistance coupling following anode bend detection are such that, first, an attempt to obtain a large fraction of the valve's amplification when using a so-called R.C.C. valve is usually accompanied by serious high note loss, due to the effects of a large working capacity. Secondly, if the shunting of the higher audio frequencies is minimised by reducing the by-pass condenser, rectification efficiency falls off, and the only palliative is a valve of lower impedance having a low-value coupling resistance, while still retaining a by-pass condenser of sufficient capacity to ensure good rectification.

Unfortunately, this expedient entails a reduction of overall amplification, a condition which is regarded by many as a disadvantage.

Sufficient has been said to show that a really good resistance-capacity stage is a compromise. On the other hand, as pointed out earlier, an anode bend rectifier when used with a large input signal has only a little more than its nominal impedance, so that, if the valve be suitably chosen, it can be followed by a transformer. The only condition to observe is that the nominal impedance of the valve should be of the order of 10,000 ohms. The limits are set by the fact that if a very low impedance is used precautions have to be adopted to avoid large currents flowing through the primary of the transformer; if a high impedance is used the frequency amplification curve of the stage is spoiled because the impedance of the transformer at very low frequencies is not appreciably greater than that of the valve. The following equation which is sufficiently accurate for everyday use, but is not mathematically rigid, shows the relation between amplification and frequency for transformer coupling:—

$$\text{Amplification} = M \times \text{Ratio of transformer} \times \frac{Z}{\sqrt{R_o^2 + Z^2}}$$

M = Amplification factor of valve.

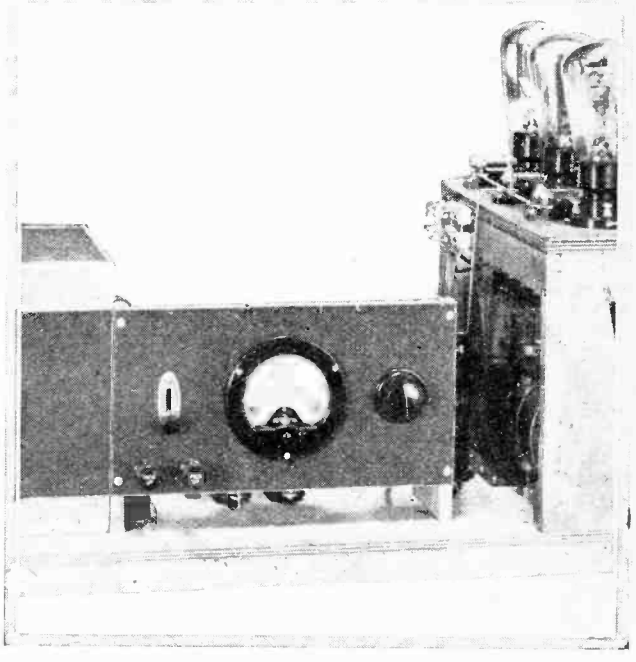
Z = Impedance of transformer primary.

R_o = Valve impedance.

Since the transformer primary impedance varies with frequency, it is seen that if Z is very much greater than R the amplification becomes M multiplied by the ratio. Because of this fact the transformer primary impedance must be kept much higher than the valve impedance at all frequencies; when this condition is satisfied an even amplification curve with respect to frequency is obtained.

Volume Control.

Perhaps the most commonly used method of volume control is that of de-tuning the H.F. circuits. From a quality point of view this could be an advantage, for, if one condenser is de-tuned slightly downwards whilst another is de-tuned in the opposite direction, the loss of high frequencies due to selective circuits is greatly counteracted. Where selectivity is desired this de-tuning is a disadvantage, so some other means of volume control has to be found. There is also the objection in the case of anode bend rectification that with the large input signal just described, pre-detector volume control



The detector panel of *The Wireless World* "Schools Demonstration Receiver." Note the milliammeter which reads the average rectified output.

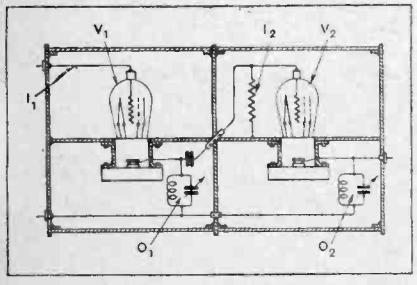
Designing the L.F. Amplifier.—

cannot be used with a normal aerial signal as it is necessary to keep up high-frequency amplification in order to load up the detector. The simplest method of volume control and the most satisfactory is to arrange a variable high resistance across the primary of the transformer in the anode of the detector, a resistance having a maximum of the order of 100,000 ohms being suitable for this purpose. A similar method can be used in resistance-capacity coupling where this resistance actually becomes an anode resistance, but it is usually difficult to obtain a variable high resistance of this order which will carry the anode current required by the valve. It was pointed out earlier in this article that a resistance of any description placed across the secondary of a transformer is a disadvantage, but a resistance placed across the primary has a definite advantage in that it improves the amplification against frequency curve of the detector plus transformer stage.

The sequence of operations for obtaining really good quality with a receiver of this type is to tune in a station at good strength, that is, until one obtains if possible a reading on a milliammeter placed in the anode circuit of a detector (valve impedance 8,000-10,000 ohms) of 0.5-1.0 milliamp. This ensures that the modulated part of the high-frequency wave is actuating the valve over the straight portion of its characteristic. This with the full amount of low-frequency amplification will overload the output stage, so that the next operation is to adjust the low-frequency amplification by means of the variable resistance just mentioned, thereby obtaining the requisite volume without overloading and consequent distortion. With such a set worked under the conditions of suitably large input and optimum H.T. and the necessary grid bias one can be confident of obtaining results entitling one to criticise the transmission of any station—an ambition which seems common to all wireless enthusiasts of the present day.

SCREENING VALVE AMPLIFIERS.

Although the use of screen-grid valves avoids reaction due to capacity coupling between the internal valve electrodes, it does not prevent reaction effects due to the proximity of external connecting leads and components in the input and output circuits respectively. For this additional screening means are necessary. One such arrangement recently designed by the British Thomson-Houston Co. (Patent No. 285020) is illustrated in the figure.



Complete screening by two-section compartments.

Two H.F. valves are enclosed in a common metal casing, which is subdivided into four compartments, each housing the leads and components of the separate input and output circuits, 1_1, 1_2, and 0_1, 0_2 respectively. The valve holders are mounted below the transverse partition panel in such a way that each valve is readily accessible without disturbing the existing circuit connections.

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EARTHING-SWITCHES.

The best form of earthing-switch is one in which a direct aerial-to-earth connection can be made outside the building, so that there is no danger of a lightning-discharge taking place inside the house. At the same time, it is obviously convenient to be able to control the earthing-switch from inside the room where the receiving set is situated.

The drawing shows a convenient arrangement of this type (Patent No. 300780). The outside fitting consists of a rotary drum D mounted on the external wall of the house and operated by a Bowden-wire control from a lever L located inside. The drum D is fitted with a spiral spring S, which normally causes a curved contact strip C to bridge the aerial and earth terminals A, E so as to form a direct short-circuit. By moving the lever L into the position shown, this bridge contact is broken, and the down-lead terminal A is simultaneously brought into direct connection with the end of the Bowden-wire control. The latter then acts as a lead-in conductor from the aerial to the receiving set, through a wire A1 connected to the spindle of the control handle L.

PATENT NOVELTIES.

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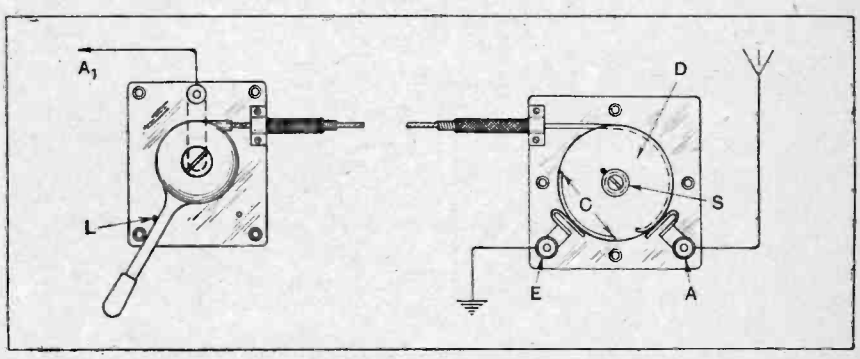
EXPONENTIAL HORNS.

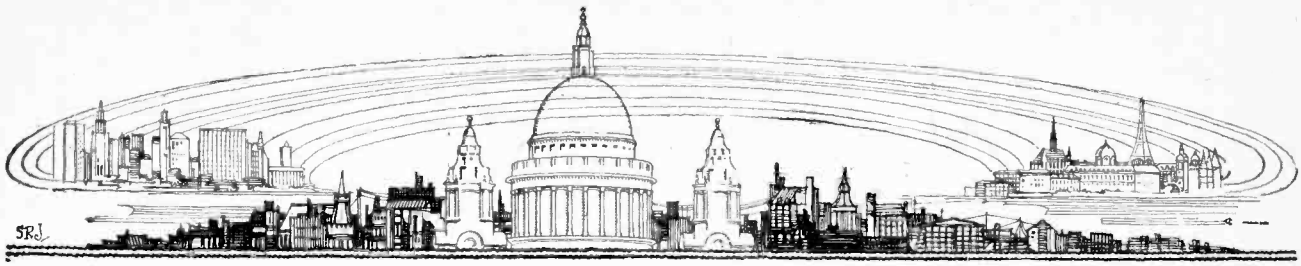
In a well-designed loud speaker horn (a) the proportion of available mechanical energy in the diaphragm converted into sound should be a maximum, and (b) this proportion or factor of performance should be the same for all the audible frequencies. The requirement under (a) depends upon the area of the initial throat opening of the horn, whilst that under (b) depends upon the rate of expansion of the bore and the overall length of the horn.

In the exponential or logarithmic type of horn, the area of the bore is designed to increase by a constant percentage per unit length, progressively from throat to mouth. Theoretical considerations show that the smaller this percentage increase is kept the more uniform is the loading on the diaphragm for various frequencies. Further, in order to minimise end reflection from the mouth of the horn, the flare should be as large as possible. These requirements obviously involve a long horn.

The Igranic Co. have recently evolved a new principle of design in which the above-mentioned features are secured in a horn of comparatively small overall length. Instead of keeping the percentage increase in bore area a constant factor, as in the standard logarithmic horn, it is made to increase progressively per unit length from throat to mouth.



Indoor Bowden-wire control of an outside aerial-earth switch.



CURRENT TOPICS

Events of the Week in Brief Review.

ANOTHER FLAG DAY.

A proposal for a radio flag day for the provision of wireless in the local workhouse is under consideration at Hitchin.

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BRITISH LICENCE INCREASE.

The number of receiving licences in force at the end of May was 2,760,878. This shows an increase of 20,000 over the figure for April. In addition, 14,830 licences have been issued without charge to blind listeners.

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OFFICIAL GRATITUDE TO FRENCH AMATEURS.

Amateur transmitters in France who have made important contributions towards short-wave research are to be relieved of all wireless taxes, writes our Paris correspondent. The announcement was made at the recent Conference of French amateurs in Paris.

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PREMIER TO BROADCAST FROM U.S.A. ?

The Prime Minister has received an invitation from the Chicago Federation of Labour to broadcast in the autumn over the American network of stations. He is promised an audience of 100,000 and "a chain hook-up that will enable radio listeners to hear you throughout America and Europe."

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S.A. BANS BROADCAST ADVERTISEMENTS.

The South African Broadcasting Company has decided to discontinue the inclusion of advertisements in the programmes. Commenting on the decision, *South African Wireless Weekly* remarks: "The absence of these advertisements will not even be noticed after the first two nights, for we have all got so used to them that we never take the slightest notice of them."

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WHEN THIEVES FALL OUT . . .

By the use of a secret wireless station, a gang of swindlers in Berlin are reported to have defrauded bookmakers of sums estimated at between £5,000 and £10,000. According to the Berlin correspondent of *The Daily Telegraph*, the clandestine receiver has been used to pick up the results of French races before they were generally available in Germany. The fraud was detected when the members of the gang quarrelled amongst themselves.

RADIO DIFFUSION.

The Union Internationale de Radiophonie is to change its title to Union Internationale de Radiodiffusion. The next session will be held in October at Barcelona. In the spring of 1930 a meeting will take place at Budapest.

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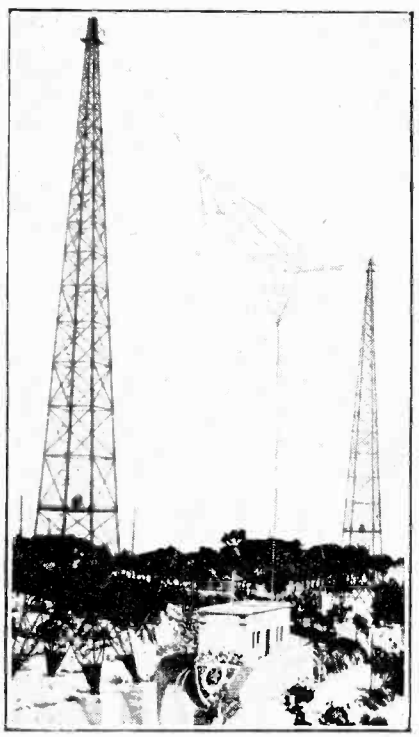
RADIO LABORATORY FOR THE BLIND.

"La Radio aux Avengles," a French organisation for the relief of the blind, has initiated a movement for providing blind wireless enthusiasts with a laboratory in which they can construct sets and receive special instruction from qualified radio engineers. The scheme also provides for the distribution of a radio journal printed in Braille.



BILBAO, one of the Spanish broadcasting stations which have escaped the economy axe. It occupies a fine site overlooking the Bay of Biscay.

NONE SO BLIND . . .

A listener fined £5 and costs at the Belfast Police Court for owning and operating a wireless set without a licence pleaded ignorance of the law. He had been a listener since 1923.

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S.A. BEAM BOOM.

A Johannesburg report states that beam shares are booming. Applications representing upwards of £900,000 were received in response to the recent issue of £48,694 in the Wireless Telegraph Co. of South Africa.

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SHORT WAVES FROM SIBERIA.

For the benefit of trappers in Polar regions the Soviet Government is planning the erection of a short-wave station at Turukhansk, Siberia, on the edge of the Arctic Circle. The transmissions will include news bulletins and weather reports.

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TWIN WAVE TRANSMISSIONS IN ITALY.

The high power broadcasting station now being constructed by the Marconi Company at Rome will broadcast on two wavelengths simultaneously, viz., 254 and 80 metres. The transmissions will be intended primarily for the Italian colonies in Africa.

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POSTMEN AND PIRATES.

Dublin postmen are reported to have launched a successful protest against a rule requiring them to give information concerning the whereabouts of unlicensed wireless sets. Through their official union the postmen pointed out that they wished to remain on friendly terms with householders. The Parliamentary Secretary to the Post Office has now assured the Union that postmen are "under no compulsion whatever" to report pirates.

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THE WILY OSCILLATOR.

At a convention of the Northumberland and Durham Group of Radio Associations, held at the North-East Coast Exhibition on Saturday last, June 29th, it was moved "that this Convention considers that the system of dealing with complaints respecting oscillation is cumbrous and inadequate."

Another motion on the agenda ran: "That this Convention considers that in view of the fact that the B.B.C. are en-

tirely dependent upon the licence payers for its income, the said licence payers are entitled to more detailed information as to the disbursement of the funds in the administration of the B.B.C."

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BRITISH INDUSTRIES FAIR, 1930.

New quarters have been found for the London section of the British Industries Fair, 1930, in the specially reconstructed Olympia at Hammersmith. The Fair will be held from February 17th to 28th, and it is expected that, as in previous years, the radio industry will be well represented.

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FIELD DAY FOR ALL.

Members of any radio society are invited to take part in a Direction-finding Field Day—the last of a series—to be held at Elstree, Herts, on Sunday next, July 7th, by the Golders Green and Hendon Radio Society. The requirements are a portable set capable of reception on 150 metres, a pair of headphones, frame aerial, compass, map and means of transport. Several valuable prizes are offered.

Full particulars are obtainable from the Hon. Secretary, Lt.-Col. H. Ashley Scarlett, D.S.O., 60, Pattison Road, London, N.W.2.

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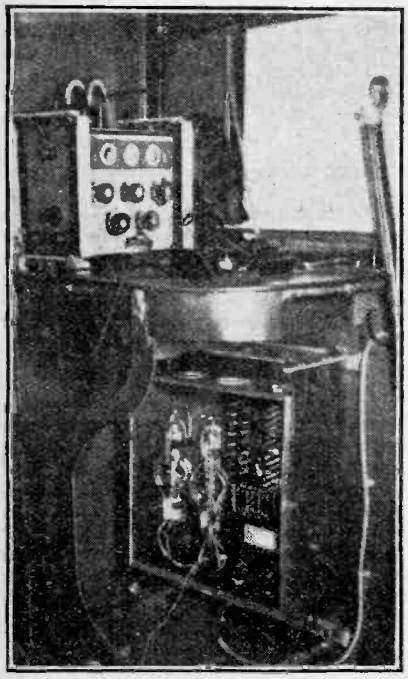
LOUD SPEAKERS AT R.A.F. PAGEANT.

Nearly sixty Marconiphone loud speakers will be employed for public address purposes at the R.A.F. Pageant at Hendon on Saturday, July 13th. Five special 32-valve power banks will comprise the last amplifying stage, and the total number of valves used will be nearly 180. The total H.T. current will be 6,000 milliamperes at 350 volts, while on the L.T. side 350 amperes will be taken.

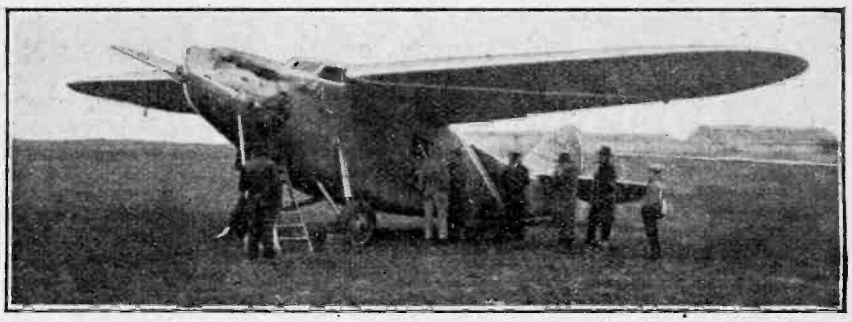


FRENCH AIRCRAFT WIRELESS. The radio equipment, fitted with Dario valves, used on board the "Yellow Bird," shown above.

PATENT LAW: ANY COMPLAINTS?

The Patents Committee, under the chairmanship of the Rt. Hon. Sir Charles Sargant, has begun its investigations, and persons and associations who wish to submit suggestions or to give evidence before the Committee are invited to communicate with the Secretary, Mr. R. W. Luce, Industrial Property Department, Board of Trade, 25, Southampton Buildings, W.C.2.

The Committee was appointed by the Board of Trade to report whether any amendments in the Patents and Designs Acts or changes in the practice of the Patent Office are desirable.



A TRANSATLANTIC VICTOR. The "Yellow Bird," on which the French airmen, MM. Assolant, Lefevre and Lotti made their recent crossing of the Atlantic. The wireless equipment, which was in constant use throughout the journey, is seen below.

U.S. TEST PROGRAMMES FOR BRITAIN.

A new series of transmissions specially intended for reception in Great Britain in the early evening has been inaugurated by WGY's short-wave station, 2XAF, at Schenectady. The transmissions are carried out daily, except on Saturdays and Wednesdays, according to the following schedule: Sunday, 7.30 to 10.30 p.m., 15,340 kilocycles; Monday, 7 to 9 p.m., 13,660 kilocycles; Tuesday, 7 to 8 p.m., 15,340 kilocycles; Thursday, 7 to 9 p.m., 13,660 kilocycles; Friday, 7 to 8 p.m., 15,340 kilocycles. All time references are B.S.T.

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CANADA'S WIRELESS HOTEL.

The first complete broadcast receiving equipment, combined with a local public address system, to be installed in any hotel in Canada, has just been placed in commission by the Canadian National Railways in the Chateau Laurier at Ottawa. The equipment includes a broadcasting studio occupying part of the eighth floor, 90 "points" in the public rooms and private suites for special microphones, loud speakers and pick-up apparatus, together with a portable signalling system with telephone communication for the control of programmes originating in the hotel. There is also a control board by means of which the hotel may be connected directly by wire with any one of the 11 broadcasting stations which the Canadian National Railways operate in Canada between Halifax and Vancouver.

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WIRELESS WEB FOR SOUTH AMERICA.

In the international scramble for the development of South American communications a point has been scored by the United States, according to a New York message. All America Cables, a subsidiary of the International Telephone and Telegraph Corporation, has obtained wireless telegraph and telephone concessions in Ecuador, Peru and Columbia. The Columbian concession authorises the construction of a high power station at Bogota, with two additional stations on the Atlantic and Pacific coasts respectively.

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NEW B.B.C. WAVELENGTHS.

Certain revisions in the wavelengths of the British broadcasting stations under the Prague plan were announced by the B.B.C. shortly before the plan came into operation on Sunday last. The following is a complete table of the British wavelengths now in use: —

Station.	Frequency in kilocycles.	Wavelength in metres (approx.)
Daventry (5XX)	193	1,553
Manchester	797	377
Daventry (5GB)	626	479
Glasgow	752	399
London (1)	842	356
London (2)	—	—
Cardiff	968	310
Aberdeen	995	301
Bradford	1,040	288.5
Bournemouth, Dundee, Edinburgh, Hull, Liverpool, Plymouth, Sheffield, Stoke, Swansea	1.040	288.5
Newcastle	1,148	261
Belfast	1,238	242
Leeds†	1,500	200

† 1,500 k.c. (200 metres) is not a British exclusive wave under the Prague Plan, but special arrangements have been made for its use by the Leeds transmitter.

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REGIONAL BROADCASTING FOR SWITZERLAND?

The latest scheme for improving Swiss broadcasting calls for the erection of two high power transmitters, one at Sursee and the other at Moudon, in the south-western district of the country. The same plan contemplates the taking over of the existing stations at Geneva, Lausanne, Berne, Basle and Zurich, and for the construction of small relays at Sitten, Olten, St. Gall, Chur, in addition to one at Locarno, Bellinzona or Lugano. The entire system would be linked up by special telephone cables, thus permitting an interchange of local programmes.

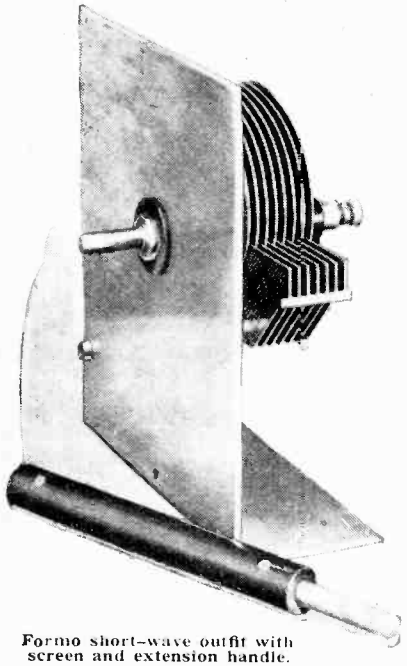
As the *Plan de Prague* has allocated five exclusive wavelengths to Switzerland, it would be possible to use some of these as common waves on which the smaller and weaker relays could operate without causing any interference.

WIRELESS WORLD LABORATORY TESTS

A Review of Manufacturers' Recent Products.

FORMO SHORT-WAVE OUTFIT.

This consists of a 0.00015 mfd. logarithmic type variable condenser, mounted on a vertical aluminium screen for fixing to a baseboard. An ebonite



Formo short-wave outfit with screen and extension handle.

extension handle 4in. long enables the condenser to be mounted close to the coils and well back from the panel, thereby totally eliminating all hand capacity effects.

The moving vanes of the condenser are supported at both ends, the two bearings being carried in moulded pillars with brass insets. Electrical contact to the moving vanes is made through the back bearing and not by means of a pigtail. This may give rise to noises on the very short wavelengths if the rubbing surfaces become dirty; however, during our tests there was no trace of scratch or other objectionable noises due to this method of making contact.

The screen is provided with an earthing terminal, and since this will normally be "earthed" it was connected to the moving vanes when measuring the capacity of the condenser. The minimum capacity was found to be 12 micro-microfds. and the maximum 0.000164 mfd.

The outfit is made by the Formo Co. (Arthur Preen & Co., Ltd.), Crown Works, Cricklewood Lane, London, N.W.2, and the price is 10s. 6d. without dial.

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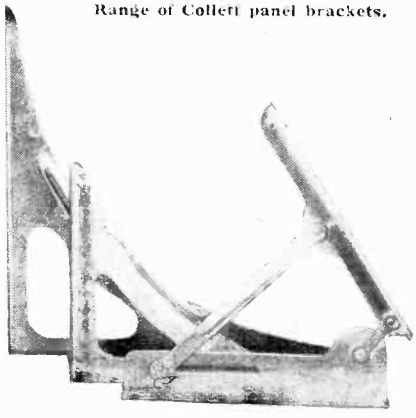
COLLETT PANEL BRACKETS.

These panel brackets are available in two kinds, fixed and adjustable. The fixed type are made in large and small sizes, measuring 3½in. × 3½in. and 6in. × 6in. respectively. The prices are 1s. 3d.

Range of Collett panel brackets.



and 1s. 9d. per pair. The adjustable type measures 5in. × 5in., and enables the panel to be set at any angle between 60° and 90° with the baseboard. These are offered at 3s. the pair.

The makers are the S. H. Collett Manufacturing Co., 60, Pentonville Road, London, N.1.

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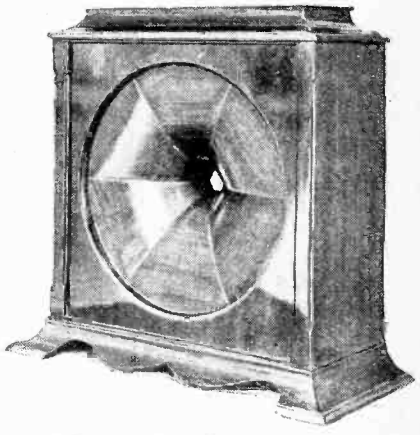
"REALISTIC" LOUD SPEAKER.

The range of loud speakers made by Messrs. W. H. S. Vincent, 72, Penton Street, Islington, London, N.1, under the trade name of "Realistic," has been augmented by a handsomely finished cabinet cone in polished mahogany, selling at £6 6s. The distinctively shaped diaphragm, built up from sections of thin



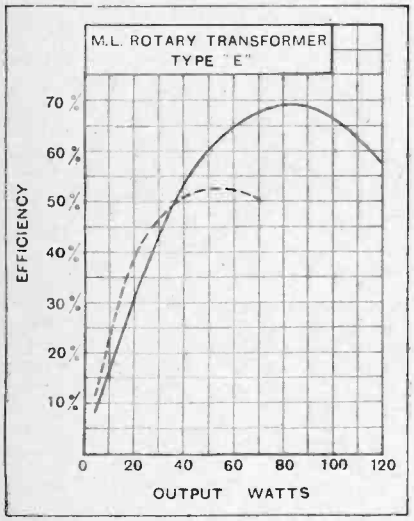
"Realistic" cabinet cone loud speaker in polished mahogany case.

veneer wood as described in these pages on November 14th last, is retained. An adjustable movement is fitted, which, when correctly set, gives good sensitivity.

A practical test on a high-quality amplifier revealed a slight tailing off in response at the upper and lower ends of the audible scale, but this was only in evidence when compared with a high-class moving-coil instrument. The middle register is well brought out.

M-L ROTARY TRANSFORMERS AND MOTOR GENERATING SETS.

The success of the small anode converters has led to a demand for a larger machine capable of delivering an output suitable to operate public address amplifiers, radio gramophone sets for dance purposes, and similar requirements. The "E" type rotary transformers are rated to give 100 mA. at 400 volts, but our tests showed that the machines are capable of a much larger output, the voltage being higher than the rated value.

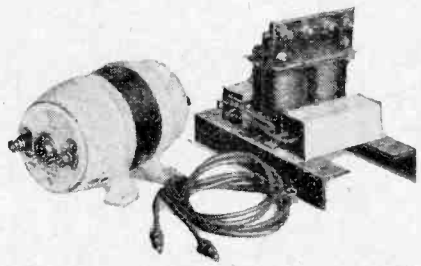


Efficiency curves of the Type "E" rotary transformers.

The models dealt with in this review are wound for 12- and 210-volt inputs, but machines can be wound to suit any input voltage between 12 and 250. The 12-volt model is ideal for use with mobile amplifiers, since it can be run off the car accumulator. If especially required, the machines can be wound to give an A.C. output which is approximately sinusoidal, but in this case the maximum watts available will be less than for a D.C. output.

Efficiency and voltage regulation curves were taken for the "E" type machines, and these are plotted on the accompanying graph. The full line curves refer to the 210-volt model, and the broken line curves to the 12-volt model. An efficiency of 70 per cent. was obtained at 85 watts output (670 volts, 125 mA.) from the 210-volt model, while the maximum efficiency was recorded with the 12-volt model when 55 watts (400 volts, 130 mA.) were drawn from the output end. The efficiency was found to be 52.5 per cent. These figures are highly satisfactory for small machines.

The machines are made by the M-L Magneto Syndicate, Ltd., Victoria

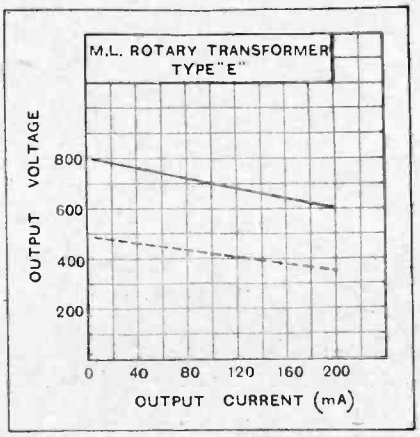


M-L rotary transformer Type "E" and smoothing circuit.

Works, Coventry, and the price has been fixed at £12 5s. for either type.

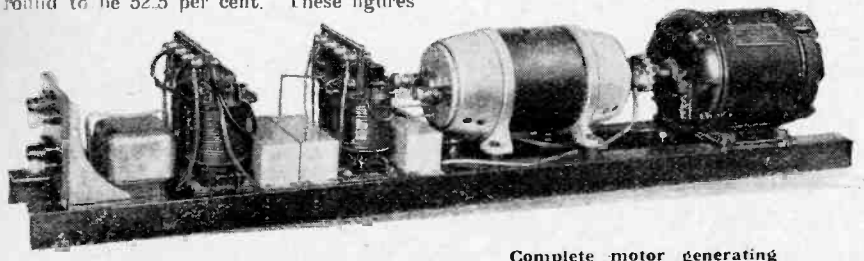
A special smoothing equipment, consisting of two chokes wound on a massive core, with 4-mfds. condensers assembled on a stout iron frame, is supplied for use with these generators. The measured D.C. resistance of each choke was found to be 45.5 ohms; the voltage drop across these will be negligible. The smoothing equipment is offered at £4 5s.

These machines can be obtained giving high- and low-tension outputs and driven by a separate motor. The motor-generat



Voltage regulation curves of M-L rotary transformers Type "E."

ing set illustrated comprises a 220-v. A.C. motor coupled to a Type F generator delivering 400 volts at 200 mA. at one end and 6 volts at 6 amps. at the other. It includes smoothing equipment, both H.T. and L.T., and automatic "cut-out" to guard against damage due to short-circuit of the output. The complete equipment is mounted on a substantial bed plate made up from stout angle iron, and the price has been fixed at £40.



Complete motor generating equipment fitted with Type "F" generator giving 400 volts and 6 volts.

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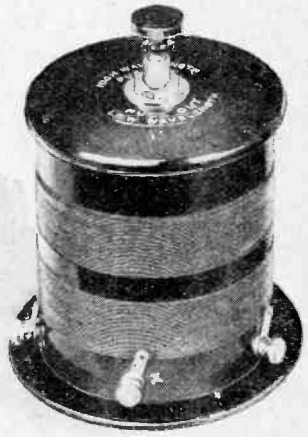
BULGIN MULTI-COIL.

This is a dual range coil particularly suitable for use with screen-grid valves, since by adopting the tuned anode circuit, or tuned grid arrangement with parallel feet *via* a choke to the plate of the valve, simplified switching is possible. The type "A" is the aerial-grid unit, and the type "B" the H.F. coil.

The device consists of a 3in. diameter former carrying the medium-wave coil, wound in two sections, on the outside, while the long-wave portion is wound on a slotted former mounted inside the 3in. tube and with its axis at right angles to that of the medium-wave coil. The long-wave coil is centre-tapped and electrically connected between the two sections of the medium-wave coil.

A simple push-pull three-point switch short-circuits the loading coil. Three



Bulgin multi-coil with wave change switch incorporated.

terminals are fitted, 1 and 2 being connected to the outside ends of the medium-wave coil, while the terminal marked "X" is the electrical centre tap for both long- and medium-wave coils.

An "A" type unit was submitted for test, and when connected to a standard receiving aerial, with a 0.0001 mfd. condenser between the aerial and the centre tap, tuned from 215 metres to 620 metres on the medium waveband and from 1,060 metres to 2,570 metres on the long waves. A 0.0005 mfd. variable condenser was used. The makers give the ranges as 250 to 550 and 1,000 to 2,250 metres respectively.

The price of "A" and "B" coils is 15s. 6d. each. Another type ("C") is available also at the same price; this includes a reaction winding. The makers are Messrs. A. F. Bulgin and Co., 9, 10, 11, Cursitor Street, Chancery Lane, London, E.C.4.

B 22

Broadcast Brevities

NEWS FROM ALL QUARTERS.

By Our Special Correspondent.

H. G. Wells at the Microphone.—Bigger Studio Audiences ?—Western Regional.

A Talks Coup.

Mr. H. G. Wells making his first appearance before the B.B.C. microphone should be an interesting phenomenon to us all, whether we be "dyed-in-the-wool radio hams," set constructors, or merely gentle listeners. The famous publicist is definitely booked to appear at 9.15 p.m. on Wednesday next, July 10, and I gather that Savoy Hill is so delighted over the *coup* that the question of "censorship" which usually arises has not been discussed. It is known, however, that Mr. Wells' talk will be based on his recent speech in the German Reichstag on the subject of world peace.

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Tyranny of the Talks Manuscript.

In securing a speaker of Mr. Wells' calibre the B.B.C. deserves every congratulation, more especially in view of the fact that the creator of Mr. Britling is one of the illustrious few who have not hitherto disguised their unwillingness to broadcast.

Perhaps we are on the eve of a new era in broadcast talks in which, incidentally, the manuscript will be less of a tyrant than at present. Nowadays broadcast "talks" are not talks at all, but merely readings by people who, in many cases, have been endowed with most talents except elocution. The pity of it is that, if allowed to, they could *talk* with grace and distinction.

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Sunday Morning Thanksgiving.

The Thanksgiving Service for the King's recovery, to be held in Westminster Abbey next Sunday morning, is to be broadcast from all stations of the B.B.C., including 5SW, the Empire short-wave station at Chelmsford.

It is expected that broadcast receivers will be installed in a number of churches to enable congregations to participate in the Abbey service.

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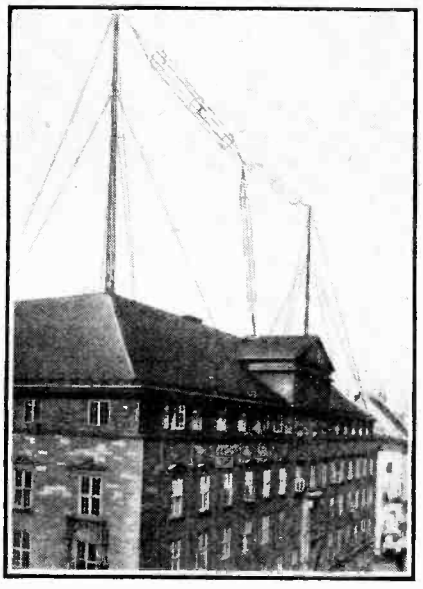
"Disclosure."

The play for broadcasting on July 11 from 2LO and 5XX is to be "Disclosure," and not Gerhardi's "Lord Brute," which was originally arranged. "Disclosure" is by O. Wyndham and Ivor McClure.

That Studio Audience.

It disturbs me to be told that the B.B.C. intends to enlarge the studio audience in the near future. The complicating factor about the studio audience is that it is always a scratch team, with no sense of the microphone and no time in which to learn studio manners. One batch of novices succeeds another, and as each is intoxicated by the novelty of the experience, laughter



NORWAY'S BROADCASTING CENTRE.
A new view of the Oslo station, which transmits on 493 metres.

and applause swamp the performance and the listener takes pot luck.

A friend of mine suggests that the "studio audience" should consist of a group of hirelings, in another room, who would clap and laugh throughout the programme. Their efforts would be "faded-in" and "faded-out" at appropriate moments.

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Bristol and the Western Regional Station.

Bristol, it seems, is doomed to disappointment in regard to the Western Regional Station. Ever since broadcasting began, the citizens of Bristol have strenuously demanded a station of their own, and in view of the fact that a site for the new Western Regional is to be chosen in the course of a few months the plea is being renewed. The B.B.C. has decided, however, that the Western Regional must be located "somewhere in Wales," probably near Cardiff. But Bristol may expect that an independent studio will be provided from which local programmes can be relayed to the regional station. It is probable that many other important cities and towns will have studios of their own.

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"Flivvers" at the Proms.

Already a skeleton programme has been mapped out for the B.B.C. Promenade Concerts. The eight weeks' season will open at the Queen's Hall on Saturday, August 10, under the conductorship of Sir Henry Wood. A feature of this year's "Proms." will be a number of new British works, the composers represented including Arnold Bax, Arthur Bliss and Herbert Howells. In some cases the composers will conduct. Two revolutionary innovations will be Honegger's "Rugby," describing the game in terms of music, and an American symphony—"Flivver 10,000,000," by Frederick S. Converse—described as "a joyous epic for orchestra." I gather that it will be a hymn to mass production.

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B.B.C. Takes the Hint.

I am glad to note that the B.B.C. has acted promptly in removing a programme anomaly to which I drew attention in a recent issue. For some time past Belfast listeners have been tantalised by Mr. Harvey Grace's Saturday talks from London on "Next Week's Music." These were broadcast from 2BE in common with other B.B.C. stations despite the fact that very little of the music referred to was included in Belfast's programme! In future, while Mr. Harvey Grace is giving his talk, Mr. E. Godfrey Brown, the musical director at Belfast, will discourse on music actually to be broadcast from that station.

The Editor does not hold himself responsible for the opinions of his correspondents.

Correspondence should be addressed to the Editor, "The Wireless World," Dorset House, Tudor Street, E.C.4, and must be accompanied by the writer's name and address.

SELECTIVITY AND QUALITY.

Sir,—A chance remark in a letter by Mr. C. W. Carr in an issue of some months ago, in which he speaks of "those many wireless enthusiasts who have plumbed the depths of sound wireless," reminded me of a problem in which very little advance seems to be made.

Whilst it is possible to obtain a very convincing reproduction from the *local* station by employing a moving coil loud speaker and a carefully designed low frequency amplifier, any attempt to obtain good reproduction on a set of high sensitivity, on the H.F. side (and consequently fairly high selectivity) ends in disappointment. I do not mean to say that it is impossible to obtain a station, some miles distant, with very fair success, but it is impossible to do justice to the capabilities of a modern loud speaker under such conditions. This of course is due to the mutilation of the side-bands in the high-frequency portion of the receiver. I should be much interested to hear the views of any of your readers on this subject, which is surely one of topical interest on the eve of the introduction of the regional scheme and the consequent necessity of selectivity in a receiver.

This seems to be a "depth" which could stand considerably more plumbing and most recent advances in receiver design (i.e., S.G. valves, low loss couplings, etc.), whilst doubtless excellent in their primary object tend to increase this defect.

I am quite aware that there are difficulties in the way, but if attention is attracted to this subject and interest created in it, radio designers may perhaps be stimulated to increase their activities in an attempt to solve this problem, and sensitivity and good reproduction may be made compatible.

London, S.E.13. R. L. SOPER.

AMATEUR STATUS.

Sir,—I must heartily congratulate you on the leading article in your June 19th issue, regarding the amateur status in this country. I am very glad you have taken it upon yourselves to voice the matter, and I trust it will be of some avail.

On several occasions your columns have proved the medium of reform. May they be so in this case.

Antrobus, Cheshire. J. SPEAKMAN (BRS 98).

Sir,—I wish to congratulate you more than heartily upon your leading article in the June 19th issue, and I am sure there are many others that think the same but will not trouble to write saying so. Regarding your last paragraph, of course, there is plenty of room, and might I suggest that you press for a band of one-metre width from, say, 12 to 13 metres and, whilst on this subject, why not press for the authorisation to use the 80-metre band which the Washington Conference gave to amateurs?

Thanking you very much indeed for your endeavours.

Burgess Hill, Sussex. "INTERESTED PARTY."

VALVE OUTPUT.

Sir,—The letters from Mr. Reeves and Mr. Bowsher are very interesting, and it is to be hoped that the valve manufacturers will adopt a standard system of calculating the power output of their valves.

If two valves are placed in parallel, then the effective impedance is halved and the output is doubled.

I am, however, not clear as to the case of two valves arranged in the so-called "push-pull" system. How does one calculate the maximum undistorted power output of two valves used in this manner? The effective impedance is doubled, I understand.

For comparative purposes three cases may be taken: (1) One PX.650 valve; (2) two PX.650 valves in parallel; and (3) two similar valves in push-pull, all with 200 volts anode voltage and −40 volts grid bias. The listed amplification factor is 3.5 and the impedance 1,750 ohms. "KEENTONO."

Blackburn.

MORSE INTERFERENCE.

Sir,—I notice that several correspondents who have written in recent issues on the above subject have taken it for granted that all Morse interference on medium-wave broadcasting stations is due to transmitters actually within the medium waveband.

In my experience, however, the strong harmonics set up by powerful wireless-telegraphy stations working on the long waves are responsible for a good deal of this interference.

The Air Ministry stations, GFA and GFB, seem to be particularly bad offenders in this respect, at any rate, as far as the London area is concerned. The former especially produces a number of remarkably strong harmonics within the 200-600-metre waveband which become painfully audible when they happen to heterodyne the carrier-wave of a distant broadcasting station.

On one evening recently, for example, I was able to read the whole of the evening shipping forecast from GFA with my set tuned to Radio-Belgique!

One appreciates, of course, that GFA and GFB conduct an important "meteo." service of forecasts and reports of value to shipping, etc., but steps might perhaps be taken to reduce the harmonic interference without seriously impairing the efficiency of the transmissions on their fundamental wavelengths. I understand that special attention was given to this matter (apparently with some success) in the case of the new transmitters installed some little time ago at Croydon Airport.

Wandsworth Common, S.W.18. W. OLIVER.

IT'S UP TO THE B.C.L.

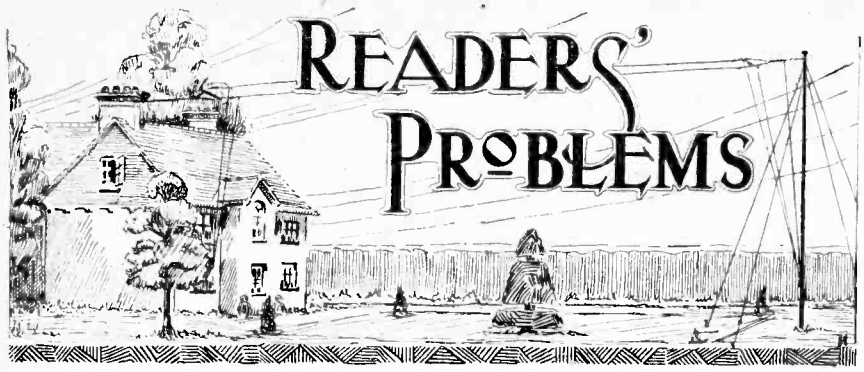
Sir,—As a keen reader of *The Wireless World* since pre-broadcast days—when your journal was "the only one" for the amateur—I deprecate the allocation of the "Correspondence" page to so much destructive criticism of the B.B.C. policy and programmes.

I assume that most readers of your paper have sufficient technical ability to bring their receivers up to date. The provision of a screen-grid H.F. stage would bring in most Continental stations worth having (and what could the B.C.L. desire better than Hilversum or Kalundborg as a suitable alternative to the occasions when the B.B.C. programme is dull?).

To jog along and grumble is like putting up with an old car and yet grousing at the limitations thus imposed. The radio licence fee of 10s. does not limit the listener to the B.B.C. programmes, and at all events the B.C.L. gets more for his money than did the old enthusiast in the days of the "Morse only" reception (*via* "crystal").

I would advise the B.C.L. to anticipate the regional scheme by having his receiver *modernised*, and thus in the meantime be able to select his own programmes instead of taking *all* that may be offered, to his surfeit, of matter indigestible.

THOS. A. FAWCETT.



"The Wireless World" Supplies a Free Service of Technical Information.

The Service is subject to the rules of the Department, which are printed below; these must be strictly enforced, in the interest of readers themselves. A selection of queries of general interest is dealt with below, in some cases at greater length than would be possible in a letter.

Choosing Inductances.

I have a number of commercial plug-in inductances marked with their values in microhenrys, and propose to use them in the construction of a loosely coupled tuner for long-wave broadcasting only. What value would be necessary to cover the band with a 0.0005 mfd. tuning condenser? E. T.

A coil of about 2,000 microhenrys should be sufficient to enable you to reach the upper limit of the "official" long-wave broadcasting band, but by using a value of, say, 3,000 microhenrys the lower limit of your range would not be unduly high; in fact, anything between the two values we have given would be fairly satisfactory.

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For Headphone Reception.

My set, intended solely for headphone reception, comprises two high-amplification H.F. stages, followed by an anode bend detector. I have seen it stated that this form of detection is not the most suitable when telephones are connected directly in the anode circuit, but prefer this method, and should like to retain it. My main difficulty is that capacity effects are troublesome; when my hand approaches the aerial end of the set a certain amount of instability is produced. I take it that this trouble could be overcome by taking steps to restrict the circulation of H.F. currents through the phones, and should be obliged if you would give me a circuit diagram of a recommended arrangement for the detector. It should perhaps be added that the set is completely screened, with the exception of the aerial-grid coil. H. B.

It is not unusual to find that "end-to-end" feed-back through stray capacities is often responsible for trouble in a high-efficiency multi-stage H.F. amplifier such as that you describe, but there should be no great difficulty in overcoming the trouble. We suggest that the detector connections should be arranged as shown in Fig. 1. An H.F. choke is inserted directly in the detector anode circuit, and a by-pass condenser, C, is shunted between plate and filament. This condenser should be as large as you can conveniently make it without impairing the quality of reproduction, and in all probability a value of between 0.0005 and 0.001 mfd. will be suitable. It is safest

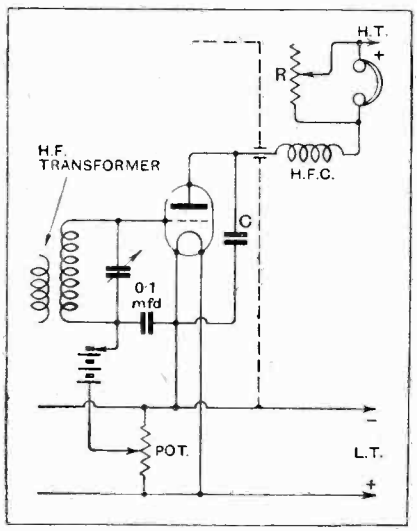

Fig. 1.—Bottom bend detector with phones in its anode circuit.

to mount the choke outside the screening box in the position shown, in order to avoid any risk of coupling between it and the detector grid coil—in this case the secondary of the H.F. transformer.

By connecting a volume control resistance, R, across the telephones, you will be able to operate the detector under the best conditions without producing excessively loud signals, and at the same time quality will be improved when the resistance is set at a comparatively low value.

We have shown, in addition to the detector grid bias battery, a potentiometer for fine regulation of voltage; this is a refinement that will seldom be really necessary with modern valves of the type used for anode bend detection, but it may be useful in a long-range set when receiving extremely weak signals.

oooo

Remote Control.

Will you please refer me to a back number of "The Wireless World" giving instructions for making a relay (for remote control purposes) with the parts of an ordinary electric bell? N. P. R.

This conversion was described in an illustrated article in our issue of July 27th, 1927. Although the relay was for a somewhat specialised circuit arrangement, giving control both of volume and of filament switching, it would be equally suitable for ordinary purposes.

A word of warning: simple relays of this kind are apt to give trouble if they are called upon to interrupt a heavy current.

oooo

Transportable Short-wave Set.

For use in West Africa, I am thinking of building a short-wave receiver in "transportable" form, complete with its batteries in a single containing case. An improvised "open" aerial will be used. On account of the climate, the current supply problem is a difficult one, particularly with regard to H.T., and I have decided to use the smallest number of inert dry cells that will give reasonable results. Can you give me an idea as to the lowest permissible H.T. voltage, and also say whether the general circuit arrangement of the original "Empire Receiver" or of the "New Empire Receiver" would be the most suitable for my particular purpose? T. C. A.

We suggest that the circuit of the original "Empire Receiver" described in *The Wireless World* of June 29th, 1927, would be the better of the two you mention. This set should give very fair results with an H.T. voltage of about 40 (25 to 30 dry cells).

RULES.

(1.) *Only one question (which must deal with a single specific point) can be answered. Letters must be concisely worded and headed "Information Department."*

(2.) *Queries must be written on one side of the paper, and diagrams drawn on a separate sheet. A self-addressed stamped envelope must be enclosed for postal reply.*

(3.) *Designs or circuit diagrams for complete receivers cannot be given; under present-day conditions justice cannot be done to questions of this kind in the course of a letter.*

(4.) *Practical wiring plans cannot be supplied or considered.*

(5.) *Designs for components such as L.F. chokes, power transformers, etc., cannot be supplied.*

(6.) *Queries arising from the construction or operation of receivers must be confined to constructional sets described in "The Wireless World" or to standard manufacturers' receivers.*

Readers desiring information on matters beyond the scope of the Information Department are invited to submit suggestions regarding subjects to be treated in future articles or paragraphs.

Parallel-feed Transformer Coupling.

Is there any reason why a volume control resistance should not be shunted across the primary winding of an L.F. transformer connected in a parallel-feed circuit? G. L. B.

This method of volume control is applicable to the "parallel" form of connection, and is applied in exactly the same manner as when the primary is connected in series with the valve anode.

oooo

Modified Screening Box.

I am thinking of making up a set on the lines of "The Flat-Dwellers' A.C. Three" for use with an open aerial, but should like to use a copper screening box measuring approximately 8in. cube, which I already have. Do you think that this would be a satisfactory substitute for the completely screened case used for the set as originally described, and, if so, will you please give me a diagram showing which components should be included in the metal case? H. D. L.

It should be possible to construct a successful set on the lines you suggest, but the use of rather less complete screening than that included in the original will entail meticulous care in "decoupling" the various circuits.

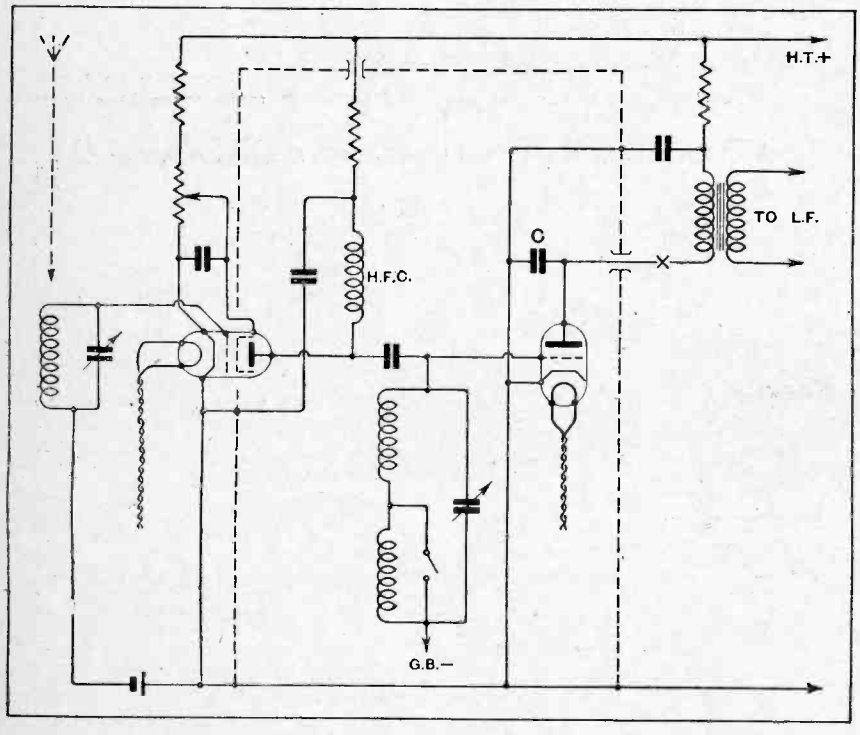

Fig. 2.—Parallel-feed H.F. amplifier, showing screened components.

The circuit diagram for which you ask is given in Fig. 2. In view of your proposed departure from the original layout we think it will probably be necessary to take more elaborate precautions with regard to the anode circuit of the detector, and it will be advisable to connect the detector anode by-pass condenser between plate and cathode of the valve, and very possibly to insert an H.F. choke in the position marked X. As an alternative to the use of a choke you could use a non-inductive resistance of two or three thousand ohms; a value of this order would not seriously reduce the amount of L.F. amplification obtainable.

oooo

Waveband Switching or Interchangeable Coils?

I have seen it stated that a receiver is considerably more sensitive when interchangeable coils are used than when waveband switching is adopted, and am consequently in doubt as to whether it will be wise to proceed with my proposed scheme for fitting wave-change switches to my set. Will you please give me your opinion on the matter? J. B. S.

We think that the statement quoted by you is unduly strong. While it cannot be denied that switching induces some small loss, the falling-off in amplification is generally so small that it is difficult to measure, let alone to hear any reduction in signal strength due to it. But there is another aspect of the question not always appreciated; a set with plug-in coils built to a given standard of efficiency will tend to be rather more compact than when a switch change-over is included. This is for the reason that in the latter type of receiver space must be allowed for two sets of coils, and, as you are doubtless aware, the efficiency of a high-frequency inductance winding is dependent to a great extent on its physical dimensions.

H.F. Transformers, Tuned Anode, or Parallel Feed?

I am at a loss to know which is the best form of H.F. coupling for my projected set. A large-capacity H.T. accumulator is to be used, and so I take it that there is no reason why I should not avail myself of the simplicity of the tuned anode method; but will this give as much amplification as a properly designed transformer?

Again, there is the parallel-feed method with an H.F. choke in the plate circuit. Is it possible for a set including this arrangement to be as sensitive as when either of the other schemes are employed? S. L. W.

It is quite impossible adequately to compare the relative merits of these methods of coupling in a few words, but, speaking generally, it is true to say that tuned anode coupling can provide as much pure H.F. amplification as any other device, although, if the valve impedance is on the low side, it will be necessary to convert the coil to an auto-transformer by "tapping down" the plate connection.

The parallel-feed method cannot give as much amplification as either of the other methods, because the choke is in parallel with the tuned circuit, and consequently is responsible for a reduction in its dynamic resistance.

In making comparisons from the point of view of amplification efficiency, it must not be forgotten that the residual inter-electrode capacity of the valve must be taken into consideration, and in practice it generally makes little difference from this aspect alone whichever form of coupling is chosen, as it is generally possible to reach the limit of amplification with any one of them.

oooo

More Magnification Wanted.

Taking into consideration the fact that I am compelled to use a very short indoor aerial, the performance of my "Everyman Four" is more than satisfactory, but there are occasions on which I should like to extend its range. Is there any simple method whereby its overall sensitivity may be greatly increased? C. D.

We fear it is inevitable that your range of reception should be somewhat limited when the set is operated with a very short aerial, and it is not possible to improve matters to an extent that is readily audible without making sweeping alterations. We assume, of course, that your H.F. valve is of an efficient modern type, and that your detector valve is both suitably chosen and correctly operated in the matter of grid bias and anode voltages.

We are inclined to make the more or less obvious suggestion that you should use as many as possible of your present parts for the construction of a "two-H.F." set; but before doing so you should try the effect of joining your aerial directly to the "grid" end of the aerial-grid transformer, and not to the normal aerial terminals. When a very short length of wire is used as a collector, this alteration often makes a very decided improvement in signal strength.

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AMATEUR STATUS.

AT a time when the United States of America is offering congratulations to its radio amateur organisations on the prosperity and strength of the movement a very different state of affairs prevails in this country and one which merits no congratulations.

We understand that at the present time there are just over nine hundred amateurs in Britain with transmitting permits. This figure shows a very definite reduction on former totals, for the number of amateurs licensed by the Post Office has stood as high as fifteen hundred only a short while back. The Post Office would no doubt say that the falling off in numbers is due to lack of interest on the part of the amateur, but we believe that whilst the interest and desire to participate in experimental transmission is still as keen as ever, the Post Office regulations have made it so difficult to conform to the conditions imposed on a licensee that the majority of amateurs are giving up their interest in disgust. We fail to see why the Post Office regulations in regard to the operation of amateur transmitting stations should be so exacting. If the amateurs were given a band within which to operate, then their own organisation would see to it that the individual amateurs would "play fair" amongst themselves, and, for the Post Office, it would be time enough to interfere when any amateur was detected working outside the band allocated for amateur use. The British amateur has always held a high reputation in the European ether.

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"OLD LAMPS FOR NEW."

SINCE the publication of correspondence under the above heading in *The Wireless World* we have received a large number of letters from readers expressing their satisfaction at the very generous attitude adopted by British valve manufacturers generally in the matter of replacements of faulty or doubtful valves. It is very pleasing to have this definite evidence of the advantage which the purchase of valves manufactured in this country offers, where the purchaser can get into direct touch with the actual manufacturer if any fault in construction should impair the life or the performance of the valve.

We do not think, however, that this attitude adopted by the manufacturer entirely disposes of the situation which prompted the correspondence already published on this subject. It will be remembered that the complaint was made that as valves were sold at present the purchaser had absolutely no guarantee that the valve had not already been in use, say, by the retailer, for demonstration purposes. Then along came another correspondent who admitted that he was able to borrow valves regularly from his local wireless dealer and return them after he had tried their performance in his experimental sets.

Sealed Valve Cartons.

We consider that it ought not to be possible for such a position to exist. It may be argued that no special precaution is taken in the case of electric lamps to prevent them from being used; but surely this is a rather different matter, since the valve is so much more fragile and much damage could be done to a valve without preventing the filament from lighting. It would seem very desirable that the valve manufacturers should devise some means of protecting the customer from the risk that the valve he purchases has been tampered with, and some special design of carton would easily give the necessary protection. Or the carton need merely be sealed in some suitable manner to prevent opening by anyone other than the purchaser.

The TUNED GRID CIRCUIT

Parallel Choke Feed Circuit in H.F. Amplifiers.

By A. L. M. SOWERBY, M.Sc.

IN the majority of cases where a radio-choke is employed in a receiver it is used in the plate circuit of the detector valve, when its function is to deflect some of the radio-frequency component in the plate circuit through the reaction control circuit. Such an arrangement is shown in Fig. 1, which shows a single-valve receiver in which the choke is placed on point-duty in this manner.

The tuned grid H.F. coupling has been rather neglected in receiver design. Is this method of H.F. amplification inferior in its results to the more usually adopted tuned anode or transformer? In this article the circuit conditions are carefully analysed and the merits of the arrangement explained.

Figures that have been given for typical commercial chokes in the section entitled "Laboratory Tests" show that the impedance offered by a choke, when shunted by the various stray capacities present in the circuit, amounts to something like ten to forty thousand ohms on the broadcast band, rising as the wavelength is increased to a maximum of perhaps 300,000 ohms at the frequency of resonance. It has been pointed out[1] that the low impedance offered by the choke to currents of the frequencies used for the broadcast band is not of moment when the choke is employed in the manner suggested in Fig. 1, for the reaction condenser also offers a low impedance at these frequencies, so that a current adequate for the provision of proper reaction effects flows through the coil and condenser shunted across the choke.

Apart from this use, and from applications in high-frequency filter-circuits of various kinds, the radio-choke has also found employment in the coupling between successive stages of high-frequency amplification, or between the last of such stages and the detector valve. Sometimes the choke constitutes the whole of the coupling, as in Fig. 2, while in circuits on the lines of Fig. 3 it is supported by the presence of a tuned circuit. The present note is intended to emphasise the radical difference between these two apparently similar circuits, and to show the behaviour of a coupling in which both a choke and a tuned circuit are included.

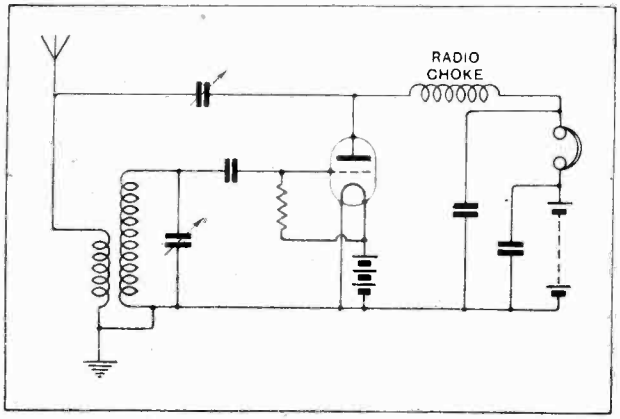

Fig. 1.—A single-valve receiver in which a radio-choke is employed to deflect high-frequency currents into the reaction circuit.

The amplification attained in a circuit such as that of Fig. 2 will be higher the higher the impedance of the components connected in the plate circuit of the valve. We must therefore have some idea of the impedance of a typical choke at various wavelengths before we can make any very confident statements about the degree of amplification to be expected from such an arrangement. The impedance curve of a typical choke is reproduced in Fig. 4, from which it will be seen at a glance that over the lower broadcast band of wavelengths from 200 to 600 metres the impedance is low. We can, therefore, state with perfect certainty that the amplification that can be extracted from the circuit of Fig. 2 is also low, being only a fraction of the amplification factor of the valve.

If we compare the circuit of Fig. 3 with that which we have just been discussing, we see that the only change is that now a tuned circuit replaces the grid leak.

Choke Coupling *v.* Tuned Grid.

Since there is no objection to using a grid leak of five megohms if we so desire, while the dynamic resistance of a tuned circuit can only with difficulty be raised as high as one-tenth of this value, it would appear reasonable to suppose that the total impedance between plate of V_1 and earth in Fig. 3 would be even lower still, and that the amplification of this arrangement would be even less than in the preceding case.

This mode of viewing the circuit is really based on the well-known fact that if two resistances are placed in parallel more current flows through the two than would flow through either alone, so that the combination has a lower resistance than either of its component parts. It is not safe, however, to apply these direct-current notions to alternating-current problems, and in the present instance the result of so doing has been to lead us to an utterly erroneous conclusion. A slightly more detailed examination of both circuits will bring to light the fallacy in our reasoning.

When the choke stands alone, as in Fig. 2, the

[1] "H.F. Chokes," *Wireless World*, Sept. 26th, 1928, page 372.

The Tuned Grid Circuit.

...uit of the valve is simply ...el with a selection of stray ... and coupling condenser, if ...y chosen, make so trifling a ...l impedance between the anode ... they may be neglected altogether. ...hat if the high-tension supply is ... condensers, as is usual, "H.T.+" ...me high-frequency potential as the filament of the valve, Fig. 2 may be simplified down to the skeleton diagram of Fig. 5. In this simplified diagram the H.T. battery is omitted, and C and r have been inserted to represent respectively the total stray capacities and the high-frequency resistance of the radio-choke, the inductance of which is indicated by L.

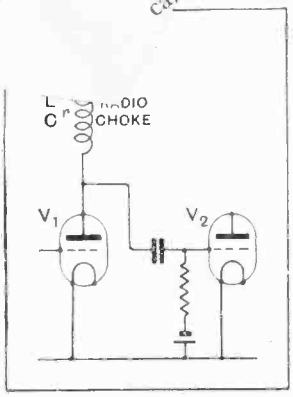

Fig. 2.—H.F. stage in which a radio-choke is the sole coupling between the valves. Compare Figs. 3 and 5.

The stray capacities, which include the stray capacity of the choke itself, amount altogether to a very respectable number of micromicrofarads — perhaps 20 to 25—while the inductance of the choke is usually in the neighbourhood of one or two hundred millihenrys. Since the resonant frequency of an average choke, even outside the set, is found to correspond with a wavelength of two or three thousand metres, one might expect that on the broadcast band it would behave chiefly as a condenser.

Low Impedance of Choke Coupling

If we now consider the impedance value to 300-metre signals of the capacity suggested as typical we obtain a figure of 7,000 ohms, while the impedance offered by the inductance is nearly a megohm. Clearly, practically the whole of the high-frequency plate-current of the valve will flow through the stray capacity, and the inductance will play practically no part in determining the behaviour of the circuit at wavelengths within the lower broadcast band. From the high-frequency point of view we may therefore ignore the L, r branch in Fig. 5, and consider the plate circuit as containing only the capacity C.

It is not necessary, for our present purpose, to go into the figures for amplification that will be obtained for such a circuit. It is enough to point out that 7,000 ohms is far too low an impedance to provide amplification anywhere approaching that obtainable from even the worst tuned stage, and to bear very carefully in mind the fact that on the broadcast wave-band the choke behaves exactly as though it were a small condenser.

Following the same method that we have already used in analysing the circuit of Fig. 2, we can reduce that of Fig. 3 to the scheme shown in Fig. 6. This, as might be expected, is simply Fig. 5 with the tuning coil of inductance L_1 and resistance r_1, and the tuning condenser C_1 connected in parallel with the choke. The full analysis of the behaviour of such a circuit would lead to mathematical complications of the most alarming description, without yielding, so far as one can see, the smallest scrap of useful information. We will, therefore, content ourselves with a commonsense qualitative discussion of it, which will be equally useful, and will be very much less like hard work.

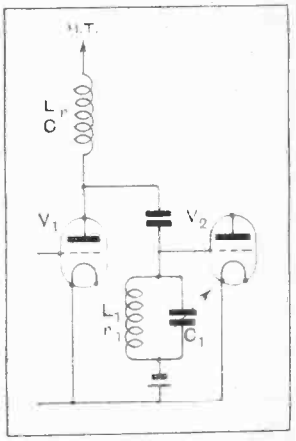

Fig. 3.—Circuit differing from Fig. 2 in that a tuned circuit, of dynamic resistance perhaps of 0.25 megohm, replaces a grid leak. Nevertheless, the total impedance between plate of V_1 and filament is greater, not less.

In the first place, we have already seen, while investigating Fig. 5, that the branch L, r, representing the inductance and resistance of the choke, amounts to an impedance of about a megohm. In comparison with the much lower impedance of C, the stray capacities, we can therefore proceed to forget this branch completely. Imagining it removed, we are left with nothing but the stray capacities C of which the stray capacity of the choke itself is but a small part, in parallel with a perfectly ordinary tuned circuit of the familiar "tuned anode" type. These stray capacities will have no other effect on the tuned circuit than that of compelling us to use a lower setting of the tuning

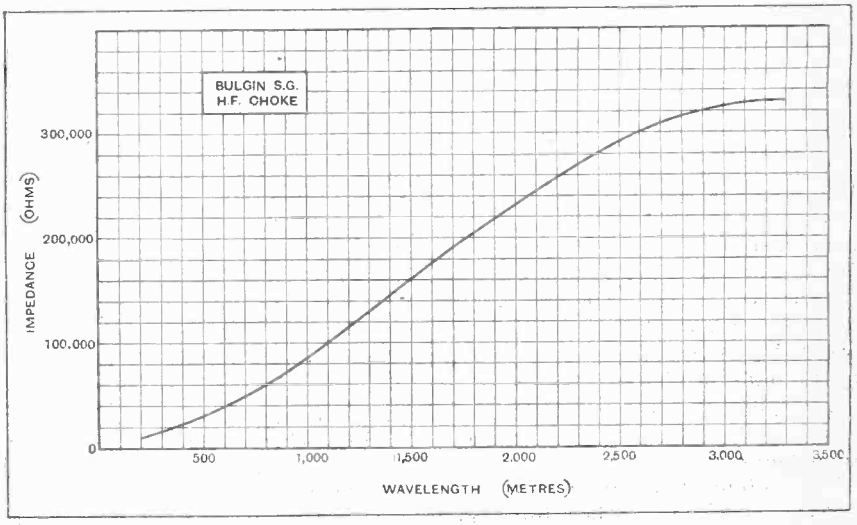

Fig. 4.—Impedance curve of H.F. choke (Bulgin). External capacity, 8 micromicrofarads.

The Tuned Grid Circuit.—

condenser C_1 than would have been required, for the same wavelength, if they had been absent, for the total tuning capacity in the circuit is made up of C_1 and C in parallel. The whole complex circuit lying between the points X, X is thus equivalent to a simple tuned circuit of the most everyday kind, so that we may regard the circuit of Fig. 3 as being nothing more than a variant of the simple tuned anode arrangement.

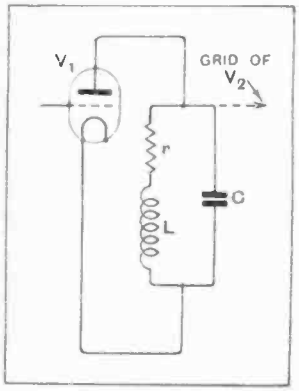

Fig. 5.—Simplified "skeleton" diagram of the circuit of Fig. 2. C represents the total of stray capacities in the plate circuit of V_1.

The fallacy in the argument that by putting a tuned circuit in parallel with the choke the maximum total impedance could not be made to exceed that of the choke alone now stands revealed. Any tuned circuit consists of two impedances (coil and condenser), both quite low in value, but opposite in sign. At the wavelength to which the circuit is tuned, they are in addition equal in magnitude, so that their effects cancel out almost completely, leaving a high impedance for the combination of the two. The choke, when used alone on the broadcast band, provides, as we have seen, only one of these impedances; by the addition of the other (the inductance L_1) this can be cancelled out for any one wavelength, while the introduction of the condenser C_1 provides the finishing touch by making it possible to obtain the balance at any frequency within the tuning range.

Losses Arising in the Choke.

Although the introduction of the choke does not affect the *general* behaviour of the tuned circuit, we must not too hastily jump to the conclusion that the tuned circuit of Fig. 3 is completely unaffected by its presence. If the inductance of the choke were infinitely high, its resistance zero, and its stray capacity entirely free from losses, this would indeed be the case. The fact that none of these impossible conditions is fulfilled in any choke results, like any other deviation from perfection, in increasing the effective resistance r_1 of the tuned circuit L_1C_1, and so flattening the tuning a little and decreasing slightly the amplification attainable.

The magnitude of the resis[illegible] choke is not very great, though [illegible] quite perceptibly the performance o[illegible] all other losses have been kept to th[illegible] value. Measurements that the writer [illegible] various times indicate that the best of the [illegible] chokes are equivalent on the lower broadcast [illegible] resistances of the order of one megohm connec[illegible] parallel with the tuned circuit. This figure, howe[illegible] is subject to quite wide variations, the lowest and highe[illegible] of which records are to hand being respectively 350,000 ohms and 4 megohms for the same choke on different but neighbouring wavelengths.

"Back-coupling" Avoided.

It is at least safe to conclude that the circuit of Fig. 3 will give a little less amplification than the corresponding tuned anode circuit, so that when it is desired to extract the utmost amplification from a screen-grid valve the simple tuned anode is preferable. As this is inclined to lead to difficulties unless high-tension accumulators are used to supply the anode current, one is generally compelled to employ either a high-frequency transformer or choke-feed, as in Fig. 3, either of which will help towards "de-coupling" the various anode circuits of the receiver, and both of which tend to lessen amplification a little.

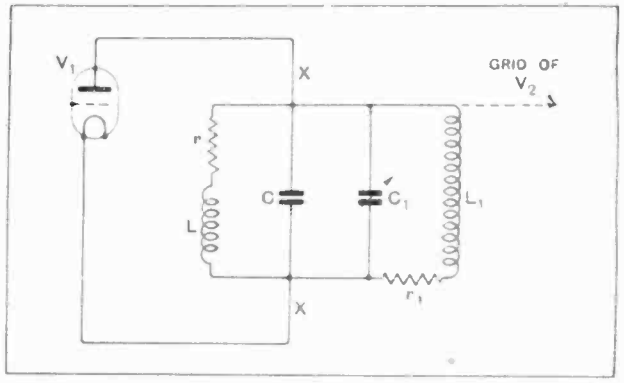

Fig. 6.—Skeleton diagram of the circuit of Fig. 3. The connection between the two can be traced by the lettering, which is arranged to correspond.

Whether choke-feed or transformer coupling is the better alternative it is at present hard to say, but there can at least be no doubt that the use of a radio-choke in this connection is a matter which calls for more detailed investigation than it has yet received.

A.C. SCREEN-GRID VALVES.

MAINS operated valves mounted on standard bases but with the addition of a fifth centre pin were described in a recent issue. Apart from the convenience derived by the substitution of mains in place of the L.T. accumulator, other important advantages are worthy of attention. Owing to the absence of a potential drop such as exists across the filament of the battery operated valve, the electron stream becomes less restricted. This effect is, of course, due to the absence of a magnetic field near the emitting surface. In consequence greatly improved characteristics are possessed by the new screen-grid indirectly heated valves apart from those advantages due to a more generous source of current supply.

Readers will have already appreciated the enormous H.F. stage amplification which can be obtained from the A.C./S valve, and it is therefore interesting to note that there is shortly to appear on the market an extensive series of A.C. screen-grid valves having amplification factors from 400 to 1,000 combined with high impedance. With such characteristics it is possible to attain a stage amplification of over 200. H.F. amplification should now enter upon a new era of prosperity.

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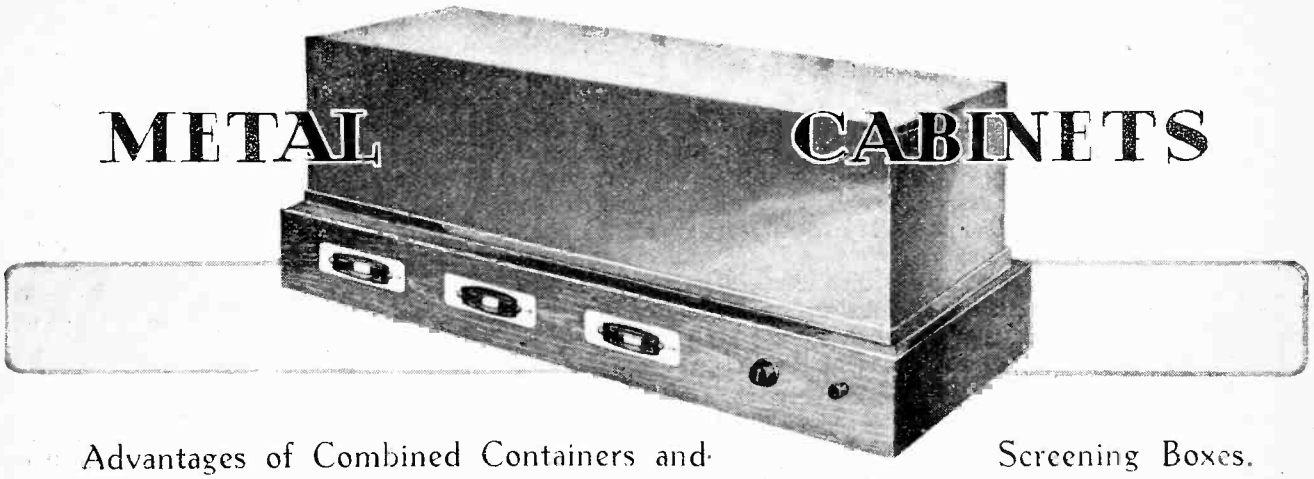
METAL CABINETS



Advantages of Combined Containers and Screening Boxes.

RECEIVERS with screen-grid H.F. amplifying valves call for more extensive screening than those in which neutralised triodes are used. This is one of those sweeping generalities that are so dangerous when applied to technical wireless matters, but in this case, and speaking from a strictly practical point of view, the statement may be allowed to stand without qualifications. Every serious wireless worker, after having made initial tests of his first eagerly awaited S.G. valves, must have come to the conclusion that, in order to get an amplification equal to, not to say in excess of, that afforded by ordinary triodes with good interstage couplings and comparatively simple screening, it was essential to take meticulous care to minimise interaction between circuits.

If our experimenter was in any way concerned with the design of sets for home construction, his findings in this matter probably gave rise to some regrets, as the need for elaborate screening obviously tended to offset the advantages of the new valve in the way of its capability to provide good amplification with small, simple and inexpensive coils. There can be no question that screened sets on more or less conventional lines are none too easy to build, as compared with their comparatively simple prototypes of a few years ago; not only does the average amateur find that metal is a difficult material in which to work, but he also learns that components inside a screening box are always more or less inaccessible, and consequently difficult to wire.

Five Hundred Times Amplification.

This trouble of inaccessibility can be overcome by making the box in sections, and so arranging matters that the sides and back are secured in position after all, or at any rate most, of the wiring is done. But again we come up against a drawback: present-day practice inclines always towards higher and higher amplification—both per stage and overall—and in a highly efficient amplifier screening is often found to be inadequate unless all joints are well and truly "closed" in such a way that an electrical seal is formed. This condition can hardly be realised if the box is built up of sheets bolted together, although a fairly satisfactory screen of this kind can be devised for a single H.F. stage of which the amplification does not exceed some 50 or 60 times, provided some care is taken in the disposition of components.

It seems probable that in the near future we shall expect—and get—an amplification of something like 500 times from a single stage, helped, of course, by neutralisation and the use of the most modern high-efficiency valves. Preliminary experiments with this kind of high-frequency amplifier would indicate the need for mounting the valve in such a way that it is not affected by the field of the coils, and in any case this precaution must almost always be observed when building a two-stage amplifier designed for a reasonably high degree of sensitivity. Consequently, it becomes necessary to devise some form of "outboard" mounting, which tends considerably to increase the bulk of the set and also to mar its workmanlike appearance.

The Demand for Better Screening Boxes.

But enough of this jeremiad; let us close our tale of woe on the economic note. A three-compartment screening box, to be more or less self-supporting and capable of performing its functions in a "high-gain" set, must of necessity be fairly rigidly built, and in consequence will not be cheap. Adopting a conventional method of construction, we find that the majority of the surface area of the insulating panel will be completely wasted, and that a large and comparatively costly cabinet will be necessary to house the whole set, of which the bulk has perhaps been increased by excrescences in the form of projecting valves.

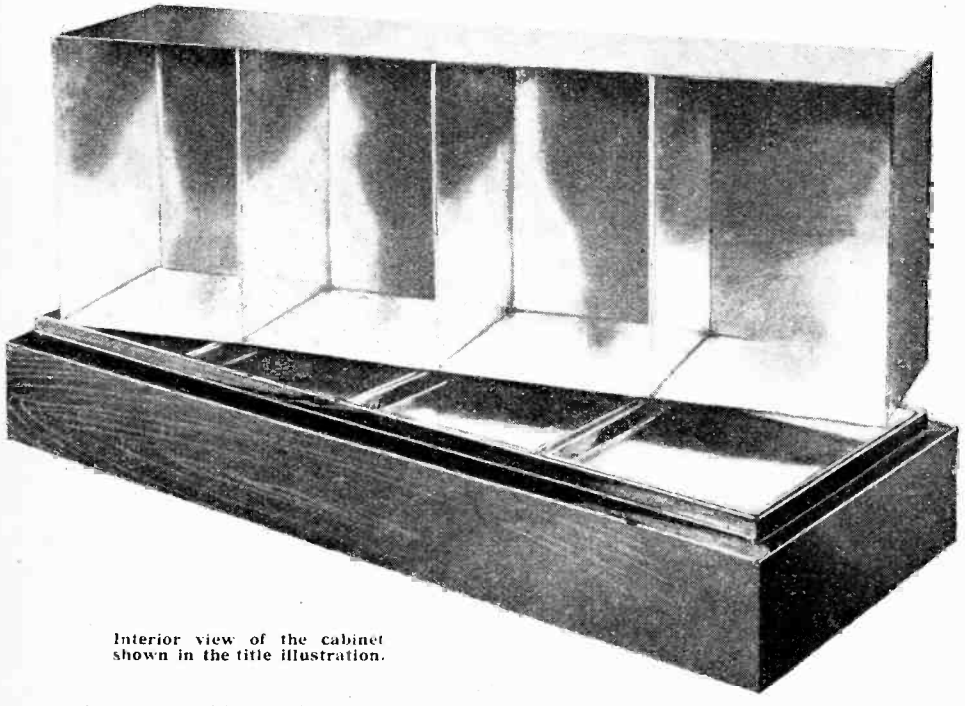
The remedy for all this seems to be fairly obvious: What is needed is an inexpensive all-metal, or a wood-and-metal case combining the functions of screen and container. It should be designed to give reasonably good access to the components, must be efficient electrically, and should be at least sufficiently inoffensive to the eye to merit a place in a living room, even if it cannot hope for the *entrée* into more formal surroundings. Those whose wireless sets must look like something other than what they are may be satisfied by the addition of ornamental woodwork camouflage, at, of course, an increased price.

As far as the present writer is aware, thought has not been extensively devoted to the design of containers to

Metal Cabinets.—

comply with these requirements, although the matter has had the attention of the technical staff of *The Wireless World*, to whom the present-day constructional difficulties in the way of the set builder are a matter of very real concern. It is probably easier than ever it was to make a good set, judged by ordinary standards; only when we come to consider receivers with outstanding performance as distance-getters does the necessity arise for exceptional care in screening.

The experimental metal cabinets of which illustrations accompany this article were intended to accommodate (1) a four- or five-valve set with two H.F. stages; (2) a four-valve set with a single highly efficient H.F. stage and a separately-tuned aerial circuit; or (3) a three-valve A.C. mains set with a similar aerial tuner, its H.T. eliminator, and with a single neutralised H.F. stage giving



Interior view of the cabinet shown in the title illustration.

the maximum possible amplification. The first container, shown on the next page, had four separate compartments in its upper section, while the base (extended to give stability and weight) was open, and was intended to accommodate H.F. valves, all low-tension wiring, and such components that do not need special screening. Its upper section was divided diagonally, and the part forming a lid was hinged along its lower rear edge. This form of construction gave good accessibility; anticipating unfavourable criticism of the appearance, it should be said that it was improved in this respect by replacing the engine-turned finish by a coating of matt-surface enamel. Even with this improvement the cabinet did not prove a success; it was by no means cheap to build, and it was a difficult mechanical problem to arrange a good electrical contact along the diagonal edges of the transverse partitions, while the mounting of components involved the drilling of a number of holes (some in awkward positions) through the metal base and partitions.

This design was finally abandoned in favour of that shown in the remaining illustration, and at the head of this article. The base is a shallow box of oak, $\frac{3}{8}$in. thick, open at the bottom, and with a top of $\frac{1}{4}$in. plywood, over which is placed a sheet of metal carrying separate trays for each compartment. Strips of metal bent at right angles are soldered to the metal sheet so as to form channels round the edges of the trays; into these channels are inserted the edges of the metal cover and also of its partitions.

Preventing Circuit Interaction.

There are several methods of ensuring a good electrical seal at the junctions between cover and base. It is possible to turn over the lower edges of the former, making saw cuts at frequent intervals so as to increase the natural springiness of the metal, or to adopt a similar procedure with respect to the edges of the trays and angle pieces. Alternatively, strips of braided metal tape, preferably bent to a U-section, may be laid along each of the channels, to serve as a form of flexible gasket.

Tinned sheet steel was used in the construction of the cabinet illustrated, and there seems to be no valid reason why this cheap and convenient material should not serve the purpose, provided that steps are taken to allow reasonable spacing between inductance coils and metal work.

It is intended that the removable cover should be entirely free from components, all apparatus requiring thorough screening being mounted on the upper trays, while other gear is secured either to the inner surfaces of the wooden plinth or to the lower surface of its plywood top. As in the case of the earlier cabinet, screen-grid high-frequency valves are also housed in this space, which will also accommodate a number of subsidiary parts for which room cannot be conveniently found in the screening boxes.

All controls are fitted to the front panel of the plinth base, and here we come to the one disadvantage of the scheme; as a matter of fact, this disadvantage is probably more apparent than real, and most of the seeming difficulties disappear if conventional methods are abandoned.. Tuning condensers are fitted with their spindles vertical and passing through the metal trays and plywood sub-base: unfortunately standard dials are unsuitable, but edgewise dials of large diameter can

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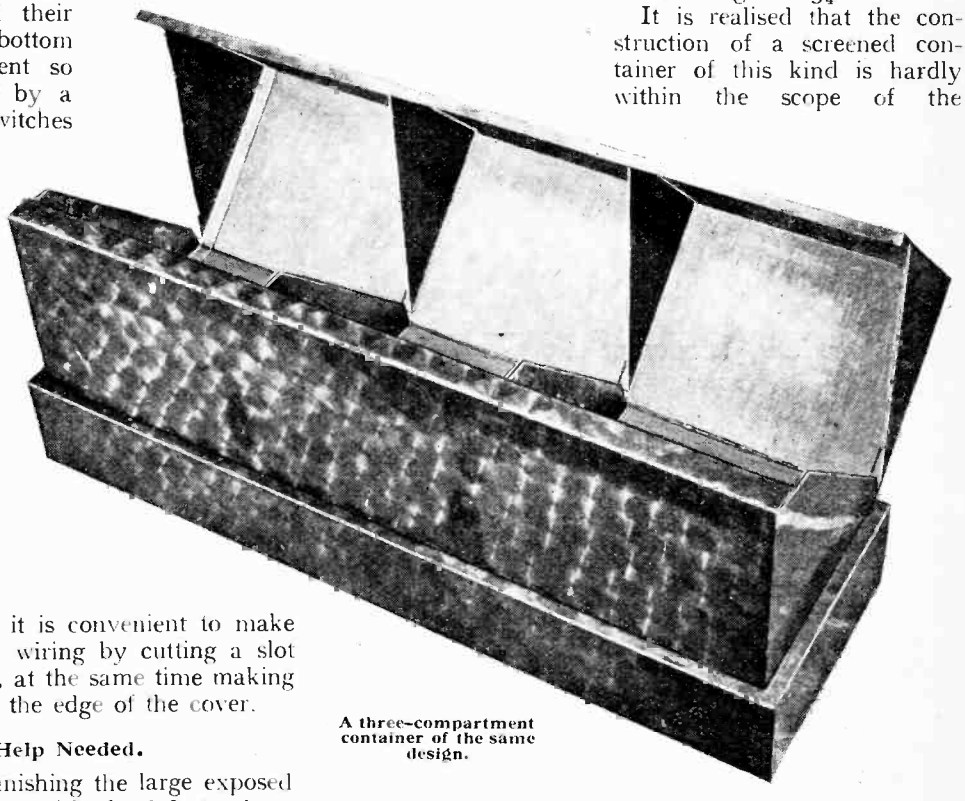
be used, and will provide more than sufficiently accurate control for any tuning circuit likely to form part of a modern set.

Waveband switches present another minor problem which is easily solved; these components can be fitted with their levers projecting through the bottom of the screening compartment so that they can be controlled by a push rod. Where several switches are used, their levers are coupled to a single long rod terminating in a knob projecting through the side of the plinth.

A neutralising condenser is secured in a similar manner, but, frequent adjustment not being required, it is sufficient if access to the knob can be obtained by tilting the entire receiver backwards.

A screen-grid valve itself provides an interstage connection, but where neutralised couplings are used, and for any "danger" leads between compartments, it is convenient to make one or two small tunnels for wiring by cutting a slot through the sides of the trays, at the same time making a corresponding depression in the edge of the cover.



A three-compartment container of the same design.

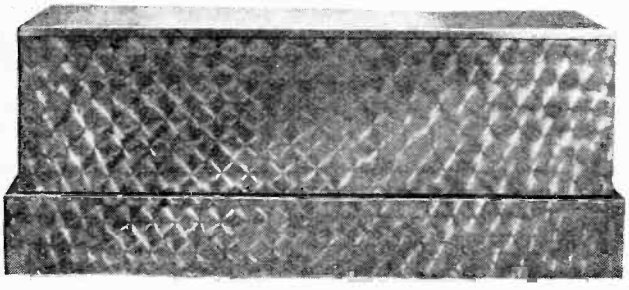
Manufacturers' Help Needed.

There is a wide scope for finishing the large exposed metal surface: this detail can safely be left to those interested, and it will be enough to say that a set built on the lines suggested can be both neat and workmanlike; having decided upon the general principles of construction, it should not be a difficult matter to improve the appearance of the cabinet.

The metal cover and base shown are well within the capabilities of a tinsmith, and, complete with a suitable wooden base, should compare more than favourably in cost with the conventional cabinet, panel, screening boxes, and baseboard which they displace.

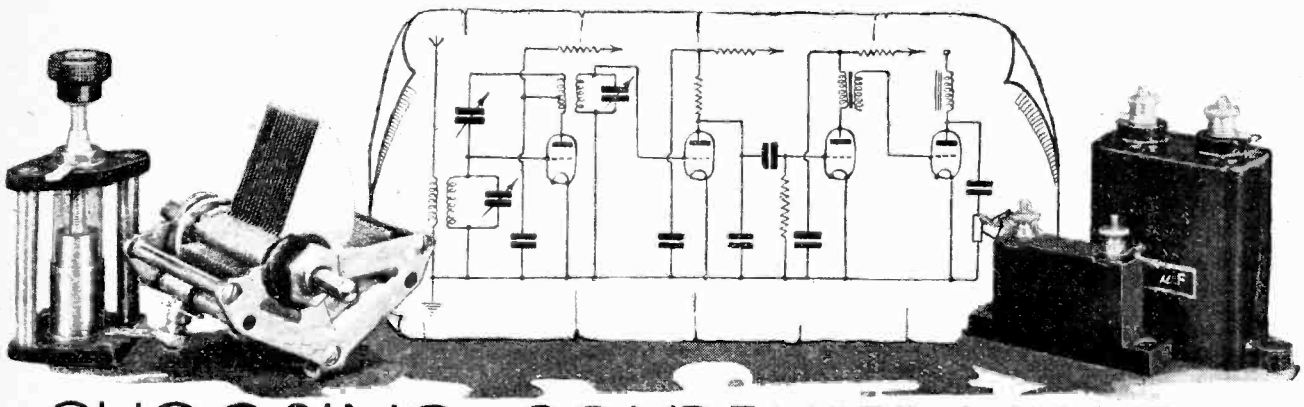
As already indicated, a cabinet as shown should have a wide range of application in the building of sensitive and comparatively ambitious receivers; in order that its usefulness may not be restricted, it is suggested that the inside dimensions of each of the four compartments should not be appreciably less than 7in. wide, 7in. high, and 9 or 10in. deep. The space inside the base should have a height of $3\frac{1}{4}$in.

It is realised that the construction of a screened container of this kind is hardly within the scope of the average amateur, but it is reasonable to hope that manufacturers will turn their attention to the commercial production of something on the lines suggested—modified, perhaps, to fall in with their own methods. Made in fair quantities, the price should be well below that charged by a sheet metal-working firm for making a single specimen to order. If suitable drum dials also become available, our remaining difficulty should disappear.



An all-metal cabinet with diagonally divided internal screens.

While these cases are, as already stated, of greatest value for accommodating the highly sensitive type of receiver, it must not be thought that they are without their uses when simpler sets are in question. For a three-valve "H.F." set of fairly conventional design a container with overall dimensions (excluding base) of some 18 to 20in. wide, 7in. high, and 8in. deep should prove suitable; the H.F. stage could easily be made sufficiently "good" to enable the constructor to obtain practically the theoretical maximum obtainable magnification, which is seldom approached when conventional methods of screening are adopted. This cabinet would be divided into two compartments, that at the input end of the set measuring some 7in. in width. An intermediate size, with three separate compartments, would also be useful; one or other of these suggested cases should be adaptable for any of the high-efficiency sets made possible by improved valve designs.



CHOOSING CONDENSER VALUES

How Incorrect Values Adversely Affect Receiver Performance.

By N. P. VINCER-MINTER.

IN a wireless set there are usually a considerable number of condensers, all of which have certain vital duties to perform. In no case, however, can one assign a definite value, except, perhaps, for the grid condenser of a leaky grid detector, which on the broadcast wavelength is usually specified as 0.0003 mfd. and advisedly so. If one takes an average set, which is probably a four-valve instrument consisting of one H.F. stage, be it triode or tetrode, detector, one R.C. stage, and one transformer-coupled stage, the total number of condensers used will average almost a dozen in number.

The first of these is the one usually placed in the aerial-lead in. The value usually assigned to this, if one be used, is 0.0001 mfd., although this is purely an arbitrary value. Using this value, one loses quite an appreciable amount of signal strength on long wavelengths in return for the selectivity gained, and it is advantageous to use in this position one of the small solid-dielectric variable condensers now on the market for this purpose. No losses need be feared as the result of the solid-dielectric, since the aerial circuit will in any case possess considerable damping.

0.00025 or 0.0005 ?

The condenser C_2 (Fig. 1) used for tuning the grid circuit of the H.F. valve should have a maximum value of 0.0005 mfd. for best all-round results on the normal broadcasting wavelengths. When choosing a condenser for this position it is imperative to choose one having as low a minimum as possible. If rather more voltage build-up is desired, together with a rather less crowded tuning scale, a 0.00025 mfd., 0.0003 mfd., or a 0.00035 mfd. condenser should be used. It must be remembered that in such a case selectivity will be rather less, and the frequency range covered by the tuning circuit will be curtailed.

C_4, which serves to by-pass energy across the grid battery, should be sufficiently large to by-pass all H.F. energy direct to filament negative. In other words, its reactance to the lowest radio frequencies with which the set is designed to deal must be very low. A 0.1 mfd. condenser is fully large enough here, but if the home constructor happens to have a spare condenser of larger value " by him " it may be used. If the set is properly laid out and the grid cell mounted so that all leads are as short as possible, it may have a lower value, such as 0.01 mfd., but it is inadvisable to attempt to dispense with it altogether in the case of a modern receiver, even if only one H.F. stage is used.

A Wasted Condenser.

Now matters are quite different when we come to the question of condenser C_{13} (Fig. 2). This is only shown in the circuit because so many people insert one in this position, thus wasting a condenser which could serve a useful purpose elsewhere. It will be realised that in this position the condenser is merely acting as a by-pass to a certain portion of the potentiometer which shunts the detector valve filament. Now we are not considering the case of a grid return lead which passes to the same grid battery as do similar connections from other valves, in which case it might be necessary to " decouple " all grid bias leads. Here we are merely considering a straightforward resistance which to all intents and purposes is non-inductive and which is associated with the grid circuit of one valve only. C_{13}, therefore, is totally unnecessary.

The value of C_8 is of very great importance, and on it hangs to a large extent the ultimate quality given at the output terminals of the receiver. The value of this condenser depends from the quality point of view upon, *inter alia*, the A.C. resistance of the detector valve. If we adopted the custom so rampant in 1926 of using a valve of very high A.C. resistance and amplification factor, as detector in conjunction with a very high anode resistance, the presence of this condenser even if only of 0.0001 mfd. value would result in serious attenuation of the upper musical frequencies, which itself gives rise to dull and lifeless reproduction in

Choosing Condenser Values.—

general, coupled with "woolliness" in speech.

In this circuit the H.F. choke is supposed to deflect most of the H.F. energy in the plate circuit via C_8, whilst R_3 deflects the L.F. energy via C_7. Now if C_8 (which at any given frequency acts as a resistance, the rule being the higher the frequency, the lower the effective resistance) is comparable in resistance value at the upper end of the musical scale to the complicated network formed by R_3, C_7 and R_6, then obviously many of the upper musical frequencies are by-passed by C_8 and never reach the L.F. amplifier. It will probably be clearer if we ignore the H.F. choke and simply consider what we will call the R_3 network and C_8 as being two resistances in parallel at a certain given frequency. It will be obvious that the energy at any given frequency in the plate circuit of the detector valve will divide itself equally in proportion to these resistances; as we want as much of the energy associated with the upper speech frequencies as possible to take the alternative path, it behoves us to keep the resistance of C_8 at any given frequency as high as possible. This means that the *capacity* of C_8 must be kept as low as possible.

Now, it will occur to us that if we cannot, for other reasons, use too low a capacity (i.e., too high an effective resistance) at C_8 we can accomplish the same thing by lowering the resistance of the alternative path. This is precisely what we actually do in practice, and it will be found that if the value of the anode resistance R_3 is not greater than 250,000 ohms, a value of 0.0001 mfd. is permissible at C_8, although it will be far better to use only 100,000 ohms at R_3, which from our preceding arguments we know now to give the same beneficial effect in quality as if C_8 had been made of much smaller capacity. It may well be asked at this juncture, why not dispense with C_8 altogether? What useful purpose does it serve? This exact functioning of C_8 is far too vast a subject to be dwelt upon here, and must be left to a later date. Suffice to say that if C_8 is too small the detrimental effect on signal strength will be serious. If we are out for signal strength regardless of quality it will pay us to increase the value of C_8 to 0.0005 mfd. on the normal broadcasting wavelength, although a higher value than this will result in no further improvements except on longer wavelengths.

Coupling Condenser Complications.

With regard to condenser C_7 the value of this depends on the value of R_6. We have neither time nor space to dwell on the factors which determine the value of R_6 itself, but it is quite easy from our arguments in connection with C_8 to indicate in what manner C_7 and R_6 are interdependent. It is necessary to consider C_7 as being merely a resistance in series with R_6. We thus have two resistances in series. Care is taken to so arrange the value of C_7 that at the lowest musical frequency with which it is intended to deal, its resistance is small compared to that of R_6. Now, small resistance means large capacity, and it would seem, therefore, as though it were best to use as large a condenser as possible at C_7. Actually, the electrical size or capacity of C_7 is limited by the fact that it will unavoidably become charged up occasionally by a strong atmospheric or signal, and if it is too large it will not become discharged before the next impulse comes along.

It will be seen, therefore, that although we are in this case dealing with resistances in series our argu-

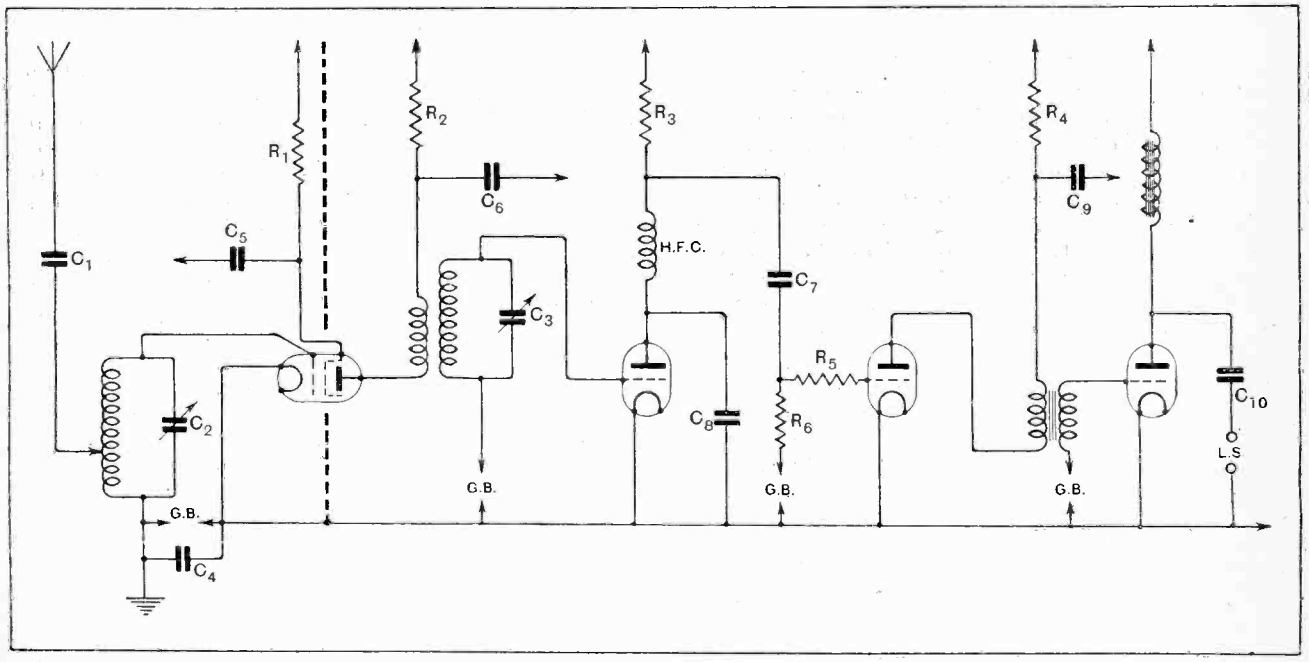


Fig. 1.—A modern four-valve set with decoupling arrangements.

Choosing Condenser Values.—

ments in the case of C_8, where we were dealing with resistances in parallel, have greatly helped us. In practice, if a value of 2 or 3 megohms is used at R_6, C_7 should be about 0.01 mfd. in value in order to preserve the correct relationship between R_6 and C_7, and these values are the most commonly used. Many people, however, prefer to use 0.1 mfd. and 0.5 mfd., although they gain nothing thereby, assuming the grid-leak resistance is of the value given here.

With regard to C_{10} it is said by some schools of thought that it is only necessary that its value be such that it offers a very low impedance to the lowest note to be reproduced in comparison with the impedance offered by the loud speaker, and so a value of 4 mfd. or 6 mfd. is usually assigned to it. In practice, however, owing to the importance of correctly reproducing transients in order to give pleasing overall reproduction to the ear (which, after all, is the thing we are trying to please) a 2 mfd. condenser is usually to be preferred.

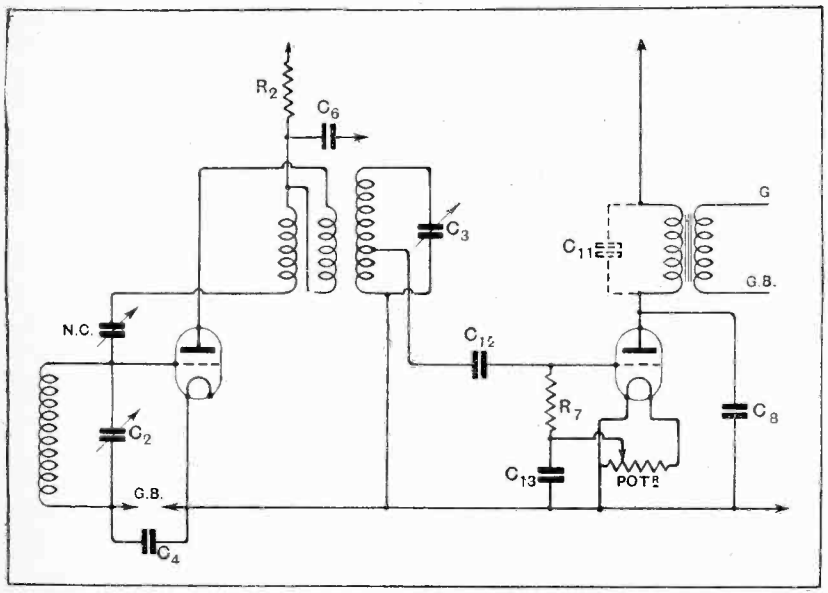


Fig. 2.—The same circuit as in Fig. 1, employing a neutralised triode H.F. amplifier and a leaky grid detector.

Importance of By-pass Condenser.

If we substitute a neutralised triode in place of an S.G. valve and use a leaky grid detector in place of anode bend, as in Fig. 2, no change will result in any condenser value except that of C_8, while the neutralising condenser, the grid condenser, and the condenser shown in dotted lines at C_{11} are newcomers. The neutralising condenser can be speedily dismissed from our minds as experience has taught us that it should have a maximum capacity of about 40 micro-microfarads, and be fairly accurately adjustable. The grid condenser has been referred to earlier in this article, and so it only remains to discuss C_8.

Now, in the first place, it should be said that there are some transformers on the market which have built into them a fixed condenser of 0.0003 mfd., which is connected in shunt with the primary. The instrument has in many cases a highly beneficial effect on the lower musical frequencies, and in such cases C_8 should be left out, and a decoupling condenser and resistance used in the plate circuit of the valve between the transformer primary and the H.T.+ connection to prevent A.C. entering the H.T. battery. This should not be taken to mean that such an arrangement is not desirable when the transformer has no built-in condenser. If the transformer is of a type not incorporating one of these instruments, it becomes highly desirable to use a condenser at C_8. Its value depends on the inductance and self-capacity of the primary. It is very unsafe to dogmatise on the value of any condenser used in this position, fully as dangerous, in fact, as it is to do so on the value of the grid condenser, and one can only say that, as a result of much experimental work, if a condenser of 0.0003 mfd. to 0.0005 mfd. is chosen it will be found to be a very effective compromise.

"Decoupling" Condensers.

With regard to condensers C_5, C_6 and C_9, these are, of course, part of the decoupling arrangements, and not concerned with the set proper. It is quite beyond the scope of this article to enter into the question of the values of these, except to state, in a purely arbitrary manner, that in the majority of cases a value of 2 mfd. is ample. The reader who has had the patience to read thus far, however, will readily grasp the fact that again we have to consider two resistances in parallel, as in the original case of C_8 and the network associated with R_3. It is solely a question of keeping the resistance due to the condenser at very low frequencies, small compared with the decoupling resistance, which, of course, is virtually in parallel with it.

The fact that values of 20,000 ohms and 2 mfd. are usually given for these two components respectively, will however, have undoubtedly been observed by readers. It is simple to find out the resistance of any condenser at any given frequency by using the well-worn condenser reactance formula. At fifty cycles, for instance, we find that the condenser is equal to a resistance of approximately 1,600 ohms. We thus have two paralleled paths for our fifty-cycle energy, one of 20,000 ohms and one of 1,600 ohms, and this energy will divide itself in inverse proportion to these resistances. It is now clear that a relatively small proportion of the A.C. energy passes through the H.T. battery or other source of H.T. supply. It will be arithmetically obvious that at higher frequencies the proportion is much smaller, so much so that in H.F. circuits where we are dealing with very high frequencies indeed, there is no need to use an anode feed resistance greater than 600 ohms. No harm, but rather a benefit, will result by using condensers larger than necessary, but using a high value of feed resistance will cause the dropping of vital volts.

The "Breaking Up" of LOUD SPEAKER DIAPHRAGMS

An Analysis of the Modes of Vibration of the Diaphragm.

By N. W. McLACHLAN, D.Sc., M.I.E.E., F.Inst.P.

WHEN the coil-drive loud speaker arrived there was much talk about "piston-action." The diaphragm, freely mounted at its periphery and driven by a member without constraint, was likened to a piston, the whole contraption moving bodily to and fro in a cylinder, so to speak. Such notions are

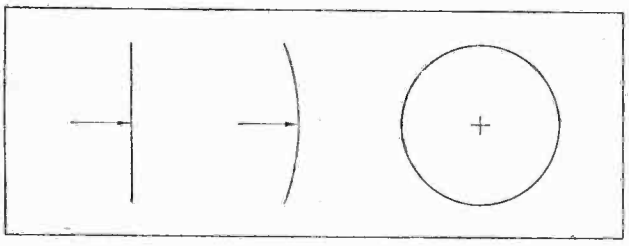


Fig. 1.—The bending of a disc of paper when acted on by a force at its centre.

very nice when endeavouring to explain matters in an elementary way, but the precise state of affairs is vastly different. Doubtless this pristine belief in piston action has led many people astray, and it is about time the illusion was shattered. For those who have studied Chapters IV and VIII in "Loud Speakers" the illusion probably never existed.

Let us take some simple examples by way of initiation into the mystery. A conical diaphragm is made from a thin sheet of paper. Imagine we have the original circular disc before the sectorial portion is removed to form a cone. Mount the circle on a compass

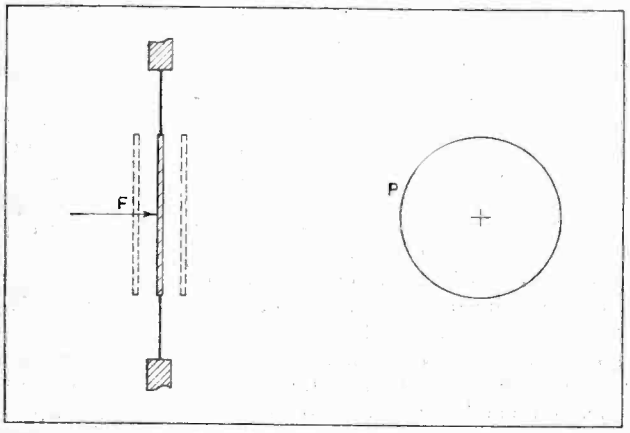


Fig. 2.—Showing steel disc freely mounted and acted upon by an axial force F. The dotted rectangles indicate the positions corresponding to A and B of Fig. 3.

needle as shown in Fig. 1—it may be mounted mentally with good results—and move the compass to and fro axially. The circle bends at its edge, and is loth to follow the motion of the centre. When the centre is pushed forward the edge follows reluctantly after a while. In other words, the disc does not move bodily, and there is a time interval between the central push and the peripheral motion corresponding thereto. If, on the other hand, the disc had been steel or brass, the peripheral motion would have appeared to occur at the same time as the central push, i.e., there would have been no lag visible to the naked eye.

The steel disc is very rigid, whereas the paper disc is very flabby. It is the much greater rigidity or degree of consolidation which enables the steel disc to move bodily, i.e., as a whole. To attain a certain degree

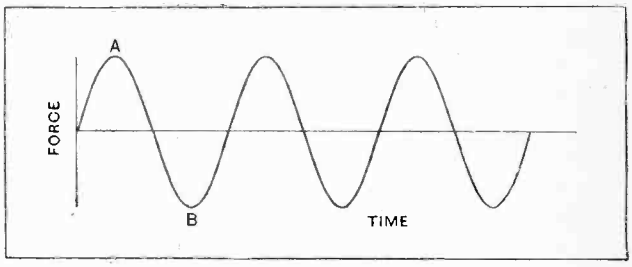


Fig. 3.—Illustrating the axial force F at any time. It is a sine wave force.

of rigidity the circular disc is transformed into a cone. When this is moved to and fro with the compass we cannot see any lag of the outer edge behind the centre. But the naked eye is easily deceived, because there is a definite lag which can be demonstrated optically in a simple manner, which will be described later.

Lag Between Centre and Periphery.

Coming back to the case of the steel disc, assume this to be freely mounted as illustrated in Fig. 2, and that we can apply an axial force to it when desired. Let the axial force be due to an alternating current passing through a coil situated in a strong magnetic field. The force is to be applied at the centre and not to a ring, as is customary in the coil-drive loud speaker. This is, of course, merely a matter of mechanical design. The relationship between force and time is illustrated in Fig. 3. When the central force F commences to act at A it is not felt instantaneously at the periphery P, because the velocity of energy propagation in steel is

The "Breaking Up" of Loud Speaker Diaphragms.—

not indefinitely large. If we see a flash of lightning the thunder does not immediately follow. There is a lapse of time whilst the sound travels from the location of the flash to the listener. The velocity of the sound is from 1,100 to 1,200 feet per second according to the state (temperature and pressure) of the atmosphere. Suppose the air could by some magical transformation process be replaced by steel, there would still be a time interval between spark and sound. In this case it would

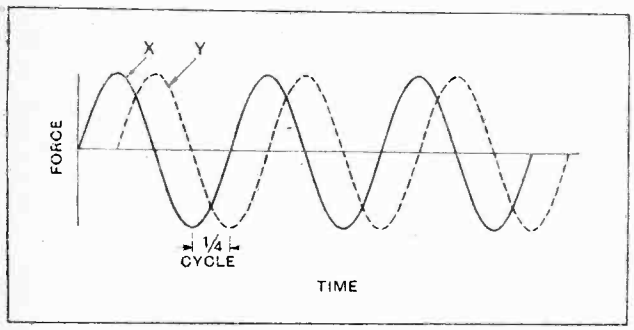


Fig. 4.—The motion of the centre is shown by X whilst the motion of the periphery, a quarter-cycle behind the centre, is shown by Y.

be smaller than for air, since the velocity of sound in steel is much higher than it is in air. The greater velocity exists by virtue of the greater rigidity of the metal steel.

The time taken for energy to travel from the centre to the circumference of the steel disc depends upon the diameter and thickness of the disc. The larger the diameter the longer the time taken, since there is a greater distance to be covered from the centre to the outside. Owing to this finite velocity of propagation of energy down the disc, it clearly cannot move as a whole, but there is a well-defined realm within which it can, for practical purposes, be regarded to move as a whole, i.e., to act like a piston.

Reduction of Output

We postulated an alternating force which would make the disc oscillate about its central or equilibrium position. If the time taken for energy to travel to the circumference is small compared with the time taken by the disc to move outwards to the dotted position shown in Fig. 2, it can be regarded as being rigid, i.e., moving as a whole. As the frequency of the applied force increases, a point is reached when the time taken to travel a distance equal to the radius of the disc is comparable with that occupied by one-quarter of a cycle (see Fig. 4). When this occurs the disc cannot be considered to act like a piston, and the whole of it is not moving in the same direction at once. To take a concrete instance: Imagine the motion at the periphery to be one-quarter of a cycle behind the force at the centre. The relative state of affairs is illustrated graphically in Fig. 4. At the point P the centre of the disc is moving to the left whilst the periphery is moving to the right. Pausing for a moment to consider what this means, it is clear that the disc radiates sound from either side simultaneously in two directions. If the radiation near the circumference is considered to be positive, that near the centre can be taken as negative. Obviously the result is a reduction in acoustic output compared with that obtained if the disc moved as a whole in the same direction.

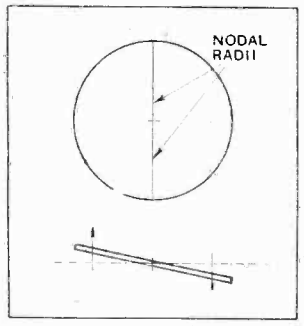


Fig. 5.—The motion of a vibrating disc at its first resonance frequency. There are two nodal radii (nodal diameter) about which the disc vibrates in opposite directions.

Effect of Disc Resonances

At a certain frequency the disc is unusually active. This is its first natural or resonance frequency. It occurs when the energy which is reflected or diverted back from the free edge enhances that supplied by the force at the centre to the maximum extent. When this occurs the disc executes a peculiar motion. One-half moves in one direction, whilst the other half moves in the opposite direction. This is illustrated in Fig. 5. Under such a condition the action of the disc is segmental (semi-circular segment in this case), and the radiation therefrom complex. The disc can be considered—so to speak—to "break up" into vibrating segments. This breaking-up phenomenon, which occurs at a frequency above that where the disc ceased for practical purposes to move as a whole, was studied over a century ago by Chladni. He invented a simple experimental process to ascertain what happened when a disc got thoroughly excited. Now, in Chladni's time there were no valve oscillators, nor other forms of sine wave generator, so that simpler and less direct means had to be adopted to inebriate the disc. The disc was usually excited by drawing a violin bow across its edge. By sprinkling fine sand on the disc the portion in motion made the grains jump until they finally took refuge on a nodal line. On each side of this line the disc moves in opposite directions, so that the radiation from the two halves will interfere with a general net reduction in output. When the disc is excited by a central sinusoidal force, as illustrated in Fig. 2, we know very well that, despite the interference due to the two halves, the sound at resonance is much louder than that at higher or lower frequencies. To enhance the sound the proper procedure is to make use of a baffle.

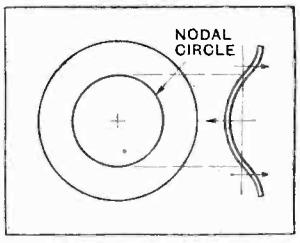


Fig. 6.—Diagram showing resonance of flat disc corresponding to one nodal circle. The inner portion is moving to the left and the other to the right at the instant under consideration.

By increasing the frequency beyond the first or fundamental resonance, it is possible to get additional modes of vibration, each being concomitant with a so-called "mode" or natural frequency. Another mode or

The "Breaking Up" of Loud Speaker Diaphragms.—resonance is accompanied by a nodal circle, as shown in Fig. 6. Here the inside and outside of the circle are moving in opposite directions. Other frequencies give four or more radial lines instead of two, and there are also combinations of radial lines and nodal circles. On the whole the vibration and the acoustic output properties of the disc are characterised by complexity. Radial lines and circles are also found in chime bells. They are—in that connection—known respectively as nodal meridians and nodal circles. Such markings on a bell are found by striking it and searching with a form of stethoscope for points of minimum or zero sound.

(*To be concluded.*)

TRANSMITTERS' NOTES AND QUERIES

French Transmitters.

The first Congress of the Réseau des Émetteurs français, held on June 1st and 2nd, was attended by delegates from Belgium, Germany, and Hungary. The recognition by public authorities of the usefulness of amateur work was emphasised. The French Post Office has decided, as a mark of appreciation, to exonerate from wireless receiver taxes all those who have collaborated in the short and ultra-short wave researches of the official laboratories.

The chief subjects of discussion included the application of the super-heterodyne method to short waves and the piezo-electric properties of quartz. A resolution was adopted asking that the amateur wave-bands allotted by the Washington Convention should not be used by official stations.

At the general meeting of the R.E.F. following the Congress, M. J. Reyt (8FD) was elected President, Messrs. R. Desgrouas (8IH) and J. Bastide (8JD) Vice-presidents, and Messrs. R. Audureau (8CA) and R. Martin (8DI) Joint Secretaries.

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Short Waves in Austria.

With reference to the note on page 613 of our issue of June 12th, we hear that the Vienna station UOXY had, up to the end of last month, received four reports of reception from England and one from Holland. Signal strength on 10.6 metres was stated to be between R4 and R8.

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A German Amateur.

Herr Helmut Burkle, Lindenallee 59, Berlin Weissensee, a young short-wave enthusiast, would like to get into correspondence with an English amateur of about the same age (17), presumably one who can speak German fluently.

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Short-wave Working in Great Britain.

Mr. E. T. Somerset (G2DT) picked up at Burgess Hill, Sussex, on Sunday, June 16th, signals on 5 metres from G5WF and G5QB at West Hampstead, the experimental stations owned respectively by Mr. W. F. Floyd and Mr. E. J. Reid.

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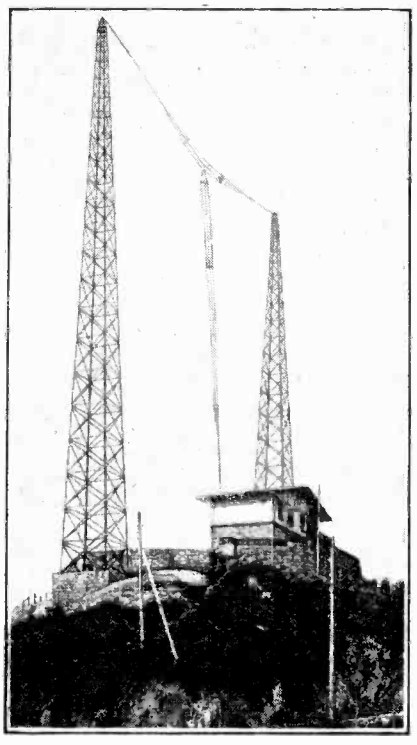
G5SW Received in Cairo.

An Egyptian correspondent speaks highly of the reception of G5SW in Cairo, stating that the relay of the Empire Day festival in Hyde Park came through without any fading, every word being distinct, and the running commentary of the Derby was also unusually clear, the cheers of the crowd and even scraps of conversation between people near the microphone being heard. He states that when "Aerial B" is used reception is usually very reliable. Incidentally, we learn that stations in South Africa seem to prefer "Aerial A," and it may prove interesting to learn which aerial is generally considered the better at various distances.



SPANISH BROADCASTING. The well-known San Sebastian station on Mount Igueldo, by the shores of the Bay of Biscay. The station operates with a power of 1.5 kW. and on a wavelength of 368 metres in common with the Seville transmitter. Programmes include frequent relays from the Madrid Studio.

Our correspondent also reports that PCJ comes in fairly strongly, but not quite up to the standard of 5SW in purity and power; 7LO (Nairobi), fairly strong but varies at times; Bandoeng, very strong, with no "background"; Drummondville, when working with London, is almost too strong in the early morning, and he has also heard Commander Byrd speaking to the American stations. The receiver used was a Det. with two L.F. stages, the last having power valves in parallel; only 50 volts H.T. is used, as more than this is found to produce distortion.

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General Notes.

Mr. H. Osborne, 77, Barrett Road, Walthamstow, E.17, asks us to state that he is carrying out tests daily and nightly until 0100 G.M.T. at his station G5NC on 21, 42 (c.w. only), and 160 metres (c.w. and telephony). Reports, especially of transmissions on 42 and 160 metres, will be welcomed and acknowledged by card.

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New Call Signs and Stations Identified.

G2DT (ex BRS 125) E. T. Somerset, Inholmes Park, Burgess Hill, Sussex.
G5DF J. D. Pinchbeck, Summerfield, Wadsworth, Hebden Bridge, Yorks.
G5FC (ex BRS 152), F. Donald Cawley, 85, Hale Road, Hale, Cheshire.
2BFL J. Batchelor, 51, Arcadia Gardens, Bowes Park, N. 22.
2BXM F. C. Mason, 37, Abbey Road, Bush Hill Park, Enfield. (Change of address).

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European Stations Heard in Australia.

Mr. G. A. Jeapes (G2XV) sends us the following list of stations heard by Mr. R. Roberts at Box Hill, Victoria, Australia:—

British: G5BY, G5YX, G5BZ, G5WK, G5MQ G2XV, G6XN, G6WY, G6WI, G5QV.
French: F8JT, F8FD, F8YPZ, F8HZ.
Finnish: OH2NM.

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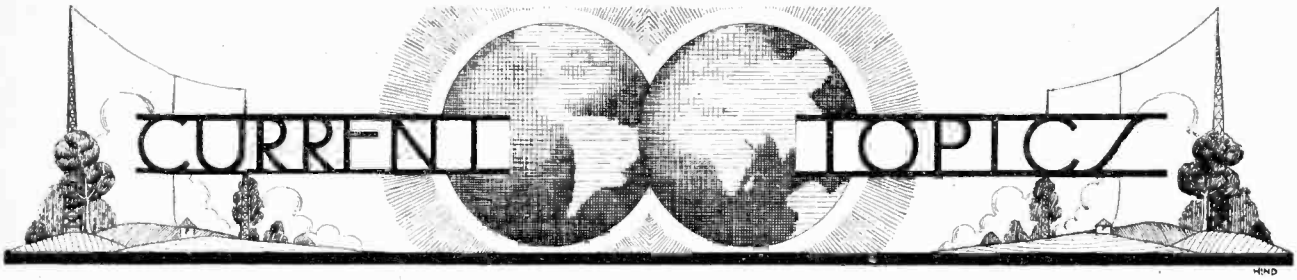
Unlicensed Stations.

In addition to the two call-signs given in our note of June 12th, we understand that G6ABC (Wales) and EI5F (S. Ireland) are also being misused by unlicensed transmitters.



Events of the Week in Brief Review.

PRISON FOR THE UNLICENSED.

No mercy is to be shown to unlicensed transmitters in Australia. According to the latest regulations issued by the Commonwealth Postmaster-General, the penalty for conducting illicit transmission will be a fine of five hundred pounds, or imprisonment, with or without hard labour, for a term not exceeding five years.

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POLICE WIRELESS IN PARIS.

A new wireless police force is to be instituted in Paris. Experiments will shortly be made in communicating from the Eiffel Tower with the police of London and Berlin.

It is stated that the "air" police will be recruited from the ranks of ex-Army telegraphists.

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FRENCH SHORT-WAVE TESTS.

The Eiffel Tower transmitter is now regularly carrying out tests on short-wave telephony. The wavelength varies between 49 and 51 metres. Experiments are usually carried out between 1130-1145, 1815-1830 and 2215-2245 B.S.T.

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GERMANY'S "WORLD" SHORT-WAVER.

From Berlin comes the report that work on the new German "world" short-wave broadcasting station is nearing completion, and that experimental transmissions are to be made at an early date. Although no definite information has been given out officially regarding the wavelength to be adopted, it is probable that the initial tests may be carried out on either 31.381 metres or 25.105 metres. The transmitting plant has been installed in close proximity to the Zeesen high-power station.

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BRITISH WIN IN FRENCH "RADIO RALLY."

The Parisian "radio rally" on June 30th, referred to in a recent issue, resulted in a triumph for Captain Leonard Plugge, who won the first prize for the most perfectly wireless-equipped touring car with his Standard saloon, "Aether III," in which an eight-valve set and loud speaker are incorporated as part of the structure.

The rally was staged between Paris and Fontainebleau, and was attended by a great number of spectators. The competition was organised by the Automobile Club de France and the Automobile Club de l'Ile de France.

ANOTHER FRENCH WIRELESS SHOW.

The town of Lille will hold a wireless exhibition from September 28th to October 7th.

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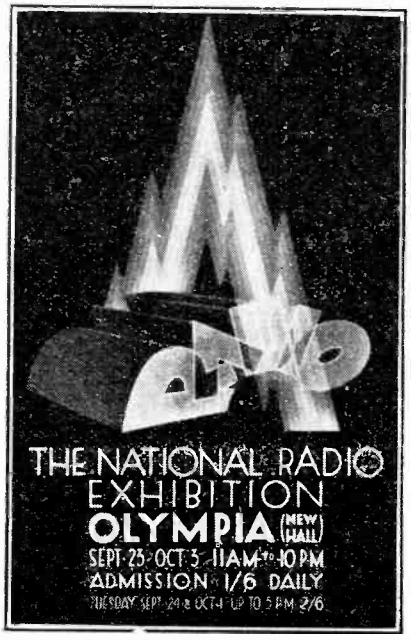
SHORT WAVES FROM AUSTRIA.

UOR2, the short-wave experimental station installed by the Vienna Ravag Broadcasting Company, now broadcasts a short programme of gramophone records on Tuesdays and Thursdays at 1300 B.S.T. and on Wednesdays and Saturdays at the end of the Vienna evening programme.



A MAGNETIC POSTER. The winning design in the competition organised by the Radio Manufacturers' Association for a poster proclaiming the Olympia Show. The artist is Mr. P. Irwin Brown.

WIRELESS APPRENTICES FOR R.A.F.

Vacancies in the Royal Air Force for six hundred aircraft apprentices between the ages of 15 and 17 are announced by the Air Ministry. The principal trades open include those of wireless operator-mechanic and electrician, fitter (aero engine, driver and armourer), and coppersmith. Full information regarding examinations and methods of entry can be obtained on application to the Royal Air Force, Gwydyr House, Whitehall, London, S.W.1.

WIRELESS BETWEEN LIGHTSHIPS.

Plans are understood to be in preparation for wireless communication between certain lightships on the East Coast of Britain and German lightships in the North Sea in order that fog warnings may be exchanged.

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41.5-METRE RELAYS FROM SWITZERLAND.

A small short-wave transmitter has been erected by the Zurich Radio Club which, by arrangement with the Swiss authorities, broadcasts the local wireless entertainments every Saturday night between 2000 and 2200 B.S.T. on a wavelength of 41.5 metres.

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MARCHESE MARCONI AND VATICAN WIRELESS.

The order for the wireless station which is to be erected in the Vatican City for the use of His Holiness the Pope and the Vatican State has been placed with Marconi's Wireless Telegraph Company, Limited.

The station will embody the latest improvements in wireless design and construction, and it is receiving the personal supervision of the Marchese Marconi. Communication will be carried out both by telegraphy and by short-wave telephony, and it is stated that the range of the station will be "world-wide."

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WAR ON BROADCAST PROPAGANDA.

A reported proposal of the Soviet Government to erect a super-power broadcasting station either at Petrograd or Moscow to transmit programmes for European consumption in German, French and Esperanto has aroused acute discussion in certain French papers (writes our Paris correspondent). The station, it appears, will be intended to "educate" Europe in the principles of Communism.

The French Press declares that this project raises "a most important problem of international law—the right of a nation to broadcast in a language other than that spoken by its subjects." It is urged that the matter should be studied by European Governments and the League of Nations.

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"GRAF ZEPPELIN'S" NEXT FLIGHT.

Repairs to the German airship *Graf Zeppelin* are nearing completion, and the date approaches when a further attempt will be made to cross the Atlantic to New York. It is understood that the arrangements made for the previous unsuccessful trip hold good for the next flight,

and it is stated that a special radio reporter sent across from the United States will join the airship from the start, and so far as possible will send verbal reports daily on a short wave length to 2XE (Rocky Point, New York) which, in its turn, will pass on the messages to WABC (New York) for broadcast to American listeners. It is expected that if favourable conditions prevail two-way communication may be established, and that the *Graf Zeppelin*, during the course of the trip, will be in a position to give its passengers the latest news bulletins.

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GERMANY'S WIRELESS SHOW.

The annual German Wireless Exhibition will be held this year at Berlin from August 30th to September 8th. As in previous years, the venue will be the famous Kaiserdamm grounds.

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POLISH RELAY ON SHORT WAVES.

Nightly from 23.00 to 24.00 B.S.T. the Posen short-wave station relays the local programme for rebroadcast on 30 metres with a power of some 200 watts in the aerial. All calls and announcements are given out in Polish, German, French, and Italian, and on some occasions in English. The interval signal consists of a metronome beating 240 strokes to the minute.

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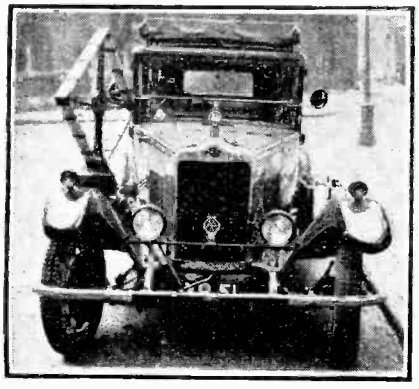
TRANSMITTING TO THE ANTARCTIC.

Known as the Byrd antenna, a special aerial system has been erected at the South Schenectady transmitting laboratory of the American General Electric Company for communication with Commander Richard Byrd's expedition now exploring the Antarctic. The aerial, which is highly directional, has been



"AETHER III," Captain Plugge's wireless-equipped car, which won the first prize in its class at the Paris "Radio Rally."

designed by Dr. E. F. W. Alexanderson, and is very similar to the other short-wave antenna erected on the same site. At regular intervals the programmes of WGY are relayed specially for the benefit of the Byrd expedition, and, although it is considered doubtful whether every transmission will penetrate the heavy atmospherics abounding in the Antarctic regions, it is expected that Commander Byrd and his men will get much better signals than have hitherto been possible.

TELEVISION IN COLOUR.

The introduction of colour into television transmissions was carried out successfully on June 27th by the American Telephone and Telegraph Company, according to a correspondent of *The Times*. It is claimed that it is now possible to add colour without complication, and, while the pictures are still restricted to the size of a postage stamp, it is stated that it would not be difficult, although more expensive, to reproduce coloured pictures on a larger screen.

The colour transmission did not entail extensive alterations to the original equipment, the only changes being in the types and arrangement of the photo-electric cells at the sending end and of the neon and argon lamps at the receiver.

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A NEW APPOINTMENT.

Mr. H. Francis White, well known in shipping circles, has been appointed manager of the Radio Communication Co., Ltd.

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AUTOMATIC TRANSMISSION FROM THE AIR.

A small captive balloon fitted with a self-acting short-wave transmitter is the subject of a paper submitted to the French Academy of Science by the military wireless service. The apparatus transmits barometer and thermometer readings.

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SAFETY AT SEA.

Extensive revisions in maritime wireless procedure are recommended in the text of the International Convention for the Safety of Life at Sea, published by H.M. Stationery Office. The Convention was signed in London on May 31st last, and now awaits ratification by the Governments concerned. The chapter on radio-telegraphy, which relates to all ships engaged on international voyages except cargo ships of less than 1,600 tons gross, refers to the fitting of radio installations, including their technical requirements, and to the watches to be kept for safety purposes on various categories of ships.

Copies of the text of the Convention are obtainable from H.M. Stationery Office, either directly or through any bookseller, price four shillings each.

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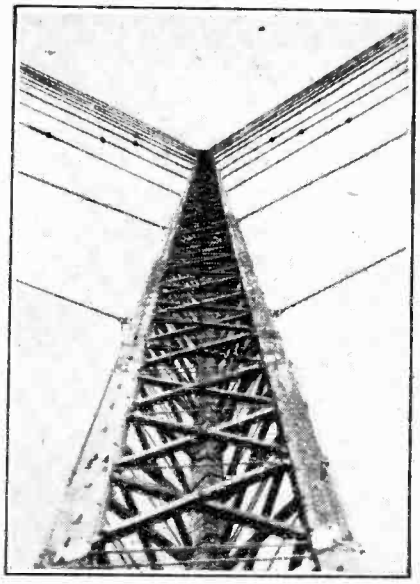
NEW EVENTS IN R.A.F. DISPLAY.

Many radio enthusiasts will find their way to Hendon on Saturday next, July 13th, to witness the Royal Air Force Display, in which wireless will play an important part.

The main event of the afternoon will consist of a great air battle and an attack on a fortified port which is occupied by a troop transport and other shipping. Six squadrons, comprising nearly 50 aircraft, will take part, including Army co-operation aircraft, single-seater fighters, and day and night bombers. During the battle an observation kite balloon will be shot down in flames, but the observer, Squadron-Leader "Sandbags," will be saved by parachute.

For the first time a squadron of Southampton flying boats will figure in the programme. These aircraft are similar to those used by the Royal Air Force for the Far East flight which concluded a 27,000 miles cruise to India, Australia, Hong Kong, and Singapore a year ago. They will leave their base at Calshot, near Southampton, and after flying over land part of the way will give



A "WORM'S-EYE VIEW" of a new Admiralty 500-ft. wireless mast at Ricasoli, Malta, constructed of wood and supported by thirty-six strands of 4½in. cable to withstand squalls.

a flying demonstration at Hendon during the afternoon.

A new feature will be the use of coloured smoke to enable spectators to follow closely the various evolutions, such as spinning, looping, rolling, and half-inverted loops, to be carried out by two pilots of the Aeroplane and Armament Experimental Establishment.

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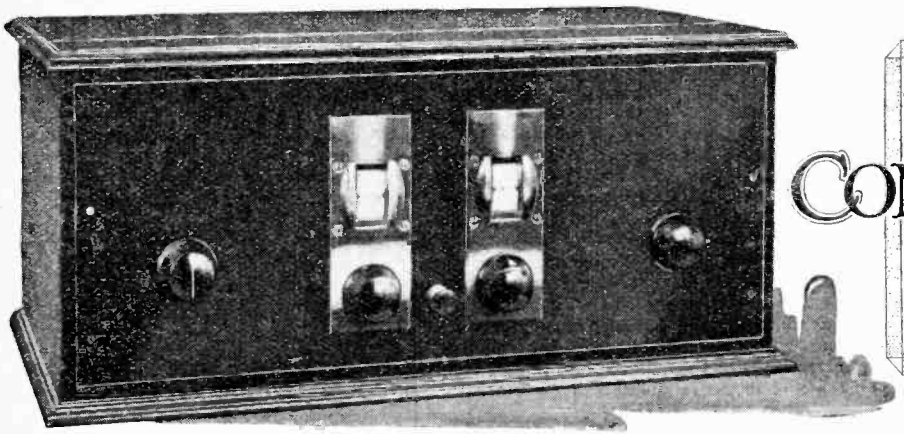
POLICE WIRELESS DEVELOPMENTS.

Extensive developments in the use of wireless by Scotland Yard and the County Police throughout the country were forecast by Major T. H. Vitty, engineer to the Metropolitan Police, in a lecture before the Chief Constables' Association at Brighton, on Wednesday last.

Major Vitty said that the wireless transmitter at present in use at Scotland Yard had a radius of between 50 and 100 miles, but there was no technical reason why this range might not be considerably extended to permit of inter-communication between London and provincial headquarters.

The lecturer explained that the principal use to which wireless was put today was in maintaining touch with the Flying Squad cars. Other uses had been experimented with lately, notably the wireless transmission of photographs and finger prints. Tests had been conducted with the "Fultograph" and Marconi-Wright picture transmission systems



KIT CONSTRUCTORS' NOTES

The Mullard S.G.P. Master Three.

IN view of our increasingly exacting needs in the matter of selectivity it is strange that producers of "kit" sets have practically ignored the possibilities of "bottom bend" detection. The attitude of commercial set builders towards this question is quite understandable, as they clearly have good reasons for avoiding another adjustment—of detector grid bias—that will require periodical, albeit infrequent, attention, but it is reasonable to assume that anyone who can assemble and wire a set is capable of carrying out this simple operation.

While anode detection is by no means a complete solution in itself of all interference problems, it is a readily demonstrable fact that a receiver with circuits of reasonably low H.F. resistance will be more selective when this system of rectification is used, as compared, of course, with the rival leaky grid condenser method. The relative merits of both systems are familiar to most readers; but perhaps there is a tendency to lay undue stress upon the lack of sensitivity of the anode bend detector and to forget that it is included in some of the best long-distance receivers—as, for example, the "Everyman Four." Speaking from a strictly practical point of view, it is not misleading to go so far as to say that there is little to choose, from the point of view of range, between the two systems. The accuracy of this statement is easily checked by constructors of the Mullard "S.G.P. Master Three" receiver, which, though primarily intended for anode bend detection, is readily convertible in a few moments for a comparative test.

Tuned Anode H.F. Coupling

In its general circuit arrangement (shown diagrammatically in Fig. 1) the set does not include any radically new features. Aerial coupling is through an "aperiodic" transformer, with alternative tappings on its primary winding for adjusting selectivity; as pointed out in the descriptive booklet, conditions may arise—as, for instance, when the local station is not operating—when it is desirable to take advantage of the increased sensitivity generally afforded by a "tight" aerial coupling.

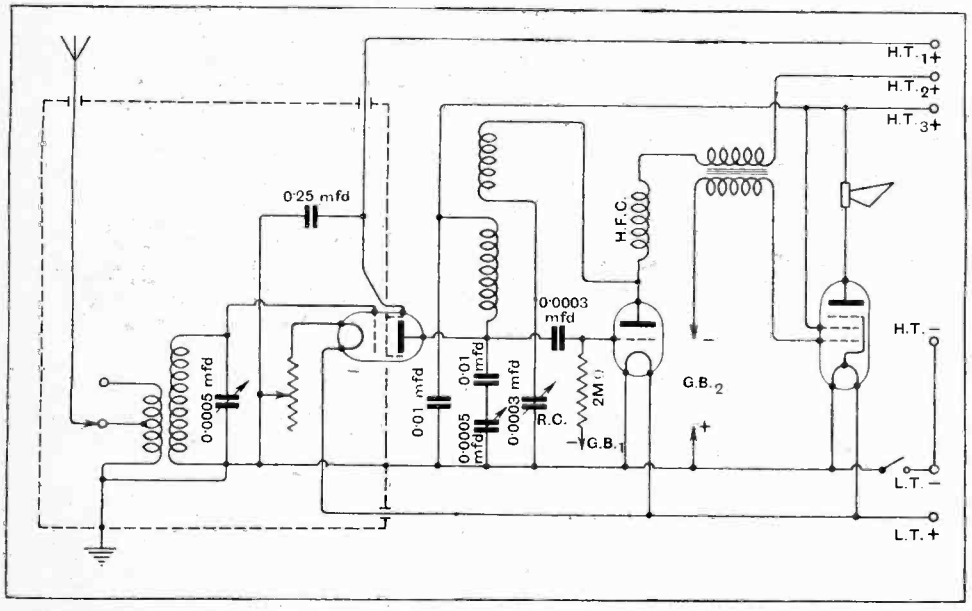


Fig. 1.—Complete circuit diagram, showing screening of grid circuit components and protective condenser in series with anode tuning condenser.

A simple tuned anode circuit is used to couple the screen-grid H.F. valve to the detector, and consequently a blocking condenser, with its associated leak, is of necessity included in the grid circuit of the latter valve. This addition is not accompanied by any observable ill effects, and the possibility of running into grid currents is almost precluded by the use of a "D" type detector valve.

Volume is controlled by operation of the S.G. valve rheostat, which is connected

p. 19

Kit Constructors' Notes.—

in the negative filament lead, with the consequence that an increase in its resistance will cause a decrease in emission, and, at the same time, will impress a negative bias on the grid.

Reverting to the intervalve coupling, it will be seen that one side of the anode tuning condenser is at earth potential, and that the oscillatory circuit is completed through a fixed condenser of 0.01 mfd. Another fixed capacity of the same value is connected in series with the tuning condenser; this serves no other purpose than that of a protective device in the event of a short-circuit between the fixed and moving vanes. In justice to the makers of the J.B. variable condensers, one should hasten to add that such a fault is unlikely to arise, as the components are accurately and strongly built. This series condenser is an addition to the original design, its connections being described in a leaflet accompanying the descriptive literature.

Danger to Valve Filaments.

An important point emerges with relation to this question of protective devices. It will be seen that negative sides of both H.T. and L.T. batteries are connected together and to one side of the on-off switch; if this switch is at "off" a high-tension short-circuit such as that described above, or, indeed, an accidental short-circuit to earth between any point connected either directly or through a low resistance to an H.T. positive terminal, will have the effect of burning out all the valves —provided, of course, that the source of H.T. supply is of comparatively low internal resistance. It is admittedly a fact that the filament circuits of most "kit" sets are arranged on similar lines, but the present writer admits his complete inability to see any justification for a scheme that increases the risk of damage due to accidental short-circuits.

A negative voltage for the detector grid is applied from a bias battery which also supplies pressure for the pentode output valve. These two valves are linked by a Mullard "Permacore" transformer, which is capable of fulfilling the rather exacting task of functioning in the plate circuit of an anode bend rectifier. Capacity-controlled reaction on normal lines is provided, one side of the feed-back condenser being earthed to the metal panel.

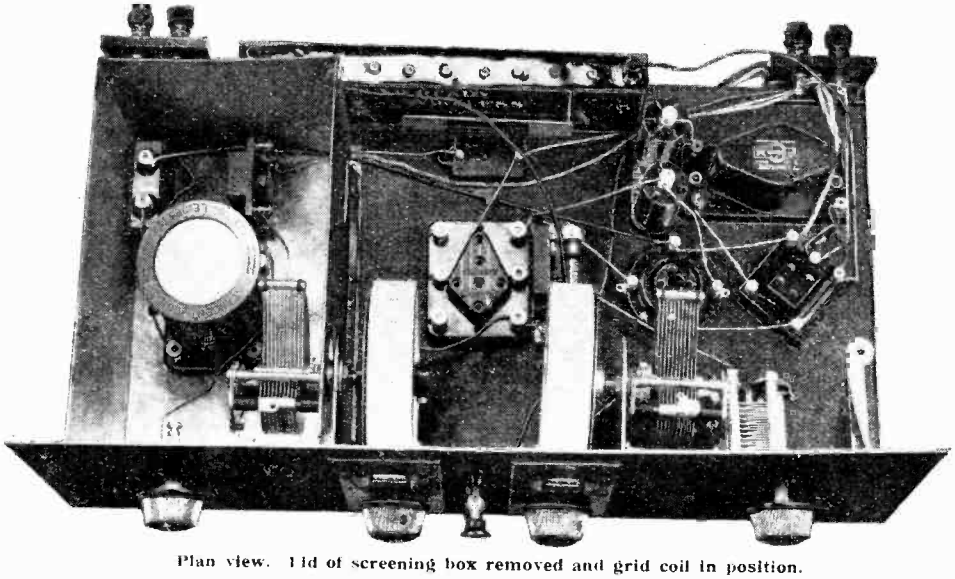
Turning to practical details of construction, the H.F. valve grid circuit is completely screened in a copper box. This plan is much more convenient than the alternative of enclosing the plate circuit components, and its adoption makes for a more compact set. The S.G. high-frequency amplifying valve is mounted horizontally, and its anode section projects through the metal screening case, which is supplied in sections ready for assembly; it is intended that wiring should be completed before its vertical members and lid are fixed in position. By these means the difficulty of working in a restricted space is avoided.

Colvern or Tangent coils are specified for the set; those included in the specimen receiver submitted for test were of the latter make. High-frequency inductances are of vital importance in any set, and the windings in the present instance seem to have been exceptionally well chosen, particularly in the case of the medium-wave coils, which are as near as makes no matter to the ideal specification for their diameter.

Performance on Test.

The use of special J.B. tuning condensers contributes materially to the good appearance of the set; these components are fitted with edgewise drum dials, and are driven by a friction disc (controlled by a panel knob) which is operated through a reduction gear. In other matters conventional practice is followed, a wooden baseboard marked with component positions and wiring being used in conjunction with a metal panel that is supplied ready drilled.

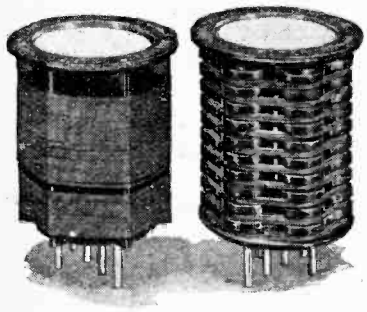
When making initial tests on the medium wavebaud the set was found to lack complete stability at certain points of its tuning scale. Self-oscillation could be easily checked either by dimming the H.F. valve filament or by setting screening grid voltage at something other than the optimum value, but these expedients cannot be considered as being good practice or even fair to the set, and attention was turned towards the screening case, of which some of the joints were imperfectly closed, particularly those between box and panel. Insertion of strips of copper gauze—an invaluable aid to the experimenter in these days of isolated circuits—proved to be an effective and complete cure. Tuning was found to be comfortably sharp, and overall selectivity, as was to be expected, of an exceptionally high order. Sensitivity



Plan view. Lid of screening box removed and grid coil in position.

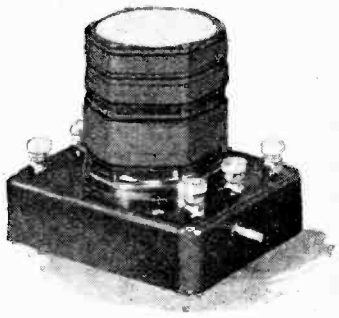
Kit Constructors' Notes.—

was well above the average standard; that this was largely due to pure H.F. amplification was proved by the fact that reaction was by no means necessary for long-distance work. Indeed, it would be a good plan to make provision for optional direct connection of the reaction condenser between detector anode and earth, thus dispensing with intentional feed back and at the same time improving detection efficiency.



Medium- and long-wave interchangeable coils.

On the long waves, as on the medium band, there was found to be some instability, but matters were, again, improved by paying attention to screening-box joints. At some settings it was observed that self-oscillation was produced when a station was tuned in, but not when the two circuits were brought into resonance at an adjacent wavelength on which there were no incoming signals. This is always a fairly sure indication that H.F. energy is finding its way into the L.F. amplifier, and accordingly a 0.25 megohm resistance was inserted between the grid of the pentode and the "G" terminal of the L.F. transformer, with the desired results. These experiments are described with a view to helping those who may encounter similar effects; in many cases no troubles are to be anticipated, as H.F. instability is largely dependent on the characteristics of the particular S.G. valve used. To be on the safe side, it is recommended that the contiguous flanges of the screening box should be scraped bright, and that particular care should be taken in fitting together the sections, not forgetting the lid.



Tangent dual-range coil with switch in base.

Plug-in interchangeable coils are used to cover the two wave-bands in the standard model, but a modification is described in which two coil assemblies, complete with built-in wave-changing switches, may be used in an otherwise similar circuit arrangement. Due to the necessarily reduced dimensions of the coils, the receiver in which they are used will have a somewhat less extended range, and its selectivity is bound to be slightly impaired.

KIT CONSTRUCTORS' PROBLEMS.

The Information Department Service has been extended to deal with problems encountered by builders of "kit" sets discussed in these pages. Receivers already treated are the "New Cossor Melody Maker," Osram "Music Magnet," Mullard "Master Three Star," Six-Sixty, "Mystery Receiver," Ferranti "Screened Grid Three," Formo "Screened Grid Three," Dubilier "Toreador Screened Grid Four," and the McMichael "Screened Three." The service is subject to the rules printed in the Readers' Problems' section.

An Idle Terminal.

For use with my "1929 Cossor Melody Maker" I have obtained an eliminator which has two output terminals marked 60 volts and a third marked 120 volts. One of the former is intended for feeding the screening grid and the 120-volt connection will be for the main supply; to what point should the other terminal be joined? B. H.

The anodes of the valves in this set are fed with a common H.T. voltage, a lower pressure, of course, being applied to the screen of the S.G. valve. This being so, the extra connection would appear to be unnecessary, so the terminal may be left "free." Possibly it might be an advantage to use it for feeding the detector anode circuit, but a voltage of 60 is rather too low for a high-impedance valve. It may be, however, that on the very light load imposed by this valve the actual voltage will rise to a sufficiently high value; it must be realised that the voltages indicated on an eliminator are seldom more than a rough approximation, an average current consumption being assumed by the makers.

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Wood or Metal?

Will you please tell me whether it is best to use a wood or a metal cabinet for my "Osram Music Magnet"? C. S.

It is injudicious to take any liberties with a set including ganged tuning controls, and on the whole we think you will be wise to use a wooden cabinet. It will be realised that the inductance of tuning coils is reduced when a mass of metal is brought into proximity with them, and, as it is unlikely that both plate and grid coils will be equally affected, the use of a metal container introduces an element of risk.

We should add, however, that in any case this effect cannot be very serious, and if you are specially inclined towards the use of metal it would be worth while going to the trouble of making an initial test by placing sheets of the material you propose to use in the positions that will be occupied by the top, sides and back of the case, and noticing if there is any obvious falling off in the performance due to these additions.

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Two-stage L.F. Amplifier.

Do you think that it would be possible to make up a set on the lines of the Ferranti "A.C. Three," but with two high-frequency stages coupled by R.F.2 transformers (as at present used in the single stage)? If possible, I should like to use a simple vertical screen between each stage, instead of enclosing the various components associated with each circuit in metal boxes. G. R. B.

It is difficult to give a definite answer to your query without carrying out some practical experimental work, but on the whole we doubt very much if your proposed receiver would be completely stable over the normal tuning ranges. The long-wave windings are astatically wound, so on this band it is quite probable that you would be successful, but for short-wave reception it is more than likely that stability would be lacking: this in spite of the extensive decoupling devices that are included. It would certainly be safer completely to screen the individual circuits.

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Adding L.F. Amplification.

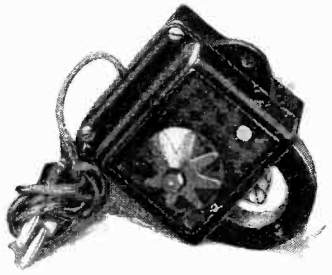
As you will see from the heading of my letter, I live in a district remote from broadcasting stations, and am accordingly compelled to consider the addition of another L.F. stage to my Cossor "Melody Maker." Would you advise resistance or transformer coupling? S. L. L.

Good results can be obtained by adding an extra stage, coupled by either method; but on the whole we are inclined to recommend that you should interpose a resistance coupling between the detector valve and the extra L.F. amplifier. The overall amplification ordinarily obtainable from two modern transformer-coupled stages is likely to be excessive for ordinary requirements, and so, if you prefer to adopt it, we suggest that a volume control resistance should be shunted across the primary of the first transformer.

A Review of Manufacturers' Recent Products.

LOEWE LOUD SPEAKER UNIT.

This cone loud speaker movement is assembled in a neat moulded container, and consists of a generous-sized horseshoe magnet fitted with a single pole-piece and a reed armature arranged crosswise with respect to the arms of the magnet. The single pole-piece is not fixed to one end of the horseshoe magnet, but located approximately half-way along one of the arms. One end of the armature is fixed to the extreme end of the magnet on the opposite arm to that carrying the bobbin. The armature, therefore, completes the magnetic circuit. A small fixed condenser of the Lnewe vacuum type is connected across the bobbin. The distance between the reed and the pole-piece is adjustable.



Loewe adjustable reed type cone loud speaker movement.

This unit is being offered at 13s. 6d. by the Loewe Radio Co., Ltd., 4, Fountayne Road, Tottenham, London, N.15.

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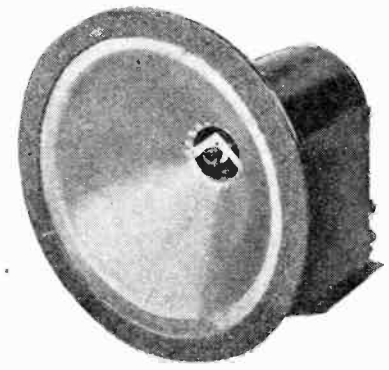
"SUPER" MOVING COIL LOUD SPEAKER.

The model submitted for test was for D.C. mains excitation, and found to consume 0.14 amp. at 220 volts, representing 30 watts approximately. A low-resistance coil is fitted and accurately centred in a gap of small cross section. The centering device assures that the coil has a parallel motion, an important feature in view of the small gap employed. Moreover, examination showed that considerable force would be required to displace the coil and cause it to touch the sides of the gap. A Ferranti input transformer is used and is accommodated in the base. Tested on a high quality amplifier, it showed that the performance was well up



"Super" moving coil loud speaker for 220-volt D.C. mains with input transformer mounted in the base.

to that of the standard laboratory instrument. A baffle board 3ft. square was fitted for the purpose of judging the performance. High and low notes were well in evidence, and the response to the middle register appears to be well balanced. The diaphragm is 9in. in diameter, light but reasonably rigid, and a leather surround is employed. The frame supporting the diaphragm is bolted to the face of the pot.

The sole agents are Messrs. W. Pearson and Co., 41, Great Charles Street, Birmingham, and the price is £6 10s. A 6-volt model for accumulator excitation of the pot is available at the same price, but either model can be supplied without the transformer at £5 10s.

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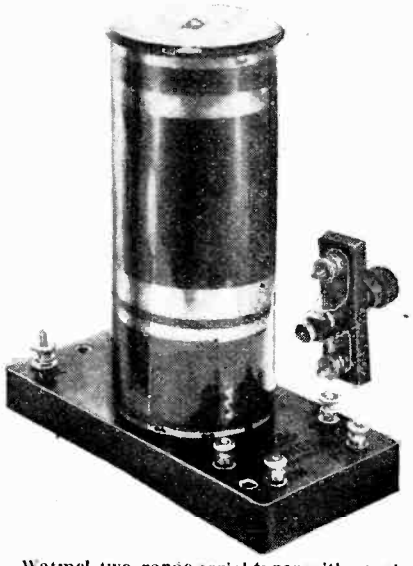
WATMEL TWO-RANGE AERIAL TUNER.

It is a truism that events move in cycles, and this appears equally true in the case of certain wireless components. Before broadcasting begun, all-wave tuners were the rage, but these were subsequently displaced by interchangeable coils. Once again they are enjoying a measure of popularity, but in a modified form.

The Watmel version of the modern two-range tuner takes the form of a cylindrical tube 5in. long×2⅛in. in diameter, on which is wound four coils; a medium-wave coil with a reaction winding close coupled and a loading coil also with a reaction coil. The two reaction windings are connected permanently in series; so also are the tuned coils, but a switch is provided which short-circuits the loading coil when receiving on the 250- to 600-metre band.

The medium-wave coil is tapped for attachment of the aerial, but tests show that selectivity can be improved, especially on the long waves, by connecting a 0.0001 mfd. condenser between the aerial and the tapping.

The wavelengths covered when connected in this manner to an average-sized receiving aerial and used with a 0.0005 mfd. variable condenser were found to be 214 to 600 metres and 840 to 1,900 metres. A panel switch is included, and the price is 12s. 6d. The makers are the Watmel Wireless Co., Ltd., Imperial Works, High Street, Edgware, Middlesex.



Watmel two-range aerial tuner with panel mounting wave-change switch.

"WATES" METER CASE.

The Standard Wet Battery Co., 184-188, Shaftesbury Avenue, London, W.C.2, have recently placed on the market a small case, covered in imitation leather, for the "Wates Volt-amp." meter. At a price of

"Wates Volt-amp." meter in case.

2s. 6d., this container should find a ready demand, since it affords a measure of protection against dust and accidental knocks.

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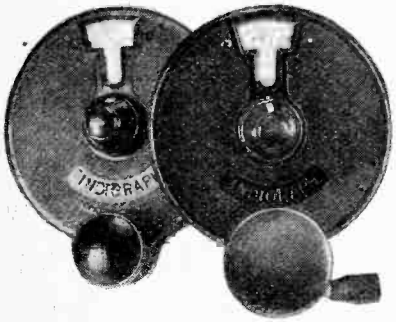
IGRANIC "INDIGRAPH" DIALS.

The latest type of Igranic "Indigraph" vernier dial incorporates a number of new features, and in addition is a sound workmanlike job. The shell consists of a handsome moulding with a window through which the graduations on the dial appear as the knob is rotated. A 0-100 scale is favoured.



Igranic "Indigraph" dials. The two-speed dial is ideal for short-wave sets.

The dial consists of a translucent material, and by fitting a small lamp behind the panel with an opening in line with the dial window it is possible to illuminate the scale and thus facilitate reading in dark or shaded corners.

The ordinary "Indigraph" has a reduction ratio of approximately 8 to 1, and is entirely free from backlash. This is offered at 6s. A pair of spanners for fixing the dial is included in each carton.

A new two-speed model with a micrometer adjustment is now available, and should be particularly useful for use on short-wave sets. The micro adjustment has been redesigned, and the new model is, in every respect, superior to its predecessor. The ratios are 8 : 1 and 500 : 1 approximately. The price of this model is 9s. 6d., and the makers are the Igranic Electric Co., Ltd., 149, Queen Victoria Street, London, E.C.4.

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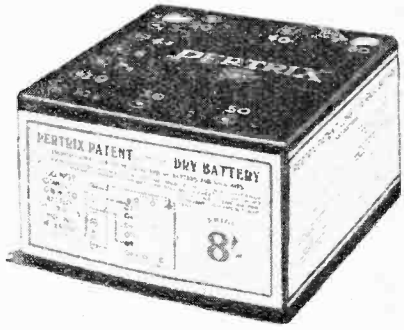
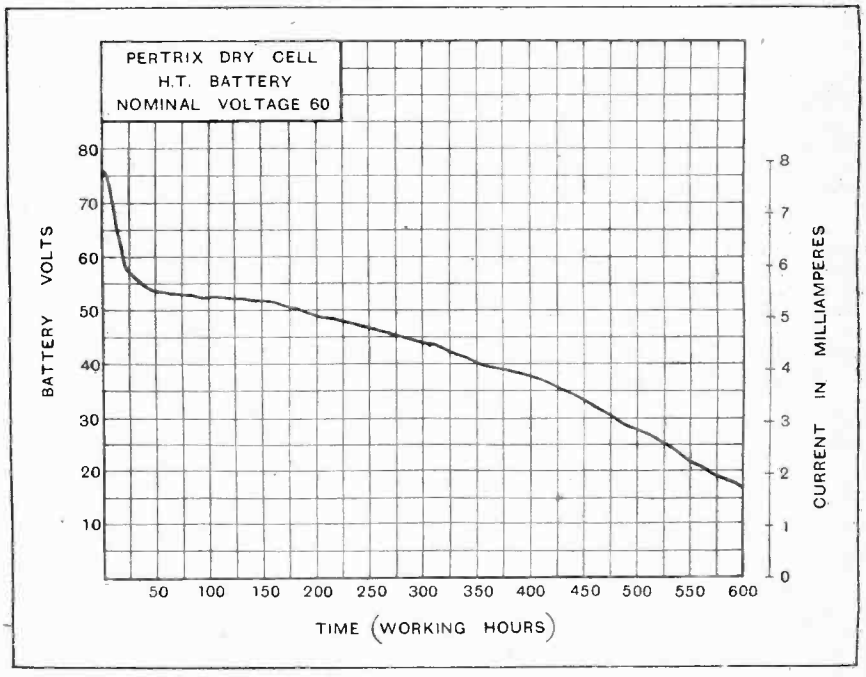
PERTRIX H.T. BATTERY.

The model dealt with in this review has a nominal voltage of 60 and is provided with tappings at 1½-volt intervals from the negative end up to 10½ volts + and thence at intervals of 10 volts. The object of this is to enable grid bias up to −10½ volts to be drawn from the H.T. battery.

The discharge test was commenced at approximately 8 mA.; the terminal voltage at the beginning reading 76. This fell rapidly during the first few hours and eventually settled down to a steady value just over 50 volts. After 100 hours, actual working time, the voltage commenced to fall steadily until the battery was exhausted. There was no natural "cut-off" unless the slight change in the slope of the curve after 400 hours' work can be taken as the "cut-off" point. Incidentally, this corresponds approximately to a state of the battery where the voltage has dropped to 0.9 volt per cell. Since it is often desirable, in the interests of economy, to keep a battery in commission until the volts per cell fall to 0.75, the useful life of this model may be taken as 470 working hours.



Pertrix 60-volt battery with tappings for grid bias.



Discharge curve of Pertrix 60-volt dry cell H.T. battery.

This model is offered at 8s., and is supplied by Pertrix, Ltd., 120, Tottenham Court Road, London, W.1.

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Catalogues Received.

Lissen, Ltd., Friars Lane, Richmond, Surrey. Illustrated broadsheet of Lissen components.

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Messrs. Wilkins and Wright, Ltd., Utility Works, Holyhead Road, Birmingham. — Illustrated folder of "Utility" switches, condensers, and drum controls.

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London Electric Wire Co. and Smiths, Ltd., Church Road, Leyton, London, E.10.—Descriptive leaflets of "Lewcos" dual range coils, and 48-page catalogue of "Lewcos" radio products.

CORRESPONDENCE.

The Editor does not hold himself responsible for the opinions of his correspondents.

Correspondence should be addressed to the Editor, "The Wireless World," Dorset House, Tudor Street, E.C.4, and must be accompanied by the writer's name and address.

SHORT-WAVE RECEPTION.

Sir,—With reference to the letter from Mr. A. G. Faithfull in the issue of *The Wireless World* for June 12th, the reception of short wave beam stations in directions other than that of the main beam is common experience, and with high-power transmitters and sensitive receivers is quite to be expected.

I think Mr. Faithfull is under some misapprehension regarding the actual nature of the transmission from beam stations. The main objects of the beam system are (1) to economise power by directing the greater part of the energy radiated from the aerial in the direction of the receiving station and (2) to minimise the fading which inevitably occurs on short waves. It is also true that interference with other services not in the line of the main beam is reduced, but the idea that it is impossible for a receiver not in the line of the beam to "tap" the transmission is quite fallacious, though, of course, in the case of the beam telegraph services reasonable privacy is ensured by high speed transmission.

A beam transmitting aerial is usually arranged to confine most of the radiated energy to a sector of a few degrees, and the greater the extent of the aerial the sharper the beam. Although the concentration of energy in this main beam may be such as to effect a saving of power of hundreds of times compared with a non-directional or, more correctly, an omni-directional aerial, smaller subsidiary beams are also radiated in other directions, not intentionally, but as an inevitable result of the use of beam aerials of the only type at present available for practical commercial use. The number, sizes and directions of these subsidiary beams depend on the type and dimensions of the aerial, and the narrower the main beam the smaller and more numerous the subsidiary beams. Although the amount of energy radiated in the "subsidiary" directions is only a small fraction of the total, it is sufficient, except under very bad conditions, to produce a signal in a sensitive receiver. It has been frequently indicated by the feats of amateur transmitters that a radiated energy of a few watts on short waves is capable, under favourable conditions, of producing signals practically all over the world. There are certain directions, at least according to approximate theory, in which no energy is radiated from a beam aerial, but at distances greater than a hundred miles or so the scattering and bending effects of the upper atmosphere play an important part, and signal strength tends to become equal in all directions except that of the main beam and, perhaps, that directly behind the reflector. One might, however, expect fading to be worse in the theoretical "zero" directions than elsewhere.

Considering everything, it would be rather remarkable if the stations referred to by Mr. Faithfull were not audible in West Africa, but the case of Huizen's East and West transmission appears to be exceptional. I do not know the type of aerial in use at this station. ERIC MEGAW.

Imperial College Union,
South Kensington, S.W.7.

RADIO EXPORTS.

Sir,—When I was in England in July last there was an instructive lecture given by a high official concerning Empire marketing, and in his lecture he dwelt very emphatically concerning odd parts and manufacturers helping the importer by sending some odd spares in small essentials. At the time I remarked "how true," and this little experience on my return to India will illustrate how essential it is to add or enclose in the carton everything necessary to fix the unit, whatever it may be, to the baseboard, panel, etc. For instance, on the outside of one carton of the many little gadgets I ordered it says, "Three spring clips are supplied." No such clips were in the carton, and in every case all screws to pin the unit down to the baseboard were missing, and various nuts and screws were *non est*. The Customs had certainly made an extensive hunt right through to discover "hidden pearls." Every wrapping had been undone—contents pushed in anyhow, and I cannot say whether the manufacturer does or does not include such wood and other screws necessary, for none was found. Now what does this mean in a country where it is not possible to walk 200 yards and obtain what you want? It may be 200 miles, and then meet with disappointment. Now all this is destructive, and no remedy has been suggested. I therefore ask all British manufacturers to close their cartons with a slip to say that it contains all nuts and screws to finish the job. We have no redress against the Customs, but the wildest of dreams may obtain somewhat of a hearing if genuine British goods said to contain so and so are missing.

The British manufacturer should also consider the Wireless Act in India, by which, without an importation licence, no more than one receiving set *a year* may be imported, or component or parts equivalent to such, including spares. What is one receiving set? No one seems to know, with the result that a few terminals and odd wire and aerial insulators are held up for weeks as constituting one receiving set! It is not the Customs duty, but the holding up that one objects to. The India market may not at present be a potential proposition, but it will be. There are 320,000,000 people in this country, a population not to be despised where radio is concerned. May I suggest that the Radio Manufacturers' Association takes some notice of the difficulties of importing British goods into this country? "RADIOX."

Roorkee, U.P.

"WIPE-OUT" AREA AND THE ETHER SEARCHER.

Sir,—May I be permitted to say a few words regarding a paragraph on the "Tyranny of a too-powerful local station and the ether searcher" in your issue of June 12th?

When the "Brookman's Twins" come into operation I venture to think that the future trend of broadcast receiver design will be to a greater waveband extension by the incorporation of short-wave reception in all but "local" sets.

That "nation shall speak peace unto nation" *via* short waves, and that the present "broadcast" bands will be used for "local" work on the lines of our regional service, seems probable internationally in the near future.

An efficient double duty receiver incorporating a tuned S-G H.F. stage has recently been designed and developed in the U.S.A., which by means of interchangeable coils tunes from 14 to 500 metres, and on this side of the Atlantic several commercial firms have marketed apparatus on similar lines, and have been mentioned in your recent issues. When once the art of "pulling-in" short wavers has been mastered it affords splendid opportunities for alternative programmes even with a good 0-v-2, although anyone with S.W. experience knows how "cranky" these waves are at times, but with modern tendency towards further efficiency on the H.F. side great possibilities await us on these lines. (Possibly even a simple anti-fading device.)

A knowledge that these irregularities—the "skip-distance" of the wave—is dependent upon the particular wavelength, time of day, atmospheric conditions, location, etc., will make reception of these transmissions just as popular as many "broadcast band" foreign receptions are to-day, which, as we all know, also have irregularities. Witness the reports on our own 5GB, which, by the way, I have received constantly at full strength over one thousand miles distant, but depending upon atmospheric conditions, location, etc.

Antrim, Ireland. W. E. M. CROOK.

B.B.C. PROGRAMMES.

Sir,—No doubt the indifference of the programmes of the B.B.C. during the last year or so is accounted for by the unhappy atmosphere which seems to pervade Savoy Hill.

Government control and red tape having proved a failure, why not put programmes in charge of those who *understand* the entertainment business? S. SLADE

Nayland, Colchester.

By Our Special Correspondent.

Prague Plan in Action.—London Regional's Aerial.—Anniversary of the Surprise Item.

5XX Controls the Ether.

How many listeners heard Daventry, 5XX, filling the rôle of ether policeman on June 20th and July 1st? On both these nights for a few hours after "close-down" 5XX relayed telephonic instructions from the Keston receiving station addressed to various broadcasting stations in Western Europe which were found to be straying from the new frequencies allotted to them under the Prague Plan.

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Measurements at Brussels and Keston.

The innovation was the outcome of an arrangement between the B.B.C. and the wavelength checking centre at Brussels. Measurements were taken both at Brussels and Keston, and, after notes had been compared *via* a private line, the results were passed on to 5XX. At nearly all the broadcasting stations west of Frankfurt official listeners were tuned-in on Daventry's wavelength in readiness for any instructions sent out. A similar arrangement operated successfully in Eastern Europe, measurements being compared by Prague and Koenigswusterhausen and the results transmitted from the latter station.

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Is the Prague Plan a Success?

Now that the Prague Plan has held sway for a week the prevailing impression is that it represents the best solution of the wavelength problem since 1926, when the Geneva scheme was first fashioned.

For a few weeks before the change on June 30th the Brussels scheme had been giving satisfaction in its own sphere, but we must remember that it omitted countries like Russia, France and Spain which are now included in the happy family.

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Hasty Judgment.

At the time of writing it is still too early to pass judgment on the scheme as a whole. In my own case I was tempted to do so on July 1st when my reception from London was ruined by an outrageous whistle. The noise stopped, however, when the man opposite, owner of a o-v-2 swinging coil set (1926 vintage), retired to rest.

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Progress at Brookman's Park.

Two of the four masts at the Brookman's Park regional station are now supporting a twin-wire aerial, but, according to Savoy Hill, this is no indication that tests are to begin immediately. A considerable amount of apparatus has still to be delivered, and it is improbable that the first transmissions will go out before the end of this month.

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B.B.C. as Pamphleteers.

To save members of the Technical Correspondence Department from nervous breakdown when London Regional 1 supersedes 2LO, nearly a quarter of a million copies are being printed of a new "Selectivity" pamphlet, which will shortly be distributed gratuitously to all who apply for it. A second pamphlet is being prepared to assist listeners in areas of poor signal strength. I can imagine trouble if the latter booklet were sent in error to a resident at Brookman's Park!

FUTURE FEATURES.

London and Daventry.

JULY 15TH.—"Versailles," a French Feature Programme.
JULY 16TH.—The Northern Command Searchlight Tattoo, S.B. from Leeds.
JULY 18TH.—Alhambra Ballet Music.
JULY 20TH.—Running Commentary on the Final of King's Prize, relayed from Bisley.

Daventry Experimental (5GB).

JULY 18TH.—Launching of H.M.S. "Exeter," H.M. Dockyard, Devonport, S.B. from Plymouth.
JULY 19TH.—"Followers," by Harold Brighouse.

Cardiff.

JULY 16TH.—A Penillion Recital.

Manchester.

JULY 15TH.—A Concert from Morecambe.

Newcastle.

JULY 19TH.—Orchestral Concert from the North-East Coast Exhibition.

Glasgow.

JULY 16TH.—Scottish Concert.

Aberdeen.

JULY 16TH.—"Scots Blend."

Belfast.

JULY 19TH.—"Carmen," by Bizet.

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Fifty-two Surprises.

The "Surprise Item" remains one of the brightest spots in the programmes, and, although the anniversary of the first of the series was celebrated last week, the B.B.C. still contrives to invest the item with the stunt flavour which was so welcome in the old days.

Among the fifty-two surprises of the past year, probably the most original was the relay from the signal box at King's Cross. Other outstanding items were the "red hot" dramatic criticism by two well-known authorities immediately following a broadcast play; the relay from film studios at Elstree; Tommy Handley's "General Election," and the playing of gramophone records—backwards!

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Grid Leak in Song and Story?

While on this subject it occurs to me that the Surprise Item might provide a fitting opportunity to do homage to the grid leak, the patent of which expires in October. On the day that the patent dies what would be more appropriate than a reverently prepared programme entitled, say, "Apotheosis of the Leaky Grid," in which this valuable component would be honoured in song and story? It is difficult at the moment to recall what the poets have sung about the grid leak, but I have no doubt that by October the B.B.C. programme department could ferret out some noble tributes. And on the musical side, what has Honegger to say?

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Talks on Flying.

A new chapter in the history of didactic broadcasting opens in September next, when the B.B.C. begins the first programme issued under the auspices of the Central Council for School Broadcasting, a body which is entirely independent of the B.B.C.

The syllabus appearing in the new B.B.C. booklet "Broadcasts to Schools," extends from September 23rd to December 13th, but a valuable feature to school teachers, I imagine, is the inclusion of the broad outline of the programme extending to June 30th, 1930.

A new venture is a series of fortnightly talks on Flying by Squadron-Leader W. Helmore, M.Sc., R.A.F., of the Royal Aircraft Establishment, Farnborough.

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By Special Request.

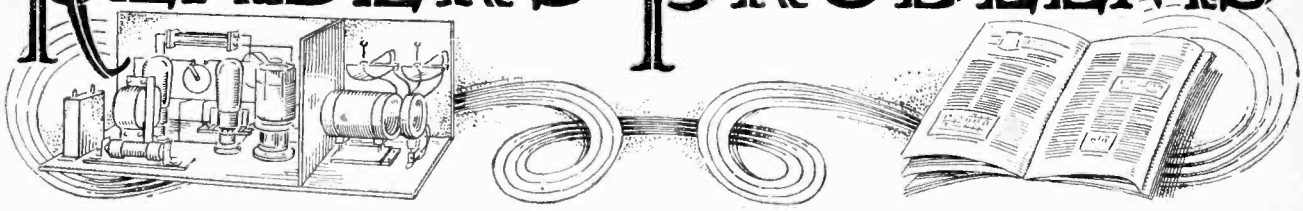
A disgusted listener telephoned to the offices of the American National Broadcasting Company during a musical performance.

"Do you ever play anything by request?" he asked.

"Sometimes," was the reply.

"Then," said the listener, "I'd be glad if you'd play draughts."

READERS' PROBLEMS



"The Wireless World" Supplies a Free Service of Technical Information.

The Service is subject to the rules of the Department, which are printed below; these must be strictly enforced, in the interest of readers themselves. A selection of queries of general interest is dealt with below, in some cases at greater length than would be possible in a letter.

Neutralising the S.G. Valve.

I have tried to put into effect the plan suggested in your recent article "More Amplification from Screen-Grid Valves," but have so far been unable to obtain satisfactory neutralisation over the whole of the medium broadcast waveband. The set is partially stable, but only when the neutralising condenser is set at minimum; from this it might be assumed that "balancing" is unnecessary in my particular case, but this is not so, as complete disconnection of the condenser makes matters very much worse. The performance of the set is already so promising that I mean to persist in my efforts. Can you give me any hints as to steps to be taken? An H.F. transformer is used as a coupling.

C. C. D.

Before making any alterations we think you would be well advised to assure yourself that your neutralising condenser has not got an excessively high minimum capacity, although there is no reason why the majority of standard components should not be used in this particular circuit arrangement.

If the condenser is normal it can be assumed with some confidence that your trouble is due to a balancing winding with too many turns; this is particularly likely to be the case if it is tightly coupled to the primary, and we suggest you should try an experimental reduction. In many cases a single turn, or even less than a turn, will be found to be ample, particularly when the capacities to be balanced out (those in the valve and incidental) are extremely small.

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Sense of Reaction Winding.

It seems to me that there should be a method of determining the correct connections of a reaction coil, and that it should not be necessary to find this out by trial and error. Is there any simple rule? W. T. P.

Provided that the convolutions of the coils are exposed and can be traced out to their terminals, it is an easy matter to determine the correct connection for the reaction coil.

The imple rule is that if we imagine oscillatory current to originate respectively on grid and plate of the valve, they should flow outwards through the coupled coils in opposite directions. This will be made clear by a consideration of Fig. 1, in which diagram (a) shows the correct connections.

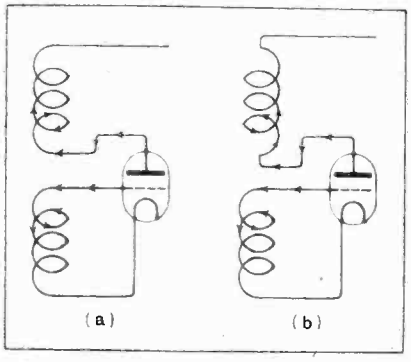

Fig. 1.—Illustrating an easily-remembered rule for determining reaction coil connections.

This rule holds good in any form of reaction circuit, whether feed-back is controlled by moving the relative position of the coils, or by varying the capacity of a feed condenser, as in the majority of modern circuits.

RULES.

(1.) *Only one question (which must deal with a single specific point) can be answered. Letters must be concisely worded and headed "Information Department."*

(2.) *Queries must be written on one side of the paper, and diagrams drawn on a separate sheet. A self-addressed stamped envelope must be enclosed for postal reply.*

(3.) *Designs or circuit diagrams for complete receivers cannot be given; under present-day conditions justice cannot be done to questions of this kind in the course of a letter.*

(4.) *Practical wiring plans cannot be supplied or considered.*

(5.) *Designs for components such as L.F. chokes, power transformers, etc., cannot be supplied.*

(6.) *Queries arising from the construction or operation of receivers must be confined to constructional sets described in "The Wireless World" or to standard manufacturers' receivers.*

Readers desiring information on matters beyond the scope of the Information Department are invited to submit suggestions regarding subjects to be treated in future articles or paragraphs.

Measuring Eliminator Output.

It is realised that an ordinary voltmeter connected across the output terminals of an eliminator will not give a true reading of the voltage existing under working conditions, but is it not a fact that it will show a true reading as long as it is connected in position?

In my particular case a simple A.C. eliminator, with a single voltage output, is used in conjunction with a three-valve receiver, and the meter (0-150 volts, 200 ohms per volt) shows a reading of 140 volts. The set seems to work extremely well, but can it be assumed that the voltage shown on the meter is that actually delivered to the set? V. S. C.

Yes, as long as the meter is connected it will show a true reading, but, as you apparently realise, there will be a rise in voltage when it is removed. It may be pointed out that if the meter were replaced by a fixed resistance having the same value as that of the instrument (30,000 ohms in your case), the voltage reading as indicated would be maintained.

oooo

Scope of Volume Control.

Is there any serious objection to using a pentode in the output position of a set embodying the general circuit arrangement of the "S.G. Regional Receiver?"

In order to obtain the best possible quality, it is realised that, when receiving strong signals from near-by stations, a good deal of the magnification afforded by the combination of detector and L.F. transformer coupling must of necessity be abandoned. I am uncertain as to whether a variable resistance shunted across the transformer primary will enable me to make a sufficient reduction in the L.F. voltage applied to the pentode when the detector is fully loaded. J. V. R.

You need have no doubts on these grounds; by setting the volume control resistance at a suitably low value, it is possible to bring about a very considerable reduction in the signal voltage passed on to the next valve. Actually, the regulation range of this form of control is greater than is normally required.

Comparative H.F. Measurements.

I am engaged in rebuilding my "Everyman Four" receiver; it is being converted for use with a screen-grid H.F. valve, and at the same time a separately tuned aerial circuit is being added, in order to provide the extra selectivity which it is expected will shortly be necessary in this district. It seemed to me that there was a good opportunity of comparing the relative merits, from the point of view of H.F. amplification, of the original and of the new circuit arrangement, and I have endeavoured to make measurements in the manner suggested in your issue of June 12th under the heading of "The Design of H.F. Transformers." Unfortunately, I have been unsuccessful, and all readings obtained are quite indefinite. Can you suggest a likely cause of failure? E. L.

It seems that the most probable reason for your inability to obtain definite comparative readings is that the voltages applied from your oscillator to the grid of the H.F. valve are either excessively small or perhaps even excessively large, but there should be little difficulty in so arranging matters that a suitable impressed voltage is obtained.

Your first step should be to try the effect of varying the output of the oscillator; assuming this to be of the parallel-feed, single-coil type described by our contributor and shown in Fig. 8 of the article to which you have referred; this may conveniently be done by altering the applied H.T. voltage. Again, a similar effect may be obtained by altering the coupling between the oscillator coil and the two-turn pick-up coil; you might possibly find it an improvement to use a single-turn coil for the transfer of energy.

It is possible that your connections are not correct, and, as a guide, we show a suitable arrangement in Fig. 2. From this you will see that the existing components in the H.F. grid circuit of the set itself should be disconnected and replaced by the coupling coil and a bias cell. No other alteration is necessary beyond the insertion of a low-reading milliammeter or a microammeter (the latter if your coupling resistance is of a high value) in series with the detector grid.

We would emphasise the point that the oscillator should be placed at some distance from the set, and that the leads between the pick up coil and the grid of the H.F. valve should be non-inductive —i.e., they should be run parallel and close together.

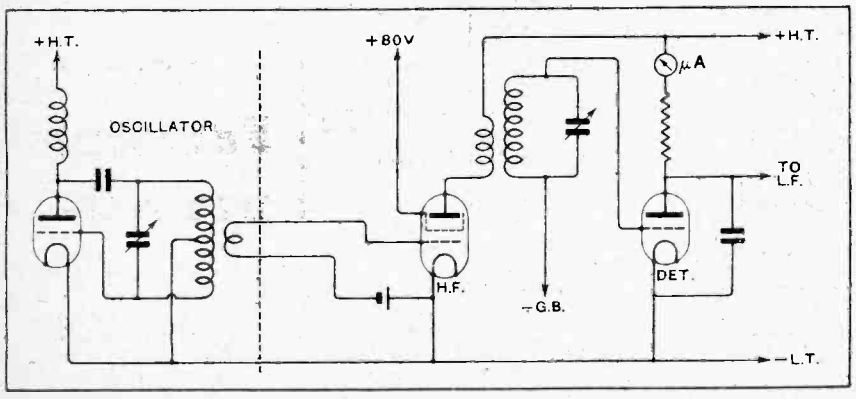

Fig. 2.—The detector as a valve voltmeter: a simple method of comparing H.F. couplings.

o o o o

Input Volume Control.

I am thinking of building the "Flat Dwellers' A.C. Three," modified for use with an open aerial in the manner suggested in your reply to "D. F. B." in your issue of May 22nd, but with the addition of a separately tuned aerial circuit. I should like to include a predetection volume control. Will you suggest a simple device? M. T. B.

It is probably true to say that the simplest method of making this addition is by connecting a high-resistance potentiometer (of 0.5 to 1 megohm) across the tuned grid circuit; instead of joining the H.F. valve grid directly to the high potential end of the circuit, it will be connected to the potentiometer slider.

o o o o

Too Good.

With a view to using the "Kilo-Mag Four" exclusively for frame aerial reception, I propose to wind special medium-wave H.F. transformers of 27/42 Litz wire. My aim, of course, is to increase amplification in order to compensate for the absence of an outside aerial. Is the plan workable? M. M.

It is hardly possible greatly to increase amplification in the way you suggest, as the use of secondary coils of a "goodness" considerably exceeding that of those specified will probably result in instability, provided the optimum number of turns are provided for the primaries.

Generally speaking, there is no point in using a "better" secondary winding than one with, say, sixty-five turns of 9/40 Litz on a 3in. former. Indeed, a transformer with this coil will probably be responsible for more amplification than can easily be handled in a two-stage set, but by choosing windings of perhaps unnecessarily low resistance it is fairly easy to adjust primaries till maximum amplification combined with stability is attained.

o o o o

Atmospherics or Power Circuit Interference?

Lately I have been troubled by "frying" and crackling noises in my loud speaker; these are particularly annoying when the set (a three-valve H.F.-det.-L.F. combination) is tuned to distant transmissions. The trouble is seldom evident when listening to my two nearest stations, and in any case the interference is weakened by detuning; it is completely obviated by disconnecting the aerial.

First-class components were used in building the set, and the terminals of my H.T. and L.T. accumulator batteries are kept clean. It seems that the interference must be due to external causes; is my assumption correct? L. D. M.

From the fact that the noises disappear when the aerial is disconnected, it can safely be assumed that the set and its accessories are free from blame, and, from your description of the symptoms, we think it almost certain that your trouble is due to atmospherics, which have been prevalent during the last few weeks. Of course, it is possible that some of the interference comes from neighbouring power circuits, but noises due to this cause are generally recognisable by their comparative regularity.

o o o o

Preparing for the Regional Transmissions.

Do you consider that a set with four separate tuning controls is impossibly difficult to operate? In this locality (within a few miles of Brookmans Park) it is to be expected that interference will be a serious problem, and I am wondering whether it would be advisable to add a separately tuned aerial circuit to my "2-H.F." receiver, which already has three dials. S. J. S.

If you have thoroughly mastered the operation of your set in its present form there is little reason to fear that the addition of an extra control will make much difference.

There is sometimes a tendency unduly to stress the difficulties of manipulating a multiplicity of tuning dials; in point of fact, when the number of controls is increased beyond one, or, perhaps more correctly, beyond two, any further additions, within reason, have very little effect in complicating operation. This is because a multi-control set must either be calibrated, or else it must be tuned by rotating each dial in turn through a few degrees in such a way that all circuits are maintained more or less in a state of resonance.

The Wireless World

AND RADIO REVIEW

(17th Year of Publication)

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METAL CABINETS.

IN the early days of amateur receiver construction the process of building a set was comparatively simple except when, in the absence of ready-made components such as we have to-day, it became necessary for the amateur to make these parts for himself. The actual assembling of the apparatus was easy, no screening was needed and no special precautions had to be taken with regard to the disposition of the parts; but as time went on, and the efficiency of valves increased, the need for greater care, particularly with regard to the H.F. side, became apparent if interaction between circuits was to be avoided. As valves still further improved in efficiency and the stage gain obtainable with specially designed low-loss H.F. couplings increased by leaps and bounds the amateur began to find that the art of the tinsmith had to be added to his other accomplishments before a modern receiver could be built at home.

The designers of *The Wireless World* sets have been concerned for some time past because of this difficulty in constructing metal screening boxes, and it is realised that for complete screening the home construction of an elaborate metal container is rather beyond the inclination and, perhaps, even the ability of the majority of those who construct experimental sets at home.

"The Wireless World" Design.

Having given very careful consideration to all the problems involved, the *The Wireless World* technical staff has proceeded with the design of metal cabinets on what are believed to be novel lines. A description of the principle of these cabinets, with general details, appeared in our issue of last week, and from this article it will be seen that it is possible to standardise the style of cabinets along these lines. The very great advantage is offered in this type of construction that all components and wiring of the set are readily accessible, wiring being done "on the flat," the main screening box fitting down over the set after the last wire has been connected.

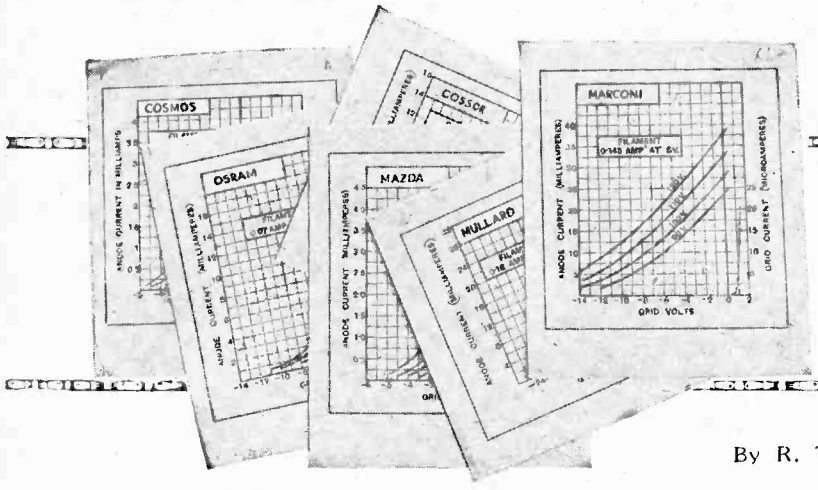
By standardising the size of metal cabinets it should, we believe, be possible for manufacturers to produce them at a price considerably below that at which they could sell cabinets specially constructed for each particular set. So long as an individual form of metal shielding is adopted for every new design of receiver the cost is bound to be high, and only by standardisation can one hope that the price can be reduced and the metal screening cabinet become readily available to the constructor.

* * * *

AMATEUR STATUS.

CORRESPONDENCE which we are receiving from readers indicates very clearly that our editorial notes on the question of the status of the British amateur were timely, and that there is throughout the country a very general feeling that the transmitting amateur is not receiving fair play from the authorities, and that, to a considerable extent, the amateur is himself to blame because he has neglected to hold his own with the Post Office and justify his existence.

We hope that the present opportunity which is given for a frank discussion of the situation may lead to a better understanding between amateurs individually and the various amateur organisations, so that, once again, as in the past, the amateur can show a united front and be in agreement as to the general policy which should be adopted to insure the continued existence of the British transmitting amateur as a factor in radio development in this country.



VALVE SELECTING CHARTS

By R. T. BEATTY, M.A., B.E., D.Sc.

A New Classification of Receiving Valves.

OUR modern newspapers supply a neat little weather chart every morning from which Mr. Everyman can, with a little concentration, predict a number of things about the coming day. He can make a fairly reliable estimate of the direction of the wind, the amount of rain fated to descend, and the number of hours during which the sun will shine.

But Mr. Everyman makes no estimates; he knows that just below this ingenious but boring chart the gist of the matter will be revealed in some such phrase as "dry and warm."

He investigates no farther; these two adjectives have settled for him the question of what he will choose for lunch and how he will spend his evening; he has made his daily weather classification. And so we leave him as he turns to the stimulating item of the vanished Park Lane money-lender.

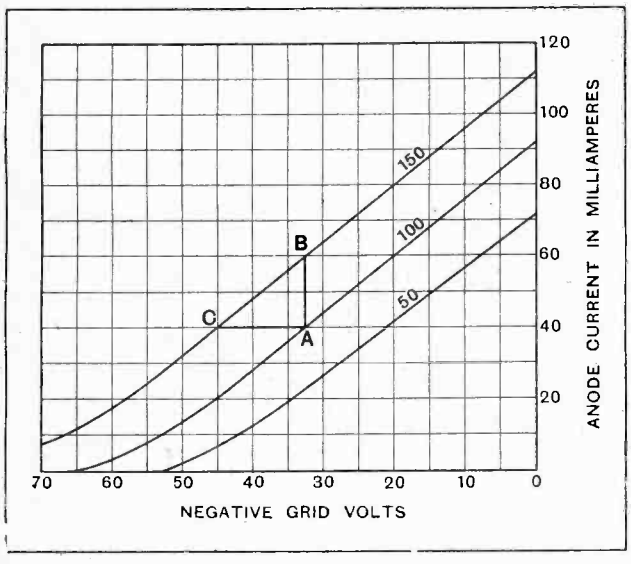


Fig. 1.—Typical valve characteristic curves from which valve A.C. resistance and amplification values can be readily determined.

Valve Charts.

Just as each day has its weather chart so each valve has its set of characteristic curves, published by its manufacturers, and people who are skilled in the study of such curves can deduce from them at a glance the most suitable place for a valve in a receiving set. Thus, in the case of the curves illustrated in Fig. 1 we see that in travelling from A to B the grid bias remains constant, the anode voltage rises by 50, and the plate current by 20 mA.; hence the *differential resistance* (A.C. resistance or impedance, R_0) is $\frac{50 \times 1000}{20} =$ 2,500 ohms, or the figure produced by the change in anode potential divided by the change in anode current in amperes.

Again, in travelling from A to C the plate current remains the same, the grid bias alters by 12.5 volts, and the plate volts alter by 50; hence the *voltage amplification factor* (μ) is $\frac{50}{12.5} = 4$, or the change in anode potential divided by the change of grid bias. It is now evident that we are dealing with a power valve; its resistance of 2,500 ohms will match well with a 2,000-ohm loud speaker, and the plate current is sufficient to give adequate volume to fill a fair-sized room. We may indeed discard the set of curves, since we have extracted from them two essential ingredients.

R—Differential resistance (also called impedance and anode resistance) = 2,500 ohms.

μ—Amplification factor = 4.

Classification of Valves by R and μ.

This result suggests an arrangement of valves according to their values of R and μ, and on Chart I the figures have been plotted in this way on logarithmic paper.[1] In order to avoid crowding the diagram, a selection of typical valves has been made, and these extend in

[1] A somewhat similar classification has recently been made for French valves by D. Deraux, in *L'Onde Electrique*, 1929, p. 38.

Valve Selecting Charts.—

an irregular procession from the south-west, where the power valves are stationed, to the north-east, the region of screen-grid valves, in which AC/S (R=800,000, μ=1,200) occupies a solitary position.

A number of dotted lines sloping diagonally across the chart is shown, and along each of these the mutual conductance is constant, its value being marked on each line. Most of the members of the procession keep within the two limiting dotted lines.

The Valves are Arranged in Groups.

A little investigation of the chart shows that from head to rear of the procession the valves are arranged in definite groups. As in an army deploying for attack, the regiments advance in succession, so each class of valve has its special location in this procession. The separation of the different classes, however, is not perfectly sharp, and the analogy would be more complete if we consider the troops in the early stages of the actual attack, when obstacles have been met and slight con-

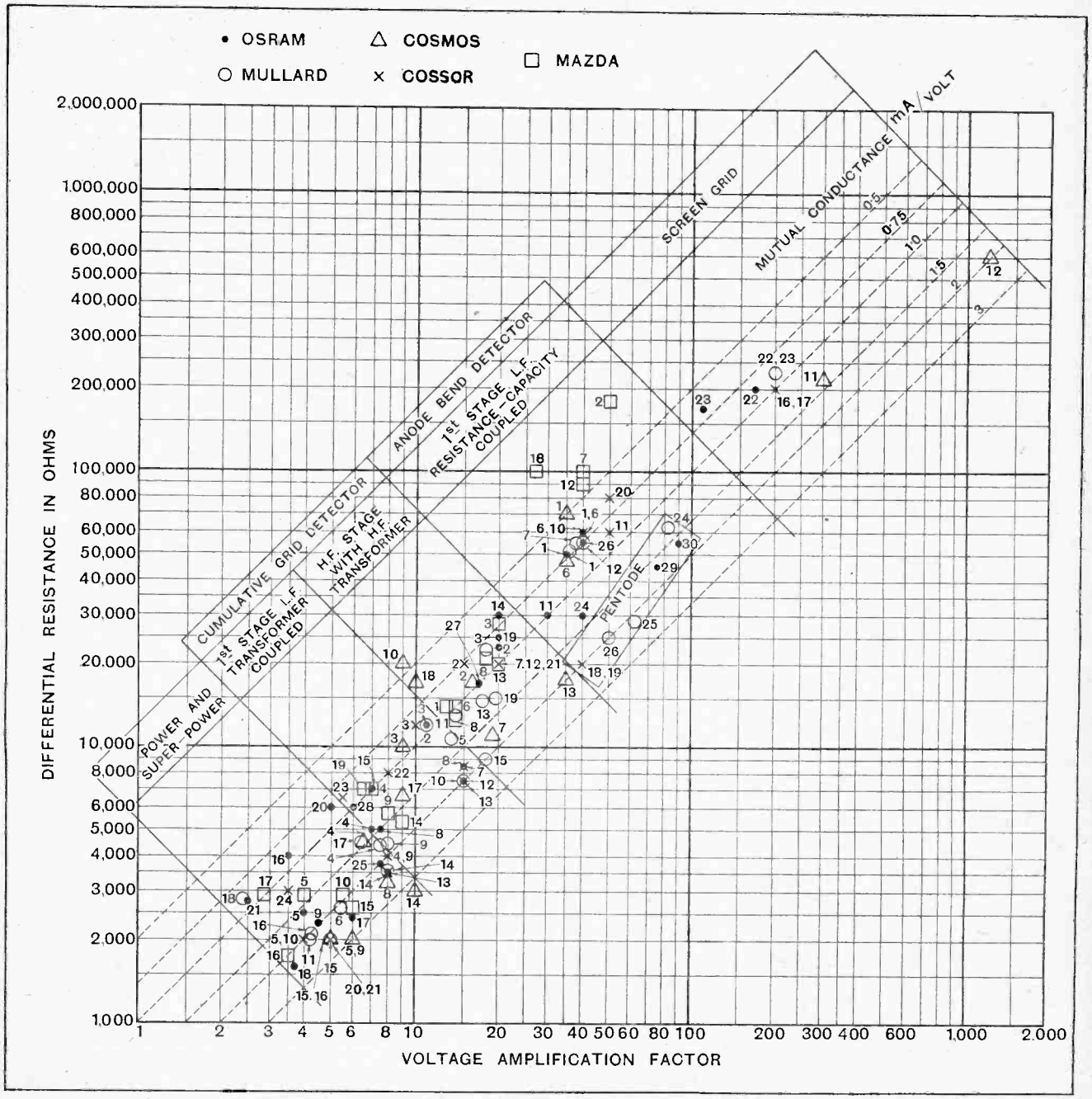


Chart I.—The suitability of a valve for a particular position in a receiver is revealed by finding its location in the centre cross chart by reference to its values of A.C. resistance and amplification factor.

Valve Selecting Charts.—

fusion has arisen so that men of different regiments find themselves standing side by side.

With this limitation in mind, we may proceed to draw a number of parallel lines running athwart the procession, and so divide it up into a series of groups.

Screen-Grid Valves.—At the head of the procession stand the screen-grid valves; they are remarkable for their extraordinarily high values of resistance and amplification, while their mutual conductance is scarcely inferior to that of a power valve. These valves are eminently fitted for high-frequency amplification with tuned plate coils or high-frequency transformers. The large mutual conductance ensures high amplification, the large resistance has but little shunting action on the plate circuit and so the selectivity is good, and finally the very small capacity between plate and grid confers stability. These valves are definitely separated from their neighbours; they do not spill over into the adjoining compartment.

Anode Bend Detectors.—Next come valves suitable either for anode bend detection or for first stage L.F. amplification with resistance-capacity coupling: they are grouped about a region where $R = 50{,}000$, $\mu = 40$. High amplification is desirable for sensitivity, and in this group it has been pushed as far as is at present possible with triodes. The high valve resistance which obtains in this group is actually undesirable, since it absorbs a considerable amount of the A.C. voltage which should appear across R_1 (Fig. 2): valve designers, however, are unable at present to solve the problem of making μ large and R small simultaneously.

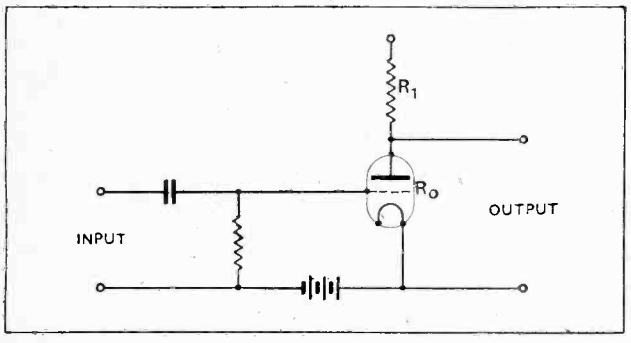


Fig. 2.—Schematic circuit representing an anode bend detector, or with a less value of grid bias a first stage amplifier. The stage amplification is $\frac{\mu R_1}{R_1 + R_0}$, a figure which advances with increase of μ (valve magnification factor) and reduction of R_0 (valve A.C. resistance).

We must not assume, however, that the most suitable valve in this group is one which has the lowest resistance: such a valve will probably pass a large plate current of perhaps 2 mA., which would require 200 volts to drive it through a plate resistance of 100,000 ohms. If a H.T. potential of 150 volts is used probably 120 volts will be absorbed in the resistance, leaving only 30 volts on the plate, under which conditions the valve resistance would be much greater than its normal value.

High-Frequency Amplifying Triodes.—The high-frequency valve occupies a delicate and difficult position. Situated as it usually is between a tuned input system and a tuned plate system, its function is to receive potentials from the former and hand them on with increased intensity to the latter. At the same time it must prevent potentials from leaking back in the reverse direction: if it fails in this duty these two highly resonant systems will fall foul of each other and uncontrollable oscillation will result.

KEY LIST OF VALVES.

	OSRAM. ●	MULLARD. ○	COSMOS. △	COSSOR. ×	MAZDA. □
1	DEH 210	PM 1A	SP 16/B	210 RC	GP 210
2	HL 210	PM 1 LF	SP 16/G	210 HF	RC 210
3	DEL 210	PM 1 HF	SP 16/R	210 LF	HF 210
4	DEP 215	PM 2	SP 18/RR	220 P	LF 215
5	DEP 240	PM 2 DX	SP 280/P1	230 XP	P 227
6	DEH 410	PM 252	SP 610/B	410 RC	GP 407
7	DEL 410	PM 3 A	SP 610/G	410 HF	RC 407
8	DEP 410	PM 3	SP 610/RR	410 LF	HF 407
9	P 425	PM 4	SP 625/P	410 P	LF 407
10	DEH 610	PM 4 DX	DE 50	415 XP	P 415
11	HL 610	PM 254	SP 215/S	610 RC	GP 607
12	DEL 610	PM 5 B	AC/S	610 HF	RC 607
13	DEP 610	PM 5 X	AC/G	610 LF	HF 607
14	DE 5 B	PM 6	AC/R	610 P	LF 607
15	DE 5	PM 6 D	AC/P1	610 XP	P 615
16	DE 5 A	PM 256	AC/P2	220 SG	PX 650
17	P 625	DFA 6	AC/227	410 SG	B 12
18	P 625 A	DFA 7	AC/X	230 PT	Two-stage valve.
19	LS 5 B	DFA 8		415 PT	TS 215
20	LS 5	DFA 9		M 41 RC	
21	LS 5 A	DO 20		M 41 HF	
22	S 215	PM 12		M 41 LF	
23	S 625	PM 14		M 41 P	
24	KH 1	PM 22		M 41 XP	
25	KL 1	PM 24			
26	H 8	PM 26			
27	HL 8				
28	P 8				
29	PT 0.8				
30	PT 235				

The maximum stage gain from grid to plate can only be obtained by co-operation between the valve and the tuned plate circuit. With triodes a neutralised step-up transformer is required, and it can be shown[2] that the best step-up ratio from primary to secondary is given by the formula:—

Square of turns ratio = parallel resistance of secondary circuit divided by valve resistance,

$$\text{or } n^2 = \frac{R_2}{R_0}$$

where n is the turns ratio, R_2 the resistance at resonance, and R_0 the differential or A.C. resistance of the valve.

When the transformer is thus designed to suit the valve resistance the stage gain is:—

half the valve amplification × turns ratio[3]

$$\text{or } A = \frac{\mu}{2} \times n$$

[2] McLachlan, *Experimental Wireless*, 1927, p. 599; Harmon, *The Wireless World*, Vol. 22, 1928, p. 144.

[3] Harmon, *The Wireless World*, Vol. 22, 1928, p. 144.

Valve Selecting Charts.—

$$\text{or} \quad A = \frac{\mu}{2} \times \sqrt{\frac{R_2}{R_0}}$$

Thus a change of valve will leave the stage gain unaltered, provided $\frac{\mu}{\sqrt{R_0}}$ remains the same: this quantity, the magnification factor of the valve, divided by the square root of its A.C. resistance, may be regarded as a figure of merit of the valve as regards its amplifying

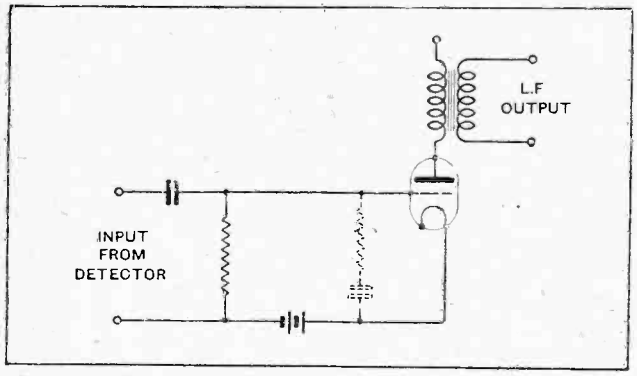


Fig. 3.—A first stage L.F. amplifier followed by a transformer coupling. The transformer load is transferred back through the grid-plate capacity and appears as an input impedance as shown in dotted lines. This impedance shunts the grid leak at high audio frequencies when μ is too large.

power. R_2 may easily attain a value of 160,000 ohms at broadcast frequencies with a solid wire coil wound on a 3in. former and a stage gain of 30 can be then obtained if $\frac{\mu}{2}\sqrt{\frac{160{,}000}{R_0}} = 30$, or $\frac{\mu}{\sqrt{R_0}} = \frac{3}{20}$.

This relation between μ and R_0 would appear as a straight line on the chart joining the points $A = 90{,}000$, $\mu = 45$, and $R = 10{,}000$, $\mu = 15$. If the reader will draw this line, which corresponds to a stage gain of 30, he will see that a number of valves lie in its vicinity, both in the anode bend compartment and the H.F. compartment, and even among the power valves, so that at first sight it would seem that a wide range of triodes is available for H.F. amplification.

But this range is narrowed down by the necessity for stability, which becomes more insecure as μ increases. If the triode is used without a neutralising circuit stability cannot be obtained anywhere along this line, and even with a neutralising circuit the balance is not perfect over the whole tuning range, and it is found by experience that it is unwise to allow μ to exceed 30. This limits the upper range. The lower range is also limited by the fact that with triodes of small impedance the plate current is unnecessarily large. Accordingly, the useful H.F. triodes are actually contained within the compartment assigned to them on the chart.

First Stage L.F.-Transformer Coupled.—In this type of circuit the valve is followed by an iron-cored transformer which, if of mediocre quality, may have a primary inductance not exceeding 30 henrys. At 50 cycles the reactance of such a primary winding is $2\pi \times 50 \times 30$, say 10,000 ohms, and if the valve resistance exceeds this value considerably, the low notes will be attenuated.

A large value of μ would result in large amplification, but here again a limiting condition occurs. The transformer load is transferred back through the internal grid-plate capacity, and appears as an input impedance between grid and filament (Fig. 3). At the higher audio-frequencies this input impedance consists of a resistance in series with a capacity, and its effect is to attenuate appreciably the high notes coming from the detector if μ is allowed to rise much above 10.[4]

Power Valves.—These bring up the rear of the procession: they are characterised by low A.C. resistance and large mutual conductance. On the chart the power and super-power valves are jumbled together, since the values of plate current and plate voltage have not been incorporated.

These valves can be better exhibited as in Chart 2, where they are located according to plate current and

[4] McLachlan, *The Wireless World*, Vol. 22, 1928, p. 465.

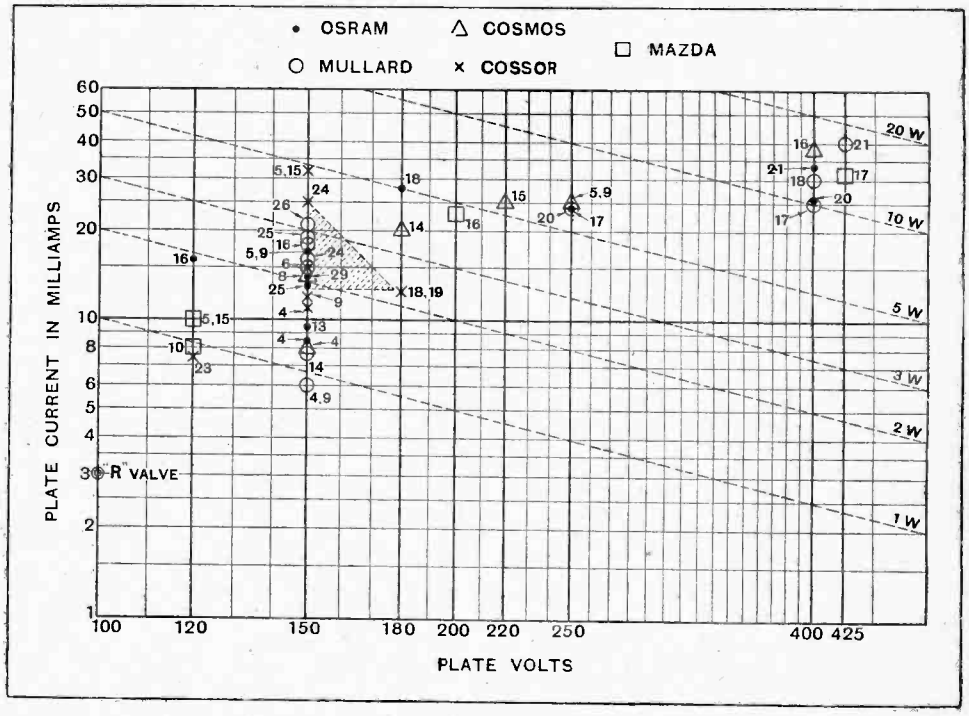


Chart 2.—Power valves classified according to anode current and voltage.

Valve Selecting Charts.—

voltage. The dotted lines crossing the diagram are lines of constant power dissipation at the plate, and valves lying above the 5-watt line may be considered as super power. The power ranges from 17 watts downwards, while right at the bottom is the War-time "R" valve, which at that time ranked as a power valve with a consumption of 0.3 watt!

The pentodes occupy an anomalous position on the chart: they lie within the shaded region at an average level of 3 watts plate dissipation, and so would appear to be excluded from the super-power series. But, owing to the peculiar shape of their characteristic curves, the fraction of this power which they can deliver to the loud speaker without distortion is about $2\frac{1}{2}$ times as great as in the case of triodes, so that really they belong to the 7.5 watt level and attain to super-power rank.

General Survey of Chart 1.—Reverting to Chart 1, we see that the procession of *triodes* does not march parallel to the dotted lines, but that as the head is approached there is a distinct tendency to move into regions of smaller mutual conductance. This regrettable feature is an inherent property of triodes: as μ is increased the mutual conductance tends to decrease.

But the advent of the tetraodes (screen grid) and pentodes has straightened out the line of march. The new valves have been brought in to redress the balance of the old. Remove the plate from a tetrode and a triode remains with practically the same mutual conductance, but with a μ of about 7. Replace the plate and the valve, keeping on the same dotted line, moves up to the front, with a μ of, say, 200. The fourth electrode was introduced to diminish the plate-grid capacity and so confer stability on H.F. circuits, but as an almost accidental result the value of R rose to about 200,000 ohms, giving the additional benefit of increased selectivity.

Again, the basis of the pentode is a power valve with, say, μ of 5 and mutual conductance of 2. Add an extra electrode and it moves along its dotted line into the pentode region, but possesses a nasty kink in its characteristic curves which interferes with its use as a power valve. Add a second additional electrode and the kink disappears, and the characteristics take such a shape that the pentode can deliver two and a half times as much power as the triode from which it sprang.

FADING VARIATIONS.

Fluctuations in signal strength caused by fading are usually troublesome in long-distance working, but are particularly so in the case of picture transmission. From time to time various suggestions have been made with the object of securing an automatic regulation or volume control which will render reception independent of the fluctuating attenuation of the ether. One such method is to transmit a special "control" impulse of a frequency lying outside the band of signal frequencies. In reception this is utilised to adjust the amplification factor of the receiving valves, preferably by automatically varying the initial grid bias of the first stage of amplification. When fading is strongly in evidence the initial valve amplifier of the receiver is in this way made more sensitive, and vice versa.

A single "control" frequency does not, however, invariably compensate for the particular type of fading caused by interference between the space-wave and earthbound components of the main signal energy. In order to overcome this deficiency it has recently been proposed to modulate the "control" impulse or note so that the latter comprises a "complex" of frequencies all lying outside the main signalling band. The control of the receiver is then continuously effective, since the current input used to adjust the initial grid bias is the average value of a sinusoidal wave and never sinks to zero. (Patent No. 298,463.)

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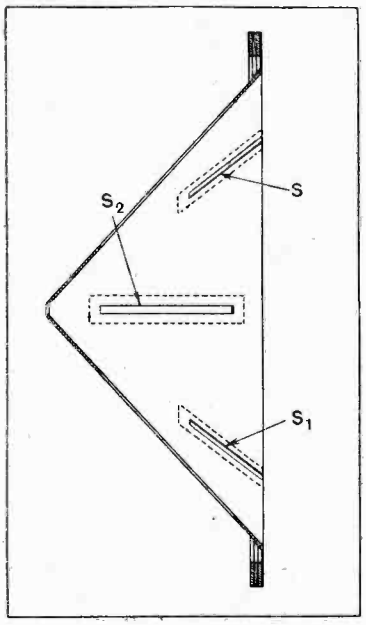
LOUD SPEAKER CONES.

Excellent reproduction over a wide-frequency range, with a particularly favourable response to the lower notes, is stated to be the result of cutting a series of radial slots in a conical diaphragm. The method is due to S. G. Brown, F.R.S. (Patent No. 301638), and is illustrated in the figure, where short slots S, S_1 are shown extending from the edge inwards, whilst a longer slot S_2 is cut intermediately.



Radial slots with tissue paper covering to improve the behaviour of a loud speaker diaphragm.

The favourable action is due to the fact that the existence of the slots adds to the flexibility of the diaphragm, and at the same time allows a certain amount of circumferential expansion under the influence of low-frequency vibrations. The slots are preferably covered over by strips of thin tissue paper or other flexible covering, so as to prevent the setting-up of undesirable short air paths between the back and front of the diaphragm.

PATENT NOVELTIES.

Books and Catalogues Received.

Messrs. Burne-Jones and Co., Ltd., Magnum House, 296, Borough High Street, London, S.E.1. — Illustrated leaflets of "Magnum" components and descriptive folders dealing with portable, trasportable, and "Universal Three" receivers.

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A.E.G. Electric Co., Ltd., 131, Victoria Street, London, S.W.1.—Illustrated leaflets of A.E.G. double-scale moving-coil voltmeters.

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Messrs. A. C. Cossor, Ltd., Cossor House, Highbury Grove, London, N.5.—Illustrated folder describing the Cossor Pentode. Also "The Cossor Wireless Book," devoting 64 pages to the "Cossor Melody Maker."

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Messrs. C. A. Vandervell and Co., Ltd., Acton, London, W.3.—Price list of C.A.V. accumulators.

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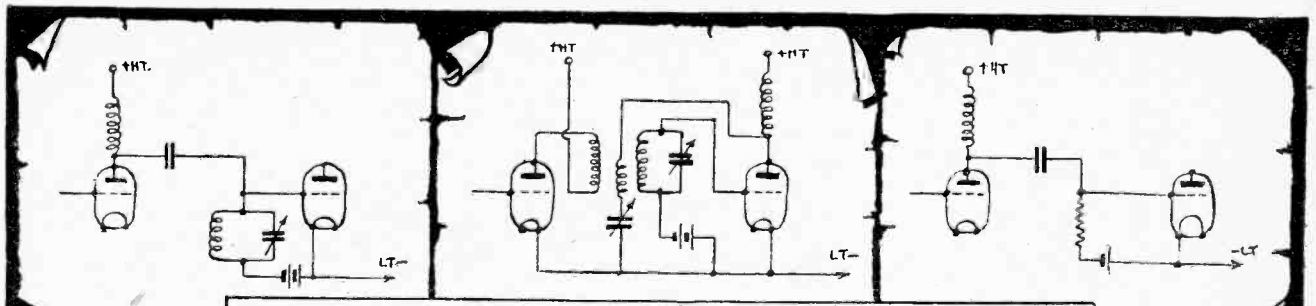
International Convention for the Safety of Life at Sea.—Signed at London, May 31st, 1929. Issued by the Board of Trade, London. In English and French. Pp. 119 (double). Published by H.M. Stationery Office. Price 4s. net.



The DESIGN of H.F. CHOKES

Method of Testing H.F. Chokes to Ensure Maximum Efficiency.[1]

SINCE the very earliest days of radio telegraphy, H.F. choke coils have played an important part in both transmitter and receiver circuits. It is with regard to the latter application that these notes have been written, and attention will naturally be focused on the modern uses of such coils. It will be as well, perhaps, to remember that a "choking coil" of any kind is an A.C. electrical device which will offer a high impedance to the passage of electrical energy when A.C. voltages are applied to it at the frequency or range of frequencies for which it is designed. Such a device must of necessity offer a comparatively low resistance to direct currents.

H.F. choke coils which are to be suitable for *all* the circuit arrangements to be found in modern radio receivers must, however, possess an additional property which is of the utmost importance in certain circumstances. This property is that the coil must show practically no sign whatsoever of "energy absorption" when voltages are applied to it at the wavelength or frequency bands for which it is to be used. It is a comparatively simple matter to design a choke coil which will give very low "absorption" over a small band of wavelengths such as 200-400 metres, and which will at the same time maintain an effective impedance of high order. When the waveband, however, is extended to cover, say, 200-2,000 metres, the problem becomes more difficult and requires careful experimental work for successful solution. Part of a circuit arrangement in a typical modern radio receiver calling for this special design of H.F. choke is shown in Fig. 1. The screen-grid valve has this H.F. choke in its main anode circuit, and the H.F. voltages developed across it will be almost identical with the voltages across the following tuned-grid circuit, which is virtually in parallel with the choke. The operation of this arrangement may seem somewhat obscure at first sight, but may be satisfactorily explained as follows: When H.F. voltages at any one frequency are applied to the grid filament circuit of the screen-grid valve, practically zero H.F. voltage will exist over the H.F. choke and the following grid circuit, unless the circuit is tuned to the frequency being used. This is due to the second grid circuit acting as a complete "damper" to the first anode circuit or H.F. choke, the H.F. choke here having an impedance which, even with badly designed chokes, is far higher than that of the non-resonant following circuit. Tuning this second grid circuit to resonance, however, will restore the high effective anode impedance required, *provided that the H.F. choke itself does not show any signs of absorption at this frequency.*

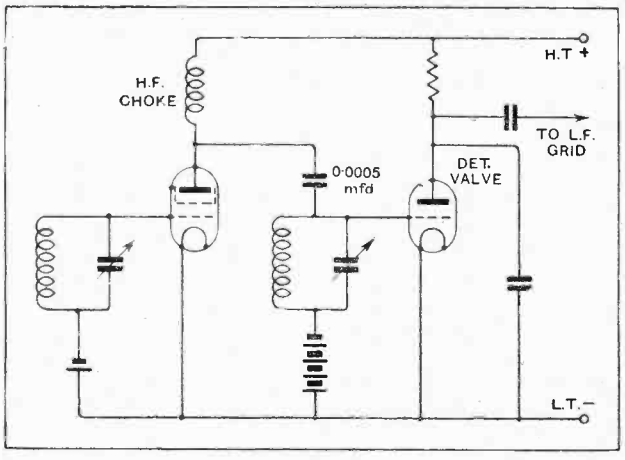


Fig. 1.—Typical parallel-feed coupling for a screen-grid H.F. amplifier.

Testing Circuit.

Fig. 2 shows a simple arrangement which is suitable for giving careful "absorption" tests on various types of H.F. chokes. The essential features are:—

(1) A low-loss screened variable air condenser.

(2) Calibrated valve voltmeter.

(3) Non-reactive radio frequency variable resistance box. (Constant with change of frequency.)

(4) Typical receiver tuned circuit coils.

(5) Calibrated C.W. wavemeter.

The double-pole double-throw switch will parallel any H.F. choke under test with the resonant tuned circuit, which is energised by the C.W. wavemeter. The single-

[1] Contributed by the Research Staff of R.I., Ltd.

The Design of H.F. Chokes.—

pole double-throw switch is used for short-circuiting the resistance box. The general method of operation is to set the C.W. wavemeter to generate at the wavelength required, then connect the H.F. choke under test to the double-pole double-throw switch and set this switch to "choke out." Short circuit resistance box by means of single-pole double-throw switch and couple the wavemeter loosely with the tuning coil suitable for the wavelength. Adjust the condenser very carefully to give maximum resonant voltage across the tuned circuit; in the test results given here, a voltage of approximately 2 was adhered to throughout (V_1). Note the variable air condenser reading (C_1) and then set the double-pole double-throw switch to "choke in"; retune the circuit to resonance and read C_2 and V_2 *without changing the wavemeter coupling*. For a band of wavelengths, therefore, a curve may be drawn showing 100 V_2/V_1 (percentage of original voltage upon inserting choke in parallel) as ordinates, against wavelength as abscissæ. The tests should be performed with great care at as many wavelengths within the band as is practicable, otherwise "absorption" points will not be revealed. If absorption is suspected close to any one or more wavelengths it will be wise to explore closely around these wavelengths to obtain the true curve shape.

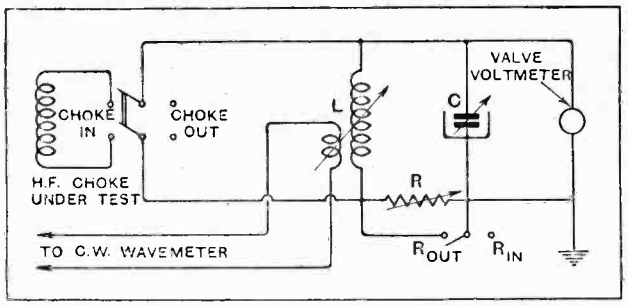


Fig. 2.—Schematic circuit diagram of apparatus used in taking the curves shown in Fig. 3.

A measure of the "inserted series resistance" effect of the choke on the tuned circuit may be readily followed at any one or all of the test wavelengths by opening the single-pole double-throw switch and setting the resistance box to read, say, 3 ohms for short-wave tests, or, say, 10 ohms for long-wave tests; then repeat the test as before, and, after reading V_2, *reduce* the resistance box to some reading which will increase V_2 to give the original voltage V_1 *without any change of coupling*. It may be necessary here to retune slightly. Both the value of the percentage of original resonant voltage and "inserted series resistance" depend greatly upon the effective resistance of the tuning coils used for the tests, so that typical moderate or low-loss coils must be used.

The effective capacity of the choke may be obtained directly either as a positive or negative value by calculating the difference between condenser readings C_1 and C_2 for any given wavelength. When C_2 is less than C_1, the choke is acting as a resultant condenser; when C_2 is greater than C_1, it is acting as a resultant inductance; when C_2 exactly equals C_1, the choke is completely non-reactive at this wavelength. Nearly all of the commercial types of H.F. chokes for use between 200 and 2,000 metres, tested under these conditions, show absorption on the short-wave band, some to such a degree on one or more particular wavelengths rendering the choke completely useless for the "choke anode feed followed by coupled tuned-grid circuit" method of H.F. amplification. Careful experiments performed showed the desirability of producing a choke having an actual total self-inductance somewhat lower than that of many commercial types, but with individual section inductances of moderately high order.

The final design (dual astatic type) found the best

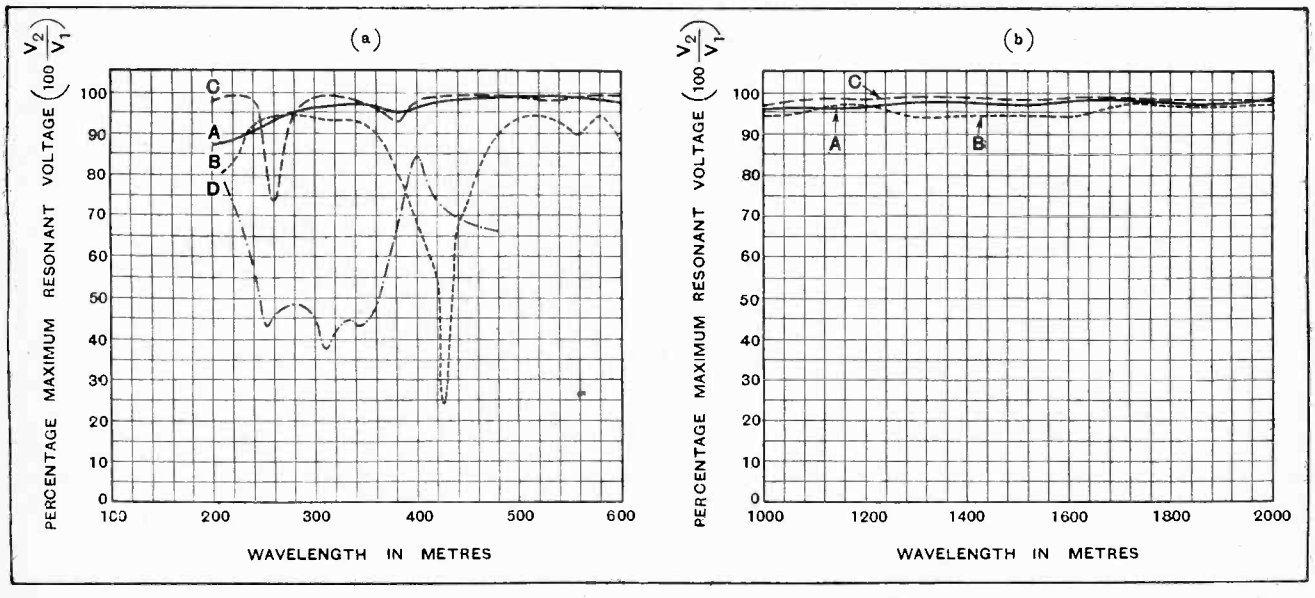


Fig. 3 (a) and 3 (b).—Absorption curves of some representative chokes taken under conditions equivalent to the circuit of Fig. 1. Choke A in each case is of the dual astatic type; chokes B, C and D are non-astatic.

The Design of H.F. Chokes.—

for the wavebands 200-600 metres and 1,000-2,000 metres, gave the curve shown by the thick line A. Other types (both experimental and commercial) gave curves marked B, C, etc. The absorption wavelengths as shown by these curves are very marked indeed for some types of H.F. chokes, so much in some cases that at their particular absorption wavelengths the chokes concerned are likely to give very serious trouble when used in the circuit mentioned previously.

Internal resonances are responsible for these serious faults in H.F. chokes, and practically nothing can be done to improve them except a radical alteration in design. A small or moderate change in turns will give a slight shifting of the absorption points, but is usually quite ineffective as regards complete elimination of them. The curves for 1,000-2,000 metres show that there is no difficulty in design as regards this section of the broadcast bands. It was found that with the majority of H.F. chokes tested, freedom from absorption could be seriously lowered by the proximity of metallic screens. Thus it would appear definitely desirable that H.F. chokes should be wound astatically in order that these screening effects should be reduced to a minimum and to avoid interaction effects between H.F. chokes and associated tuned circuits.

Cases in which H.F. chokes are used in the anode circuits of detector valves are of less importance, due possibly to the ease with which the operating conditions may be varied. The usual function of a choke in this position is to act purely as a barrier to H.F. components or currents present in the anode output circuits of these valves.

Chokes as H.F. Barriers.

This is necessary both for the satisfactory operation of reaction devices and to prevent the amplification of high- or radio-frequency currents by the L.F. section of the receivers. Energy absorption by a choke when used in this position may exercise a marked effect upon the apparent selectivity of the receiver when the reaction coupling is advanced to just below the oscillation point. The selectivity appears to become much worse rather than better as the reaction coupling is increased. In cases where capacity controlled reaction is used, any increase of the capacity whilst increasing the reaction coupling will obviously introduce the H.F. choke losses into the tuned circuit and give flatness of tuning with poor selectivity.

It is thought that these notes will be of great assistance to the designers of radio receivers, in view of the increasing popularity of the H.F. choke parallel anode feed system for S.G. valves, the advantages of which are becoming increasingly well known.

MODES OF APPLYING REACTION.

DESPITE recent advances in high-frequency amplification, it is probably true to say that the vast majority of receivers in use to-day employ reaction as the chief aid to long-distance reception, for it is still not uncommon for an H.F. valve to be little better than a passenger. The consideration of the most convenient mode of applying reaction is therefore a matter of interest to a very large number of listeners.

The favourite method a year or two ago, when plug-in coils were in vogue, was to connect a reaction coil, which could be variably coupled to the aerial coil, directly in the plate circuit of the detector valve. Even though a geared coil-holder was employed, this method was never very satisfactory, the chief reason for this being that the proximity of the reaction coil upset the tuning to such a degree that extensive retuning was necessary after every alteration in reaction coupling. The interdependence of the two controls made the tuning-in of a distant station an unnecessarily troublesome process.

Reinartz Reaction Difficulties.

The Reinartz circuit offered an improvement in this direction, but in its original form in which the reaction coil was wound as a continuation of the tuning coil and the reaction condenser was connected between the end of this coil and the plate of the valve, another difficulty made its appearance. This was due to the fact that both sides of the reaction condenser were at a high-frequency potential relative to earth, so that hand-capacity effects were liable to be very marked. Metal panels and other forms of screening are not very helpful in this connection, because in any normal case the spindle of the condenser is metallically connected to the moving plates, and as the spindle has to project through the panel for control purposes the screening is necessarily imperfect.

Later modifications of the Reinartz circuit have done away with this difficulty by connecting the reaction coil direct to the plate of the valve, and interposing the reaction condenser between this coil and earth, so that provided the moving plates of the latter are joined to earth, a metal-lined panel can be used to remove any lingering traces of hand-capacity effects.

If this type of circuit, which is perhaps the most satisfactory of all, be adopted, it is found that the tuning can be made sufficiently independent of the reaction control to make adjustment of the receiver easy, though it is usual for the setting of the reaction condenser to vary widely over the different parts of the tuning range. This, however, is not found to make tuning difficult, and so is of but little practical importance.

It is found in practice that the greatest degree of independence between the controls is attained when the reaction condenser is not too small. It is therefore easier to handle a receiver in which the reaction coil is small, or loosely coupled to the tuned circuit, but is fed through a condenser of maximum capacity, perhaps 0.0003 or 0.0005 mfd., than one in which the same degree of reaction is obtained by the use of quite a small condenser in conjunction with a large coil.

The remarks here made are equally applicable to receivers in which a stage of high-frequency amplification precedes the detector, even although in this case critical reaction should be required less frequently and is, in fact, often dispensed with altogether.

Events of the Week in Brief Review.

ONE PIRATE PER ROAD.

At the Brentford Police Court last week an official of the Richmond Postal Staff stated that one unlicensed wireless set was found on the average in each road.

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TWIN-WAVE TRANSMISSION FROM SPAIN.

The Barcelona (EAJI) station proposes to erect a short-wave transmitter on the summit of Monte Tibidabo, in close proximity to the present aerial, with the object of transmitting programmes simultaneously on medium and short wavelengths.

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HOSPITAL ASKS FOR HEADPHONES.

An appeal for 150 pairs of headphones is being issued by the Selly Oak Hospital, Birmingham. The Hospital Committee believes that there must be many pairs of discarded headphones throughout the country owing to the advent of the loud speaker.

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TRAIN WIRELESS DIFFICULTIES.

The Paris-Orleans Railway has temporarily abandoned the idea of establishing a regular service of broadcast reception on express trains. Experiments have been conducted at intervals ever since 1923, but it is realised that atmospherics and other extraneous noises have still to be conquered before a reliable service is possible. The company's engineers contend that their aims will only be achieved when the French broadcasting stations create a strong enough field strength to "smother the parasites."

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THE MULTIPLE CONDENSER PATENT.

A mild sensation has occurred in the American radio industry due to a notice received by the leading firms claiming that they are infringing a basic patent recently granted by the U.S. Patent Office. The patent, bearing the name of Walter S. Lemmon, is held by Radio Industries, Inc., and covers the multiple condenser, tuned by "gang control."

Companies which have received warning notices include Kolster, Radio Corporation of America, Bosch, Grigsby-Grunow, Zenith, and Stromberg-Carlson.

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SUNDAY CONCERTS FROM HOLLAND.

Listeners in Britain continue to express their appreciation of the Sunday evening broadcasts from Hilversum arranged by Kolster-Brandes, Ltd. The next concert will be given on July 28th at 5.40 p.m., when selections will be played by Hugo de Groot's orchestra. Hilversum's wavelength is 1.875 metres.

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BUYING BY BEAM.

A bid by beam wireless from South Africa secured one of the lots auctioned last week at Blyth, Northumberland, property sale.

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TILL WINTER COMES.

As the holiday months in Paris and the consequent closing down of theatres brings about a dearth of broadcast artists, *Radio Vitus* has decided to suspend its transmissions until October next, when the station will increase its power.

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MEDALS FOR BRAIN WAVES.

The Fifth International Exhibition of Inventions will open on October 2nd at the Central Hall, Westminster. As in previous years, in addition to the trade exhibits, there will be a New Inventions Section. Gold, silver and bronze medals will be competed for.

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THE LUNCH KIT PORTABLE.

A contributor to our esteemed American contemporary, Q.S.T., has discovered that a metal case of the kind used for lunch kits makes an excellent container for a portable set. The compartments provided for plates, bottles, etc., are used for shielding purposes.

WAVELENGTH SHUFFLING IN HOLLAND.

Severe criticism from listeners in Holland has been levelled at a decree made by the Netherlands Government authorising the Dutch broadcasting stations to exchange wavelengths at different times of the day. Under the decree, which came into operation as from Monday last, July 15, the wavelengths are allocated as follows: 1.875 metres: Hilversum, between 10.20 a.m. and 0.20 B.S.T.; 1.070 metres: Scheveningen-Haven, between 10.20 a.m. and 18.00 B.S.T.; 1.070 metres: Huizen, between 18.20 and 0.20 B.S.T.; 298 metres: Huizen, between 10.20 and 18.00 B.S.T.

On October 6 next, although the same wavelengths are to be utilised, the stations will effect an exchange, and Hilversum and Huizen will take each other's present position. It is proposed to carry out this alteration every three months.

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MAINTAINING VALVE PRICES.

In the Chancery Division on July 2nd Mr. Justice Clauson pronounced an injunction in the adjourned case of A. C. Cossor and Co., Ltd., and Richard William Bullimore, against The Gas Light Fittings Co., Ltd., of East Ham, for breach of the Limited Licence for the sale of radio valves manufactured by members of the British Radio Valve Manufacturers' Association. His Lordship

NEW D.F. TEST. The more usual procedure of tracking a concealed transmitter was reversed by the North Middlesex Radio Society recently, when parties with direction-finders, seen above, made unsuccessful attempts to get out of range of a 5-watt transmitter near Ridge, Herts. Two of the receivers shown follow the design of those described by Mr. R. L. Smith-Rose in our issues of August 15th and 29th, 1928.

granted costs against the defendants, and it was agreed that the exact terms of the injunction should be settled by counsel between the parties.

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MR. S. R. MULLARD.

We learn that Mr. S. R. Mullard is about to relinquish his position as managing director of the well-known companies bearing his name, in order to devote more of his time to other interests. Mr. Mullard will retain his office as chairman of The Mullard Wireless Service Co., Ltd., and director of The Mullard Radio Valve Co., Ltd., and will be general adviser to the companies.

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'PHONE SETS FOR OWNER-PILOTS.

A lightweight wireless telephone set for use on light aeroplanes has been designed by the Marconi Company to enable owner-pilots and clubmen to communicate while in flight with ground stations, as is done by commercial passenger-carrying aircraft.

The weight of the new set, known as the Marconi Type A.D.22, has been reduced to about 60lb. It combines a 75-watt telephone transmitter and receiver in a wooden box measuring only 15in. by 9in. by 7in., and the total weight includes complete equipment with all accessories, such as the microphone and telephones, wind-driven generator and accumulator.

A NEW RANGE OF DRY METAL RECTIFIERS.

Interesting Voltage-Doubling Circuit Described.

WESTINGHOUSE copper-oxide rectifiers have become extremely popular both for eliminators and for trickle-charging H.T. and L.T. accumulators from A.C. mains. The H.T.1 unit, already well known to readers and capable of giving a D.C. output of 100 mA. at 200 volts, has been reduced in price to 75s., whilst for those who require a rectifier with the more modest output of 120 volts 20 mA., a new half-wave unit known as the H.T.3 has been introduced selling at 21s.

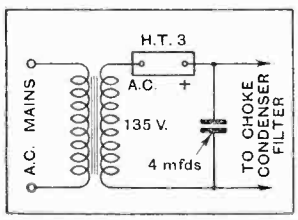


Fig. 1.—How to connect the H.T.3 half-wave unit when used as a rectifier in an H.T. eliminator. The transformer secondary must not develop more than 135 volts under working conditions and a 4-mfd. condenser must be connected directly across the output as shown.

It is interesting to note that the human ear when listening to the average loud speaker can tolerate about four times the superimposed ripple voltage from half-wave rectification as compared with that from full-wave. It is thus possible to employ rather less ambitious smoothing equipment with the H.T.3 than the theory of condenser and choke reactances would dictate. This new rectifier is connected as shown in Fig. 1. When D.C. supply mains are used for charging H.T. accumulators, should the supply fail, or should the main switch be opened, the battery will discharge through all lamps or apparatus that happen to be left connected in parallel with the mains. As an effective non-return valve in these circumstances, the H.T.3 rectifier can be put in circuit as shown in Fig. 2. Its forward resistance is small compared with the limiting resistance, but its reverse resistance is sufficiently high to make the flow-back of current negligible. The charging current should not be allowed to exceed 50 mA.

The H.T.3 unit which embodies a half-wave rectifier.

It has been usual hitherto to connect four metal rectifiers in bridge formation for full-wave rectification, but a voltage-doubling circuit has been introduced with the new rectifier—called the H.T.4—which is capable of giving the same type of output at a considerably reduced cost. It comprises a bridge network having only two rectifier units together with two 4-mfd. condensers linked as in Fig. 3. Not only is full-wave rectification obtained, but the D.C. voltage developed on no load will be approximately double that of the A.C. voltage applied to the bridge network. This voltage "step-up" is independent of the transformer, which must be designed with a secondary to give 135 volts under working conditions, and not more than 140 volts on open circuit.

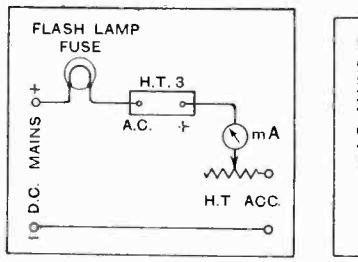


Fig. 2.—The Westinghouse H.T. rectifier used as a non-return valve in a circuit for charging H.T. accumulators from D.C. mains.

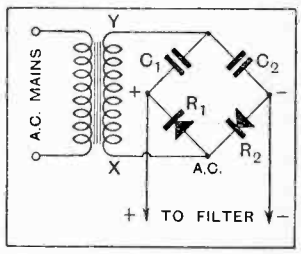


Fig. 3.—The voltage-doubling circuit using a bridge network of condensers and R_1,R_2, which together form the H.T.4 unit. The D.C. voltage on no load will be double the A.C. voltage across XY.

The doubling circuit (Fig. 3) functions as follows: When X is momentarily positive, current flows through R_1 to + and into the condenser C_1, which will charge up to the peak value of the A.C. voltage across XY. The peak value of a sine wave A.C. voltage is $\sqrt{2} \times$ R.M.S. volts, which become in this case $1.414 \times 135 = 191$ volts. The current which passes to the D.C. load circuit will return to lead Y through C_2, which will have been charged to peak value in the previous half-cycle in such a direction that it will assist the return flow of current; in fact, the transformer voltage and the voltage of the charge in condenser C_2 will be in series in driving current round the load circuit. On the other half-cycle, when lead Y is positive, current passes out to the load circuit from the stored energy in C_1 in series with the transformer secondary and returns to X through rectifier R_2, the voltage of the transformer and the stored voltage in C_1 again being added in series.

The H.T.4 rectifier to be used in conjunction with a bridge network giving a step-up of voltage.

Thus, not only is a step-up introduced irrespective of the transformer, but full-wave rectification is achieved, using only two rectifier units instead of the usual four. The condensers should be of the variety tested at 500 volts. The third terminal on the H.T.4 unit marked A.C. should be connected to the lead X in Fig. 3. For power valves the output to be derived from an eliminator embodying the H.T.4 is adequate, being about 30 mA. at 180 volts.

Broadcast Receivers

McMICHAEL SUPER RANGE PORTABLE FOUR

A Suitcase Portable of Outstanding Merit.

WHEN regarded from the standpoint of general layout, portable receivers fall naturally into two main groups, (1) the cabinet portable, played as carried in a vertical position; (2) the suitcase portable, carried vertically and operated horizontally with the lid open. For compactness and convenience of handling the latter type undoubtedly takes first place, but it has hitherto found difficulty in competing with the cabinet portable on the score of range and quality owing to the limitations imposed on the layout of the circuit and the size and weight of the batteries by the suitcase construction. Recognition of these facts is essential to a full appreciation of the merits of the receiver under review, for it sets an entirely new standard of performance for suitcase portables.

Low H.T. Current Consumption.

As is implied in the title, the circuit comprises four valves. There is a single stage of tuned H.F. amplification employing a screen-grid valve, and this is followed by a detector and two stages of L.F. amplification. The output valve is a D.E.P.215, which is an excellent valve to use from the point of view of good quality of reproduction, but is generally associated also with high anode current consumption. By judicious choice of H.T. and grid bias values, however, the makers have succeeded in overcoming this difficulty without impairing quality. The total H.T. current consumption is rated at 9 mA., and in the receiver tested the measured current turned out to be 8.5 mA., the H.T. voltage then standing at 112. The H.T. battery is of generous proportions, and a life of from two to six months should be obtained, depending on the number of working hours per day. Incidentally, the question of battery maintenance is dealt with in the instruction sheet in a very frank and straightforward manner.

If the set is to be used principally for broadcast reception in the home with occasional use out-of-doors a battery eliminator should prove a sound investment, when it will be possible to conserve the H.T. battery for out-of-door use only. A special battery plug has been incorporated for this purpose.

All four valves are housed in a narrow well and are screened by means of a hinged aluminium lid. The screen-grid and output valves are mounted on hinged valve bases, which greatly facilitate the insertion and removal of valves. Cotton wool packing effectively prevents any tendency to microphonic howling.

The control panel is a model of neatness and simplicity. Tuning is effected by means of small knurled edgwise knobs, and the dial indications are read through two small windows in the centre of the panel. The right-hand control marked "Tune" operates the tuning condensers of both the frame and the H.F. circuit, while the left-hand control is a compensating device for bringing the two tuned circuits exactly into resonance.

Remarkable Receiving Range.

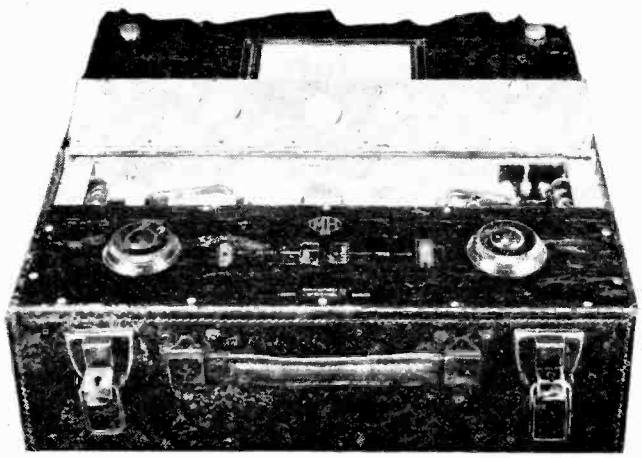
On the extreme left of the panel is a combined range switch and filament rheostat which serves as a volume control and may be used as an aid to selectivity. This control is matched on the right by a reaction control which works in opposite directions for long and short waves. The movement is somewhat limited and the adjustment consequently critical, but the set goes into oscillation smoothly and without backlash. In any case critical reaction is seldom necessary as the H.F. amplification is more than sufficient for normal requirements.

The sensitivity for a set of this type is truly remarkable. At a first sitting 28 stations were received after dark on the short-wave range alone, at least two-thirds of these being enjoyable at full loud speaker strength.

McMichael Super Range Portable Four.—

The long-wave performance is equally good, five or six stations being available in daylight as well as after dark. Local thunderstorms and atmospherics were rather troublesome during the period of the test, and it was noticed that the long-wave range was more sensitive in this respect than the short. For instance, when 5XX was seriously interrupted by atmospherics the same programme would be enjoyed from 2LO in comparative freedom.

The preliminary tests of selectivity were made 20 miles north of London, and it was found that, even with the frame set to maximum and with the volume turned fully on, interference from 2LO extended only two degrees on either side of its normal setting. Under similar conditions 5GB and 5XX spread five degrees; that is to say, distant stations could be received without interference at any setting more than five degrees from these stations. By tuning the frame to the minimum on these stations and making use of the volume control the interference from these stations could be reduced to almost negligible proportions. In this way, for instance, it was possible to receive Witzleben clear of 5GB. At a distance of one mile from 2LO conditions were naturally somewhat different. Nevertheless, one or two of the more powerful German stations were well received, and 5GB, of course, came through without a trace of interference. To sum up, we would say that the selectivity is more than adequate for most people's requirements, and the indications are that the receiver should perform satisfactorily under the regional scheme.



"Close-up" of control panel and valve compartment.

Quality of reproduction was found to be dependent to a certain extent on the tuning, and could be brought to a high standard by judicious use of the compensating tuning control and reaction. Contrary to generally accepted theory, critical reaction was used under some conditions with a marked improvement in quality. Judged in comparison with other portables the Super Range Four more than holds its own, and will undoubtedly satisfy the public demand for pleasing quality of reproduction.

Concluding Comment.

The workmanship and finish are, of course, up to the high standard which the firm of McMichael sets for itself. The leather case is of good quality and is grained to match the tuning panel and battery compartment lid.

A lucid and detailed instruction sheet is sent out with each receiver, and no question likely to arise in the mind of the purchaser is left unanswered. There is even an explanatory and reassuring paragraph dealing with the spark produced due to the charging of the reservoir condensers when the H.T. plugs are inserted. A useful tuning "abac," showing the approximate relationship between wavelength and scale reading, together with a list of the more important stations with wavelengths and frequencies, is also included.

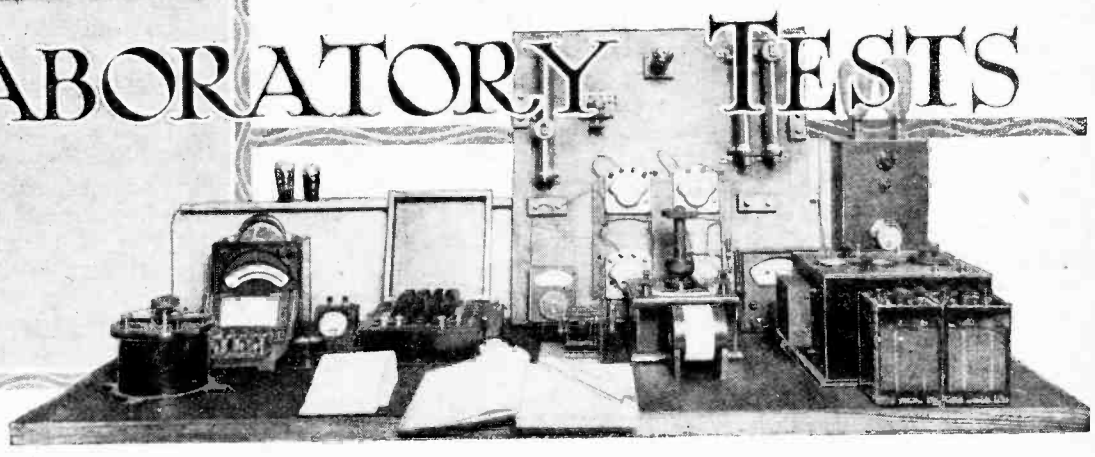
This is one of the finest portables, irrespective of type, which it has been our privilege to test, and definitely establishes Messrs. L. McMichael, Ltd., in the front rank of original and progressive leaders of design. With provision for mains operation, and at a price (22 guineas) which competes more than favourably with ordinary domestic receivers of similar performance, the Super Range Portable Four is convincing proof that the portable is the set of the future.

CENTRING A MOVING COIL SPEAKER.

THE last operation in the assembling of a moving coil speaker, the centring of the coil in the gap in the magnet, is one which sometimes gives rise to difficulties, especially if the gap has been made as small as is considered safe in an endeavour to obtain the maximum flux across the gap for the small field-current. If the centring is done when the speaker is disconnected from the set, it is sometimes found that when the set is connected and the magnet energised the coil is no longer central, or that, although the coil appears free enough when no signals are being received, it strikes the magnet when a loud deep note, such as that of an organ, is being reproduced.

It will be found to be a very great help if the coil is adjusted while signals are being received, so that one may see that the coil is free to move over the distance required. Neither music nor speech make the ideal signal for the purpose, though either will serve if nothing better is to be had. If A.C. mains are available, it is worth while to purchase a cheap transformer, giving an output of about six volts, and to connect the secondary of this to the coil during adjustments. In this way the speaker is energised by a note of very low frequency—in the usual case, fifty cycles—so that the movement of the cone is at its maximum. With the coil swinging back and forth over the wide range that is caused by the application of six volts A.C. at 50 cycles, it is quite easy to find the setting of the centring device that allows the coil this movement without touching the magnets.

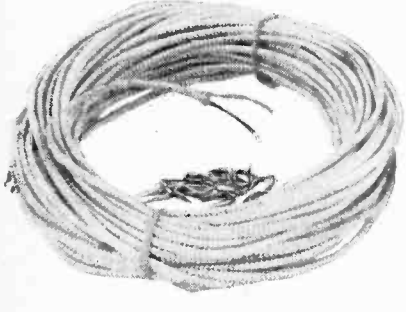
WIRELESS WORLD LABORATORY TESTS



A Review of Manufacturers' Recent Products.

"CONCORD" LOUD SPEAKER EXTENSION FLEX.

This consists of two conductors, each comprising 14 strands of No. 35 S.W.G. wire, single cotton covered and vulcanised. The two wires are run parallel, and finally covered with cotton braid. A length was tested for capacity between the conductors, and measurements showed that this works out at 24 micro-mfds. per foot. Readings were made with the wire suspended in air, and do not take into consideration capacity effects to earth.



"Concord" loud speaker extension flex.

It is supplied in cartons containing 25 yards with a box of small staples, and the price is 5s. 6d. The makers are the Concordia Electric Wire Co., Ltd., New Sawley, near Birmingham.

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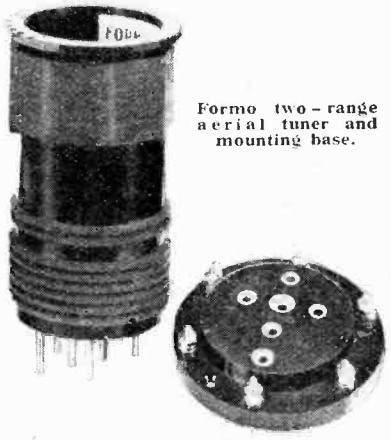
"FORMO" TWO-RANGE TUNER.

The "Formo" two-range tuner is a good example of a combined coil assembly for covering both high and medium broadcast wavebands. It consists of a cleanly moulded former 4in. high and 2⅝in. in diameter, carrying a single layer winding at the top end, and a six-section pile wound coil at the other end for loading the circuit for the long waves. These two coils are connected in series, and for medium waveband working the loading coil is short-circuited by a simple make and break switch. This is not included, but is an extra. The former is fitted with six pins, and fits into a base which screws to the baseboard of the set.

The illustration shows an aerial-grid coil suitable for use in "Reinartz" type circuits, and is provided with a reaction winding which is common to both wavebands, so that to make this practicable it has been accommodated in close juxtaposition to the long-wave coil, but well removed from the medium band portion.

The aerial is connected to a tapping on the single-layer coil, but to assure good selectivity an aerial shortening condenser of about 0.0001 mfd. should be connected between this tap and the aerial lead. Connected in this manner to a standard sized P.M.G. receiving aerial, and using



Formo two-range aerial tuner and mounting base.

a 0.0005 mfd. tuning condenser, the wavebands covered were found to be 190 to 592 metres and 840 to 1,880 metres.

The makers are the Formo Co. (Arthur Preen and Co., Ltd.), Crown Works, Cricklewood Lane, London, N.W.2, and the price of the coil only is 10s. 6d. The 6-pin coil base costs 2s.

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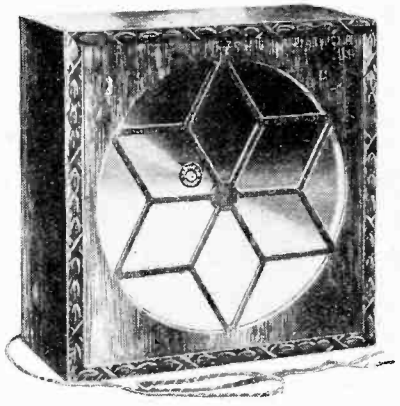
"ORPHEAN POPULAR" LOUD SPEAKER.

This is an inexpensive cabinet cone speaker selling at 30s., and made by the London Radio Manufacturing Co., Ltd., Station Road, Merton Abbey, London, S.W.19. It is available in light or dark



"Orphean Popular" cabinet cone loud speaker with an adjustable movement.

oak cabinets measuring 11in. × 11in. × 5½in. deep, and includes a 9in. diaphragm and adjustable reed movement. On the whole the quality of reproduction is good, but to obtain good sensitivity the unit must be carefully adjusted. In this state volume should be kept down to that just sufficient to comfortably fill a room of average size, otherwise the unit will show signs of distress.

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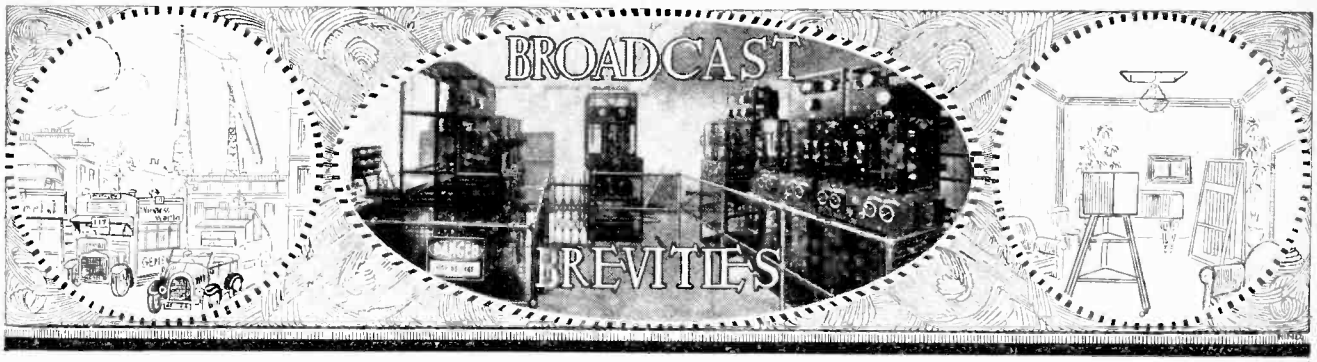

News from All Quarters: By Our Special Correspondent.

Departures from Savoy Hill.—Newspapers Without Sets.—Prague Plan Prophecies.

More Resignations.

Resignations from the B.B.C. are being maintained at a brisk rate. I hear that the next week or two will see the departure of six more engineers, all bound for the "talkies," and that another half dozen of the tribe will set off on the same pilgrimage in the very near future.

It is comforting to hear that "engineer" is an elastic term with the B.B.C. for the thought that Savoy Hill was to lose a dozen Captain Eckersleys would be intolerable.

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No "Regional" for Northern Ireland.

The only fresh item that reaches me concerning the Regional Scheme is that the projected regional station for Northern Ireland will not be proceeded with. The needs of Ulster will be covered by the existing station at Belfast, which may be slightly increased in power when the scheme approaches completion.

This arrangement should cause little or no dissatisfaction in Northern Ireland as 2BE already provides an excellent service and is, indeed, one of the most reliable of the B.B.C. group.

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Tatsfield Receiving Station.

The new receiving station of the B.B.C., now under construction at Tatsfield, is expected to be ready by the middle of August. Until then the work of wavelength checking will be continued at Keston.

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Still Experimental!

5GB suffered an unusual breakdown on Sunday, July 7th, when the start of the afternoon programme was delayed for fifty minutes owing to an air lock in a water pipe supplying the valve cooling apparatus.

As a result of this experience, special precautions are to be taken to prevent similar mishaps at the new regional stations, which shows that 5GB is triumphantly maintaining its reputation for being "experimental."

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An Appalling Mistake.

And this reminds me that a flutter occurred at Savoy Hill a few days ago when, in a Press note regarding the relaying of the Thanksgiving Service by the short-wave broadcasting station 5SW, the word "experimental" was inadvertently omitted. All sorts of dodges were resorted to in an endeavour to make amends for this appalling mistake, but it was too late.

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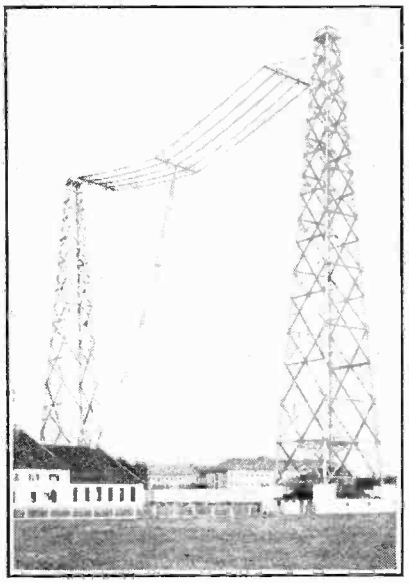
Newspapers without Wireless.

A little group of journalists attended at Savoy Hill on Wednesday last to hear Mr. H. G. Wells talk on World Peace, but I understand that they got no nearer to the great man himself than the official drawing-room, where they listened just as you and I did on a loud speaker.

Why this visit to headquarters? Surely it was superfluous? The stunning explanation is that numbers of newspapers have no receiving sets, and are thus cut off from a volcano of information which may gush forth with "news interest" at any moment.

It is true that the papers are saved the cost of the annual licence fee, but is it worth the risk?



A POPULAR GERMAN STATION. Munich, which operates on 533 metres with a power of 4kW.

Future of the Prague Plan.

Although the Prague Plan seems to be remarkably successful at the moment, prophets are arising who declare that, from a test point of view, the present season is the very worst that could have been chosen, and that the onset of winter will quickly show that the interference problem has hardly been scratched. Because signal strength is always reduced during the summer months, it is contended that stations which are now amicable neighbours will be producing unholy heterodyning by, say, October.

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M. Braillard Hands Out Bouquets.

This unhappy prediction may be correct, but for the present there is no doubt that conditions for European listening are quite good. M. Braillard, the moving spirit at the Brussels wavelength checking centre, seems immensely satisfied, and I hear that he has already distributed congratulations to various countries, notably Britain, Germany and Spain.

France is not yet settled, but it has to be remembered that the French stations are coming under a central authority for the first time, and are unequipped with official wavemeters.

Russia has yet to display a close adherence to the new wavelengths, and here, too, the absence of Brussels wavemeters may complicate matters.

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What We Really Like.

The standard of musical taste among listeners is undergoing a change, a fact which emerges from a long series of "Request" hours broadcast from 5GB. The Birmingham "Request" book now contains a preponderance of demands for so-called high-brow items, and the move in this direction is growing.

An hour of requests will be broadcast from 5GB on August 1st.

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The New Instrument.

Extract from B.B.C. official notice—

> "The cast will include . . . with a satellite of syncopation at the paino."

Possibly painful enough without the paino.

The "Breaking-Up" of LOUD SPEAKER DIAPHRAGMS

How Nodal Points are Traced by Means of Dust Patterns.

By N. W. McLACHLAN, D.Sc., M.I.E.E., F.Inst.P.

(*Concluded from page 35 of previous issue.*)

A CONICAL diaphragm can be compared with a bell, and we should expect to find similar markings. i.e., nodal radii or meridians and nodal circles. We are all familiar with the small household hand or electric bell, and know that its natural frequency is well within the acoustic range. Arguing by simile from our experience with the steel disc, we see that if the fundamental tone of the bell is 512 cycles it must start segmental action below this frequency. For the sake of simplicity we shall consider the vibrating object, bell, disc or diaphragm, to "break-up" at its first natural frequency.

A bell is much more rigid than a paper cone, although it is also a good deal heavier and thicker. One would expect, therefore, that a paper cone would "break-up" well within the acoustic range. If we tap a paper cone, the resulting sound cannot be described as musical in the same sense as that from a bell. The cone yields a muffled, dull sound after the nature of a thud. But, from theory and practice, we know that this thud can be resolved into a fundamental sound

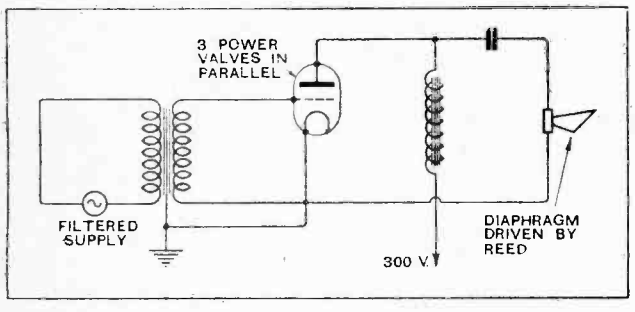

Fig. 7.—Diagram showing electrical circuit for driving cone diaphragm.

accompanied by a series of partials or overtones. Clearly the blending of these and the acoustic performance of the paper diaphragm does not conspire to produce the effect of sounding brass or tinkling cymbal. From the viewpoint of loud speaker reproduction this unusual property of the cone is distinctly helpful, although, of course, it is obnoxious at times in that it tends to colour certain reproduced sounds.

The inference to be drawn from our preceding remarks is obviously that paper cones do not move as a whole over the entire acoustic register. In fact, they "break-up" at comparatively low frequencies. From general experience I find the "break-up" frequency of a conical diaphragm of 8 inches diameter or greater to be below the middle of the pianoforte. The larger the diaphragm the lower is the break-up frequency.

Taking one's cue from Chladni, it is possible by the aid of small grains of suitable material to obtain Chladni figures which exhibit the state of motion of a loud speaker diaphragm. The apparatus used is illustrated diagrammatically in Fig. 7. Starting with a filtered supply resulting in a pure sine wave, the voltage is applied to a bank of power valves worked at anode voltage of 300 to 400, according to the amplitude desired. A suitable loud speaker movement—a reed in this particular case—with diaphragm attached, is actuated by the current from these valves. Lycopodium powder is dusted over the conical surface and the power turned on. The diaphragm vibrates and makes the powder jump. It goes on jumping until it finds lines of demarcation about which the diaphragm is vibrating in opposite directions. The behaviour of lycopodium powder has been found by early experimenters in the investigation of vibrating plates to differ from that of sand. It has been suggested that the draught created by the vibration affects the light lycopodium powder quite differently from sand.

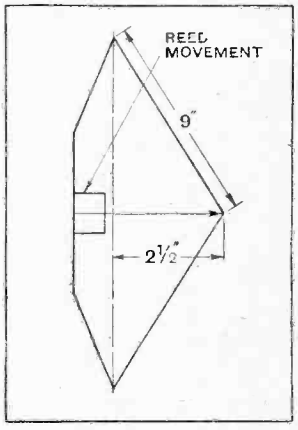

Fig. 8.—The dimensions and arrangement of diaphragm used to exhibit the "break-up" effect.

Practical Details for Successful Dust Figures.

However, in the experiments about to be described, I found that lycopodium and sand traced out the same patterns when used as a mechanical mixture or quite separately. This was fortunate, because sand slides off a conical surface so easily. So far as the diaphragm is concerned there are several points to be observed in order to obtain satisfactory results: (1) The central angle of the cone must not be too small or the lycopodium powder will merely roll to the apex. (2) The surface of the paper must not be too smooth. (3) The colour of the paper should be a good contrast with the yellow lycopodium powder. One cone of rough, brown paper, illustrated in Fig. 8, was particularly successful, because the friction on the surface was

The "Breaking-up" of Loud Speaker Diaphragms.—

adequate to prevent sliding, but not too large for the powder to be moved by the diaphragm. The first thing is to choose a low frequency which yields no dust figure. With the above diaphragm at 80 cycles no figure appeared, so that the break-up frequency had not been reached. At 90 cycles there were signs of something about to happen, and this is illustrated in Fig. 9, which indicates a certain pattern. Now, from the case of the steel disc one would expect the conical diaphragm to break up into two segments, each vibrating about a diameter. The diaphragm did not seem inclined to act this way at all, doubtless due to rough treatment, because earlier on it unfortunately got somewhat squashed at the edge.

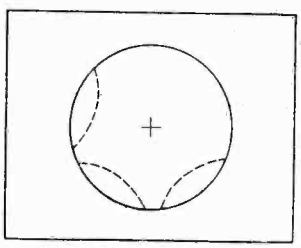

Fig. 9.—Showing the dust pattern on cone of Fig. 8 at 90 cycles.

Moreover, its mechanical and geometrical symmetry was destroyed, but this did not prevent useful information being obtained. The pattern at 90 cycles was as shown in Fig. 9, and an increase in amplitude was accompanied by "steaming" at certain points. The "steaming" is rather intriguing and occurs when the amplitude of vibration of the diaphragm is large. The lycopodium just bubbles like sea spray and is thrown off the diaphragm into this merry dance with great vigour.

Variation of Patterns with Frequency.

At a frequency just above 90 cycles six sectors appeared, as shown in Fig. 10. On pressing the surface at, say, P, the distribution altered owing to a variation in the mechanical state of the diaphragm. The powder ran up the cone towards the apex and then joined a stream sliding towards the periphery. The number of sectors increased to eight at 105 cycles, when a good deal of powder accumulated over a circle 4 inches diameter round the apex. The latter was stiffened and moved as a whole at this frequency. Beyond 105 cycles the number of sectors increased, but, owing to the accident to the diaphragm aforesaid, they were difficult to count with any degree of certainty. At 173 cycles there appeared to be 16 sectors. When a frequency of 336 cycles was reached the mode of vibration gave rise to ring markings. At 1,600 cycles there were both radial lines and rings. The lines and rings were quite irregular, due to non-homogeneity of the diaphragm. Above 3,000 cycles the movement of the diaphragm was too small to have any appreciable effect on the powder, i.e., it would not dance and play. Doubtless, additional input to the valves would have achieved the desired object. It must be borne in mind, however, that where frequencies above 3,000 cycles are concerned amplitudes of a few millionths of an inch yield loud sounds. As these experiments were not conducted in a vacuum, the listener's feelings have to be considered.

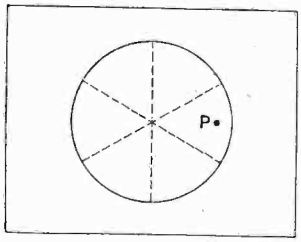

Fig. 10.—The dust pattern on cone just above 90 cycles.

Apart from the question of Chladni figures, the frequency was raised to 6,000 cycles, when it was found that removal of the diaphragm made no appreciable difference to the intensity of the sound radiated. This being so, the radiation was derived solely from the reed and its attachment mechanism to the cone—an important fact.

Summary of Observations.

To sum up the results of these experiments we can say:—

(1) Below a certain frequency a conical diaphragm will not exhibit dust figures. The absence of such figures does not mean that the diaphragm moves as a whole.

(2) At a certain frequency a conical diaphragm exhibits dust figures. With a symmetrical and homogeneous cone it is highly probable that the first dust figure is a diameter (two radial nodes), i.e., the diaphragm is divided into two equal segmental portions moving in opposite directions. In the present experiments, owing to damage to the diaphragm, this mode was not apparent to the naked eye.

(3) This first resonance or natural frequency of the diaphragm is defined as the point where it "breaks-up." The larger the diaphragm the lower the "break-up" frequency, provided the thickness and angle of the cone are the same throughout.

(4) Greater numbers of radial nodes occur at resonance frequencies above the break-up point. After a certain frequency these disappear and give rise to a nodal circle. Beyond this there are two or more nodal circles interspersed by radial nodes.

(5) This progressive break-up of the diaphragm continues until at frequencies in the neighbourhood of 6,000 cycles the sound emitted by the diaphragm *per se* is substantially zero.

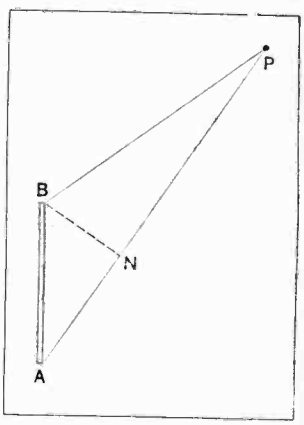

Fig. 11.—At P the sound from A is later than that from B by the time taken to travel the distance AN. AB is an edge view of the disc.

With this information at hand we have now to discuss the properties of the diaphragm as a radiator of sound. Any vibrating surface can be split up into a very large number of elemental vibrating areas (see *Wireless World*, 23rd March, 1927), and each area can be regarded as a source of sound. As we explained in the article in question, the net result of radiation from, say, a flat disc was the vector sum of the radiation from all the elemental areas. Taking the disc in Fig. 11, the point P is farther away from A than it is from B, so that the sound from B will reach P sooner than that from A.

The "Breaking-up" of Loud Speaker Diaphragms.—

Moreover the sounds from A and B will be out of phase and may interfere if the wavelength is short enough. With a conical diaphragm at, say, 2,000 cycles, where there are a number of vibrating sectors or rings, or both, it is clear that at P the net effect at any instant is due to some areas on the cone giving positive and others negative radiation. As a case in point, take the adjacent segments X and Y of a disc (see Fig. 12). X moves forward, whilst Y moves backward, so that the net radiation at P, due to X and Y, is the vector difference of the two. But there is still another effect. If X causes a positive pressure, whilst Y causes an equal negative pressure, it is clear that there will be a circulation effect from X to Y, since the former is at the higher pressure. This will tend also to reduce the radiation pressure at P.

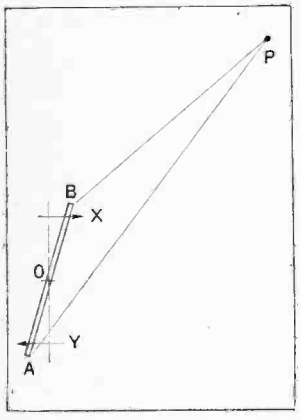

Fig. 12.—In this case the disc is vibrating about a diameter through O. The upper portion moves to the right, whilst the lower portion moves to the left. The effect at P will depend upon PB, PA and the frequency. At a low frequency the sound at P due to the two halves will cause a net reduction since one is positive whilst the other is negative.

Now, if we bear in mind the fact that as the frequency increases the diaphragm breaks-up into vibrating areas of different shapes, also that there is the circulation effect between those parts moving in opposite directions,[1] it is evident that the pressure at any point in space is the result of a very complex radiator. Instead of a simple source of sound from which the waves spread out hemispherically, we have a large diaphragm broken up into a number of vibrating areas, these representing a myriad of simple sources of different amplitudes and phases. And the pressure at any point is the vector sum of the radiation, due to all the elemental areas on the diaphragm, in combination with the circulation effect between oppositely vibrating portions.

To this hectic picture we must add the influence of transmission loss in the diaphragm. At the higher frequencies this loss is apparent, so that the amplitude of the peripheral portions of the disc will suffer attenuation. Finally, at frequencies of 5,000 or upwards the net radiation from the diaphragm is curbed by losses and interference to such an extent that its practical value is zero.[2]

With facts like these before one, it would appear to be a hopeless task to design a loud speaker to yield satisfactory results. But, taken in the proper manner, this comical performance of a conical diaphragm can be put to a very useful purpose. On the one hand we have a diaphragm whose effective area of vibration can be considered to fall away with increasing frequency. On the other we have a vibrating reed whose response increases up to, say, 3,000 or 4,000 cycles. By combining these two in the proper manner it is possible to secure a loud speaker whose response in an average room from 150 cycles upwards is quite pleasing. Of course, there are variations where the "mode" of vibration of the diaphragm alters, but these are not evinced aurally to any serious degree. By attacking the problem of the reed drive loud speaker in this manner I have been able to secure the results exemplified in the Amplion "Lion."

At the moment there exists no formula from which we can calculate the performance of a diaphragm. But by considerable practice and much experimental data the problem of loud speaker design will in time be reduced to a question of arithmetic. Just as thousands of observations and hours of computation were necessary before Kepler could formulate the planetary laws, so with the complex behaviour of loud-speaking apparatus it is equally essential that much empirical work must precede the final empirical generalisation or so-called law. Until the requisite data is forthcoming, so that the wheat can be separated from the chaff, the problem of diaphragm design must be largely based on trial and error. This must not be regarded by the pundit as unscientific. There could be no science without practical measurement coupled in its initial stages by trial and error. All theory is merely as true as the practical data from which it is formulated.

[1] "Loud Speakers," Chap. V, Iliffe & Sons Ltd.

[2] Further information on this subject will be found in "Loud Speakers," Chapters 4 and 8. In Chapter 4 the velocity of energy propagation in a diaphragm should be *less*, not greater, than that of sound.

LETTERS TO THE EDITOR.

The Editor does not hold himself responsible for the opinions of his correspondents.

Correspondence should be addressed to the Editor, "The Wireless World," Dorset House, Tudor Street, E.C.4, and must be accompanied by the writer's name and address.

AMATEUR STATUS.

Sir,—Hearty congratulations on your editorial for July 3rd. You have hit the proverbial nail fair and squarely on the head. Perhaps a few of my own experiences might be of interest.

Last year I arranged to carry out some tests in "skip distance" with amateurs in different countries, and wished to compare the effects on 45, 32 and 22 metres. I was already licensed for 45 and 22 metres, and applied for a 32 metre permit. After about six months' correspondence with the Post Office, they told me they would give me the permit if the Radio Society of Great Britain would support my application. I wrote to the R.S.G.B. (of which I am a member) and asked them to do so. They flatly refused. I pressed for a reason, but they refused to give any.

Now, I have never done anything to deserve this, and can only suppose that this is the treatment handed out to all members. How many people are going to join a body that treats its members in this way? Personally, I would have resigned long ago, only I have always hoped that things would improve. So far they have not.

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Now, with the Washington regulations in force, I will never be able to carry out these tests, as 32 metres is now banned.

Again, some time ago, the Post Office complained to me about causing interference with B.C.L.s in this district. I knew this was impossible, as I was using very low power at the time, and in any case I never transmitted during B.B.C. hours. As the Post Office got very nasty about it, I asked the R.S.G.B. to help me, but again they turned a deaf ear. After a lot of trouble, I got the Post Office to bring down a D.F. van. They found that my statements had been correct in every way, and that no interference was caused even if I did transmit!

The R.S.G.B. nowadays seem to be more concerned with "Conventionettes" and social gatherings than with honest experimental work.

I sincerely hope that your efforts for reform, and the raising of amateur status, will meet with the reward they so richly deserve.

A. JAMISON.

Bangor, Co. Down.

Sir,—In congratulating you on the manner in which you are utilising your leading articles of late to draw attention to the deplorable state of the transmitting amateur in this country I beg to draw your attention to an important factor to which you have not referred. Whilst agreeing that the R.S.G.B. is the recognised organisation for the transmitting amateur (for in its enthusiasm to retain this position it has practically ceased to be of any use to the non-transmitter), it has certainly declined in activity as regards fighting the P.M.G. for the amateur's rights. This may be due to certain aversion to quarrelling with its own officers.

The Association of British Radio Societies, an organisation which exists for, and serves, every class of amateur, has in its short existence been of an appreciable help to the transmitter in connection with the steps taken by the P.M.G. to enforce the regulations of the Washington Conference. It was directly connected with the granting of a further month's breathing space after the P.M.G.'s ultimatum of October last, and also with the approving by the Post Office authorities of a commercially made absorption type of wavemeter for use with transmitters. This Association is, I believe, the very organisation that will prove capable of so combining the interests of the Radio amateur that a united front will automatically be formed to withstand the assaults of officialdom, the only sure way of obtaining results. It is up to the amateurs themselves, therefore, to support this comparatively new body and enable it to carry on with a greater power the good work that it has already started.

At the recent Convention held at the North-East Coast Exhibition at Newcastle, where both the A.B.R.S. and the R.S.G.B. were represented on the platform, the delegates of the former body were able to inform the audience that in no single case had a society, or individual, lost its transmitting licence (in the recent reshuffling) when the matter had been looked into by the Association.

R. M. KAY, B.Sc.

Manchester.

Sir,—On behalf of the Association of British Radio Societies we wish to express our appreciation of your leading articles of June 19th and July 3rd.

The A.B.R.S. for its part has for some time been fostering a spirit of mutual respect and esteem between its members and the officials of the Post Office. We think that our efforts with regard to the question of frequency controlling apparatus for use at amateur transmitting stations may be taken as a case in point. We don't wish to claim all the credit for getting the Post Office to modify their conditions, but as has already been fully reported in our Association journal—"British Radio"—we kept up a lengthy correspondence with the Post Office until they accepted most of our suggestions.

We quite agree that the amateur (particularly with regard to transmitters) has suffered much discouragement at the hands of the Post Office, but we venture to suggest that the amateurs (or at any rate a section of them) have not as you put it, "permitted themselves to be crushed without showing the resentment of the proverbial worm." This Association has done its best to procure official understanding of the amateur's difficulties and will continue to do so, believing that the Post Office authorities are open to reason with representative opinion.

We are also substantially in agreement with your remarks about the present conduct of the Radio Society of Great Britain and its policy (or the lack of it).

The A.B.R.S. would probably never have come into existence had the R.S.G.B. fulfilled its claims and obligations. For that slackness on the part of its former officials the committee must accept the ultimate blame, but nothing is more certain than that if the R.S.G.B. had lived up to its national title (instead of being conducted as a "glorified London wireless society") the amateurs would have been in a much stronger position than at present obtains. We have no desire to rake up a good deal of what has passed, but we do wish to associate ourselves very cordially with your stand on behalf of the amateur, and to say that we shall always be glad to co-operate with you in any activity which will assist the improvement of the amateur status in this country.

LEONARD A. GILL,
Hon. Secretary, Association British Radio Societies.
J. HARTLEY,
Hon. Managing Editor, British Radio.

Sir,—As an old reader of this fine journal I wish to heartily congratulate you on your splendid editorial articles on behalf of our amateur transmitters.

It is high time a "strafe" should be started against these insane regulations, which, forced upon us by an administration whose crass ignorance, greed and suspicion of amateur radio matters, places the amateur under an official stranglehold, and also fails to "protect" the P.O. in actual practice.

On the other hand, I cannot agree that the amateur is "petering out," for at the time of writing amateur transmission in this country has never before reached a higher degree of enthusiasm, activity, or actual numbers of stations. Granted a few stations owned by electrical concerns, etc., have returned their permits under the new regulations, but they have been replaced many times over by new and enthusiastic amateur transmitters since the regulations came into force, and our ranks are swelling splendidly month by month. What we require is a live-wire society to represent us, one that will not take "no" for an answer, and is prepared to raise its voice and fight to an end.

Things badly required are :—

Full width of *all* Washington amateur wavebands; abolition of the absurd 10-watt restriction; full permission to handle public or service traffic in cases of emergency, together with an organised network of stations to deal with same.

Another point often overlooked is the great value of amateur radio as an international peace agent. I am convinced that if every other member of the community was a "ham," international dispute would be a thing of the past, for one has only to listen to the cheery chats and jokes between the world's amateurs to realise this.

May your efforts be crowned with success, and more power to your very fine journal.

"FED-UP G HAM."

Surrey.

'JUNK"—A SUGGESTION.

Sir,—Wireless amateurs often have problems to solve, but none perhaps so awkward as the question of what to do with old apparatus. One writer in "Current Topics" recently appealed for discarded apparatus to start a working lads' wireless club. But who wants burnt out transformers and obsolete forms of inductances and the copper wire that has done its duty once or perhaps several times in sundry sets and is now too kinked to be of any further use? My suggestion is that the wireless societies up and down the country should collect scrap copper on behalf of the hospitals. This should form a very useful source of "pin money" to them with copper at 1s. 4d. per lb. and likely to become dearer rather than cheaper on account of the increasing demand for this metal. The revenue from this source might quite soon become equal to that from the tinfoil collecting which is now so ubiquitous and popular, especially as pounds of scrap copper are to be found lying about, compared with mere ounces of tinfoil.

I offer this idea for your consideration, and although I am not in a position to organise a collection on national lines, I could start the ball rolling with a few pounds of scrap aerial wire, etc.

H. W. KENDALL.

(Wireless and Experimental Association).

READERS' PROBLEMS

"The Wireless World" Supplies a Free Service of Technical Information.

The Service is subject to the rules of the Department, which are printed below; these must be strictly enforced, in the interest of readers themselves. A selection of queries of general interest is dealt with below, in some cases at greater length than would be possible in a letter.

Testing an L.F. Transformer.

Thinking that the windings of my L.F. transformer had become defective, I have recently been carrying out a test. When telephones and a dry cell were connected in turn across primary and secondary terminals, clicks were produced, and were of greatest intensity when the circuit through the primary was completed. This, I take it, suggests that everything is in order.

Now for my trouble. The transformer was replaced and connected up in the set, and telephones were again connected across its terminals. Signals were observed to be very much louder with a connection across the primary than across the secondary; surely this should be reversed, on account of the voltage step-up that should take place? G. P. N.

The effects you describe would indicate that the transformer is in good condition, and it is quite natural that signals should be louder when telephones are connected across the primary terminals than when they are transferred to the secondary. This is because the latter winding has in all probability an impedance that does not match that of the telephone windings, and consequently the power delivered is greatly reduced.

o o o c

Simplified Pick-up Connections.

In your recent description of the McMichael Home Constructors' set, it was mentioned that provision was made for connecting a pick-up in an extremely simple manner—by joining one terminal directly to the detector grid and another to a negative bias voltage point. My own receiver is, in broad outline, somewhat similar to the one under discussion, but a transformer-coupled H.F. stage is used; would this method of connection still be applicable, and, if so, will you please give me a circuit diagram?

By the way, I cannot quite see how the application of a positive potential to the grid is avoided without disconnecting the grid leak. D. C. G.

In that you are using transformer coupling the position is not affected at all; in fact, this method of connection is applicable to any set having a grid detector. We show in Fig. 1 the method of making the addition to your own set. Of course, if it is more convenient, there is no objection to taking bias for the detector valve (when it is converted to a first stage L.F. amplifier) from the H.F. valve bias cell.

It is quite unnecessary to disconnect the grid leak, as the positive potential

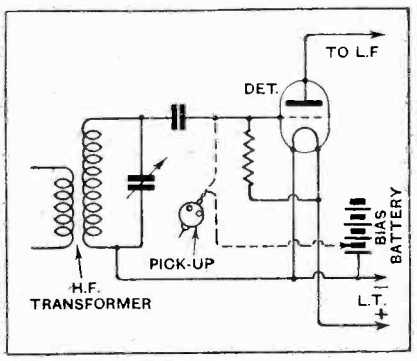

Fig. 1.—Method of connecting a pick-up in a grid detector circuit.

impressed through it on to the grid will be completely annulled by the voltage applied directly from the battery.

o o o o

Voltmeter Resistance Rating.

I read that voltmeters are generally rated in "ohms per volt." Can it be taken that my moving iron meter marked "4,000 ohms" has a total resistance of 600,000 ohms (4,000 multiplied by 150), which is the maximum voltage reading? S. D. J.

No, in this particular case the marking on the meter will indicate its total resistance.

RULES.

(1.) Only one question (which must deal with a single specific point) can be answered. Letters must be concisely worded and headed "Information Department."

(2.) Queries must be written on one side of the paper, and diagrams drawn on a separate sheet. A self-addressed stamped envelope must be enclosed for postal reply.

(3.) Designs or circuit diagrams for complete receivers cannot be given; under present-day conditions justice cannot be done to questions of this kind in the course of a letter.

(4.) Practical wiring plans cannot be supplied or considered.

(5.) Designs for components such as L.F. chokes, power transformers, etc., cannot be supplied.

(6.) Queries arising from the construction or operation of receivers must be confined to constructional sets described in "The Wireless World" or to standard manufacturers' receivers.

Readers desiring information on matters beyond the scope of the Information Department are invited to submit suggestions regarding subjects to be treated in future articles or paragraphs.

A.C. Valves and Quality.

Is there any reason why a set with indirectly heated valves should not give the best attainable quality of reproduction? I ask this question because the great majority of sets designed purely from the quality point of view seem to include battery-heated valves. E. T. C.

Battery operation is adopted as a safeguard against A.C. potentials reaching the early stages, and particularly the detector. At present the range of A.C. valves is limited, while for the small current taken one can make a choice from an extensive range.

o o o o

L.F. Amplifier Considerations.

I am sending you a circuit diagram of my proposed receiver. Will you please criticise it, bearing in mind that I require a large undistorted output, and sufficient sensitivity to enable me to receive my two nearest stations (respectively about 40 and 60 miles distant) with an ample margin of safety? Long-distance reception is of secondary importance, although, as I am favourably situated, I expect to be able to receive a number of foreign transmissions when conditions are reasonably suitable. A. P. P.

The circuit diagram submitted by our correspondent shows a single H.F. stage with an A.C./S. valve, transformer-coupled by an anode bend detector, and up to this point is fairly conventional. The detector—an A.C./G.—is transformer-coupled to a pair of P.625a valves in a push-pull arrangement; this, in our opinion, is open to criticism. Assuming normal operating conditions, an incoming signal sufficiently great fully to load the detector valve will give rise to L.F. impulses on the grids of the output valves of an amplitude appreciably below that which they are capable of handling, and thus the arrangement is not altogether economical. In other words, it will be impossible to avail one's self fully of the somewhat ambitious capabilities of the output valves without producing distortion at the detector stage.

An easy way out of the difficulty is to use as a detector an A.C./R. valve, which is capable of accepting a considerably larger input voltage, but which has the disadvantage that it will reduce the overall sensitivity of the receiver. Of course, there is the alternative of interposing another L.F. stage.

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AMATEUR STATUS.

IT is really a very simple matter to offer a criticism on the way in which the affairs of the organisations of the amateurs in this country are being conducted, but what is needed is not destructive criticism but co-operation in the right spirit with the object of ensuring that the mistakes of the past will not be repeated, and that amateurs throughout the country, no matter to what group or society they may belong, are encouraged to support a common policy which will ensure the maintenance of reasonable facilities for experimental work. There may be a number of societies and organisations independently constituted, and it would seem to us that there is no need for such organisations to be broken up in order to establish an extra body representative of the political views of amateurs generally, nor should it be necessary for any new organisation to be formed for this purpose if the Radio Society of Great Britain is prepared to undertake the work in the proper spirit.

We think that sufficient demonstration has already been given through our Correspondence columns, and through comments which have been made amongst amateur gatherings, since we raised this subject to convince the officials of the Radio Society of Great Britain that they no longer enjoy to a sufficiently full extent the confidence of the British amateur. Proposals should now be forthcoming from the Radio Society, having as their object the reinstatement of their Society as an organisation representing the amateur of this country, whether transmitter or general experimenter. Suggestions have been made by certain contributors to our Correspondence columns that the Radio Society of Great Britain is of no use. We are by no means prepared to endorse this view, since we consider that every amateur organisation in this country is of importance, and amateur status certainly cannot be maintained or strengthened by weakening or breaking those organisations which already exist to bring amateurs together on common ground. The Societies unquestionably form the only nucleus through which the desired result can be achieved, but the officials of the Societies must co-operate in the right spirit and sink petty differences which may exist because they know that the main issue, that of securing freedom for the amateur, is a policy with which they are all in agreement.

* * * *

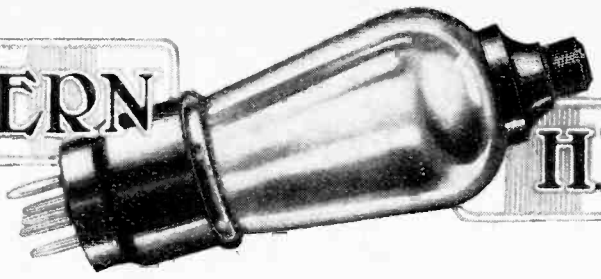
TELEVISION.

THOSE who may have been optimistic enough to look for early co-operation between the Baird Company and the B.B.C. to bring about actual television broadcasts will have been disappointed with the recent news that negotiations for arranging television broadcasts which have been in progress between the B.B.C. and the Baird Company have been broken off.

It is understood that one of the principal reasons for the breakdown in negotiations is that the Baird Company insisted upon a bigger apportionment of programme time than the B.B.C. was prepared to concede initially, and, further, the Baird Company required a guarantee that that time would be devoted to television broadcasts by the B.B.C. over a long period.

We appreciate the difficulties which the Baird Company must be experiencing, for unless it can guarantee a reasonable period during which transmissions will take place, it becomes very difficult for the company to offer receiving apparatus for sale to the public. On the other hand, the necessity for the B.B.C. to exercise extreme caution before conceding to the allocation of considerable programme time daily for two or three years must be apparent to everyone.

The MODERN H.F. VALVE



Single Stage Amplification of Two or Three Hundred with the New Screen-grid Valve.

By W. I. G. PAGE, B.Sc.

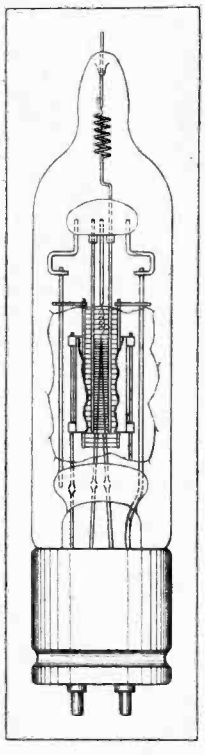
Shall I neutralise my screen-grid valve? What maximum amplification shall I get before oscillation occurs if I do not neutralise? If a three-to-one H.F. transformer with an S.G. valve is used instead of the optimum value of about one-to-one in order to obtain really good selectivity, what stage gain shall I lose? These and many other similar questions which the amateur often asks himself are answered at some length in the accompanying article. A table is given showing the remarkable characteristics of the new H.F. valves which without doubt will considerably improve the performance of radio receivers during the coming season.

SUCH strides have lately been made in the science of H.F. amplification that we now glibly talk of single stage amplifications of 200 or 300. By this we mean that a signal of 1 volt applied to the grid of the H.F. valve will be amplified by the valve and its coupling, and be impressed on the grid of the next valve (the detector when there is only one H.F. stage) as 200 or 300 volts. Dealing with practical figures such as we should meet in receiving a fairly weak transmission, it would be more reasonable to say that 1 millivolt would become 200 or 300 millivolts. A short time ago stage amplifications of 40 or 50 were considered superlative.

H.F. Valves Compared.

There is now on the market a series of screen-grid valves with indirectly heated cathodes having remarkable characteristics; furthermore, a number of the familiar battery-heated screen-grid valves have been redesigned and a new range of three-electrode H.F. valves for A.C. mains is available. With such an abundance of types, and so many characteristics within each type, the choice of the best valve and coupling for any specified conditions becomes a matter of increasing difficulty, and it is the purpose of these notes to examine the relative merits of some twenty typical H.F. valves with a view to finding the maximum stage amplification which can conveniently be obtained with them.

It will be shown that in the case of screened valves the residual anode-grid capacity, small as it is, plays a very important part in the H.F. amplification which can be attained before self-oscillation sets in. In the original screened valve designed by Hull at Schenectady over three years ago, the interelectrode capacity was reduced to 0.006 micromicrofarads—a remarkable achievement—but the valve was of an experimental nature and could not be produced commercially in quantity. A perfect metal shield around the plate of a valve to prevent that electrode and the grid from becoming a small condenser would mean that no electrons would pass to the H.T. battery, and thus there would be no plate current.



The Hull valve, the forerunner of the screened grid.

The perforations in the shield to allow the passage of a satisfactory electron stream must perforce mean a compromise between negligible electrode capacity and useful valve characteristic. The earliest British commercial screened valve—the S.625—had an anode-grid capacity of about 0.1 $\mu\mu$F, and whereas this value was a great improvement on that of the best three-electrode valve, it was not possible at, say, 300 metres to get a stage amplification of more than about 39, however perfect the external screening of circuits might be made.[1] The tiny reaction condenser within the valve feeding back energy from the output to the input was of sufficient capacity to cause oscillation to start when coils of quite unambitious design were used.

Amplification and Valve Capacity.

Many readers probably found that the limit of amplification was reached with ordinary plug-in coils, and that the use of a Litz solenoid coil simply meant uncontrollable oscillation. Actually, coils having a dynamic resistance of about 80,000 ohms at resonance[1] (at 300 metres) were the highest values permissible. A neutralised triode in those days would give an amplification of the order just mentioned—admittedly with rather specialised

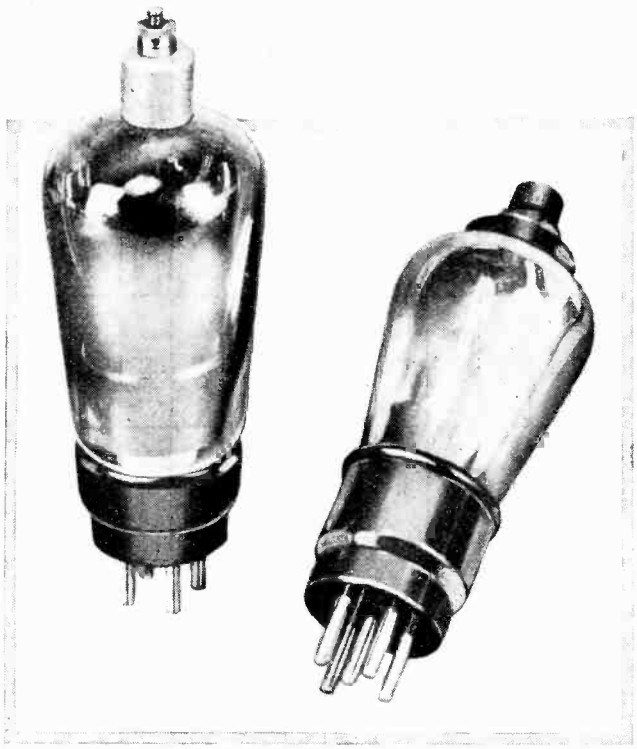
[1] See *Experimental Wireless*, October, 1927, p. 625.

The Modern H.F. Valve.—

and expensive coils—but even then the screened valve had little to recommend it.

The position to-day has vastly changed. Not only has the S.625 an anode-grid capacity five times less than that in the early examples, but there are at least two screened valves now available which have inter-electrode capacities as small as that in Hull's experimental valve (0.006 $\mu\mu$F). Let us translate this into terms of maximum possible amplification before oscillation sets in. Knowing the valve constants, and taking the lowest frequency in the medium broadcast band —namely, 200 metres—where instability will be greater than at 600 metres, due to the lower reactance of the tiny condenser at the higher frequency, it is within the realms of fairly simple mathematics to find an expression which will give the maximum stage amplification just before the threshold of instability is reached.

Further, we shall be able to show how low the losses in the grid and anode coils may be made (*i.e.* how high the dynamic resistance can be) before the capacity reaction resulting from the internal anode grid condenser will cause oscillation to commence. Such investigation of critical values assumes, of course, that external stray capacity, magnetic and common resistance couplings between output and input circuits, have been properly eliminated by efficient decoupling and meticulous attention to complete screening in metal boxes.[2]



On the left is the Mazda S.G.215 screened valve having the extremely low interelectrode capacity of 0.005 $\mu\mu$F. The new Cossor screened valve for A.C. mains is illustrated on the right.

In the appendix to this article will be found the necessary formulæ which have been extracted from a treatise on this subject in *Experimental Wireless*[3] written by Dr. R. T. Beatty. The stage amplification figures found for a number of screen-grid valves on the market are given in column 12 in the accompanying table, wherein, instead of 39, we find such remarkable figures as 206, 152, 88, etc. It must not be forgotten that up to now we have not considered neutralising; the valve capacities of column 11 have been allowed to exert their influence without hindrance. The vast improvement in stable H.F. amplification is due not only to enhanced mutual conductance in conjunction with high amplification factors, but also in no small measure to a study by valve makers of the methods of reducing interelectrode capacity.

In column 13 of the table the maximum permissible dynamic resistance of equal tuned grid and tuned plate circuits is given. That is to say, assuming, for the sake of simplified mathematics, that similar coupled tuned grid and tuned plate coils are used, the figures given in the column concerned show the lowest loss coil it is safe to employ before the threshold of instability is reached at 200 metres. When this coil is used the maximum amplification is the figure given in column 12.

When it is an Advantage to Neutralise.

As an example, a coil (280,000 ohms) of even lower losses than that generally used in an *Everyman Four* type of receiver (computed at about 250,000 ohms dynamic resistance (would have to be used with an unneutralised Mazda S.G.215 valve before oscillation started and, if perfect external screening were arranged, there would be a stage amplification of about 152. The tuned plate circuit specified is the same as a one-to-one transformer, which must be used with practically all screened valves for *maximum* amplification (see column 7).

Before we turn to the question of the advantages of neutralising, for the sake of interest and to show the extraordinary advance made in the last few years we will cite an example of the best unneutralised amplification that we could extract from a triode. Reference will be made to an old and trusted friend — the D.E.5B. valve. By working out from expression (*c*) in the appendix, the threshold instability amplification at 200 metres, assuming the anode-grid capacity as 10 $\mu\mu$F., we find the figure of 3.4. That there are now available in this country valves with an inter-electrode capacity 2,000 times less is a great tribute to the research laboratories of the British valve manufacturers.

It will now have become clear that the limiting factor of amplification with screen-grid valves is chiefly the valve capacity and perfect screening. If we can nullify the effect of this capacity by neutralisation the limit to amplification is the highest dynamic resistance to which the tuning circuits can be designed. The numerical treatment of stage gain when using neutralised H.F. transformers has already been dealt with so lucidly in the pages of this journal[4] by A. L. M.

[2] See "Metal Cabinets," *The Wireless World*, July 10th, 1929.
[3] October, 1927, and January, 1928.
[4] *The Wireless World*, April 24th, and May 1st, 1929.

H.F. VALVE STATISTICS

(*Wireless World* 24th July 1929)

1	2	3	4	5	6	7	8	9	10	11	12	13
VALVE	MAKER	TYPE	AMPLIFICATION FACTOR	A.C. RESISTANCE	H.F. PERFORMANCE FACTOR	OPTIMUM TRANSFORMER RATIO	NO OF PRIMARY TURNS	MAXIMUM STAGE AMPLIFICATION NEUTRALISED	STAGE AMPLIFICATION WITH 3:1 RATIO TRANSFORMER	VALVE CAPACITY (ANODE-GRID) ($\mu\mu f$)	MAXIMUM STAGE AMPLIFICATION UNNEUTRALISED	LOWEST LOSS COIL FOR COL. 12 DYNAMIC RESISTANCE (ohms)
AC/S.	COSMOS	S.G/A.C.	1200	800,000	132	1	68	290	121	0·006	208	165,000
AC/G.	,,	T/A.C.	35	17,500	26	3·8	18	66	—	—	—	—
SP/610G.	,,	T.	19	11,000	18	4·8	14	48	—	—	—	—
220 S G.	COSSOR	S.G.	200	200,000	45	1·12	61	112	73	0·023	75	—
41.M.SG.	,,	S.G/A.C.	400	200,000	89	1·12	61	224	146	—	—	—
41.M.HF.	,,	T/A.C.	25	14,000	21	4·2	16	52	—	—	—	—
610 H.F.	,,	T.	20	20,000	14	3·54	19	35	—	—	—	—
H.F. 610	EDISWAN	T.	25	21,000	17	3·45	20	43	—	—	—	—
S. 215	MARCONI AND OSRAM	S.G.	170	200,000	38	1·12	61	95	62	0·014	81	184,000
S.625	,,	S.G.	110	170,000	27	1·2	57	66	46	0·022	55	—
DEH.610	,,	T.	40	60,000	16	2	34	40	—	—	—	—
HL.610	,,	T.	30	30,000	17	2·9	24	43	—	—	—	—
DE5.B.	,,	T.	20	30,000	12	2·9	24	29	—	(10)	3·4	—
S.G.215	MAZDA	S.G.	300	270,000	58	1	68	144	84	0·005	153	280,000
PM.16	MULLARD	S.G.	200	200,000	45	1·12	61	112	73	0·015*	88	160,000
PM.S4.V.	,,	S.G/A.C.	1000	1,330,000	87	1	68	158	61	0·015*	98	—
PM.354.V.	,,	T/A.C.	35	14,000	30	4·2	16	73	—	—	—	—
PM1.H.F.	,,	T.	18	22,500	12	3·3	21	30	—	—	—	—
PM5.X.	,,	T.	17·5	14,700	14	4·1	17	36	—	—	—	—
PM.26	,,	P.	50	25,000	32	3·2	21	80	—	—	—	—
SS. 215. SG.	SIX-SIXTY	S.G.	190	220,000	41	1·07	64	102	64	—	—	—

Columns 6, 7, 8 and 9 refer to H.F. transformer coupling for triodes and screened valves, whilst in columns 10, 11, 12 and 13 are given certain data for screened valves only. Columns 12 and 13 refer to the case where a one-to-one transformer (or tuned anode) is used and where it is assumed that the tuned grid and tuned plate coils have the same dynamic resistance

The Modern H.F. Valve.—

Sowerby that little more need be said here. Taking an *Everyman Four* type of H.F. transformer and using a neutralising winding of an equal number of turns to the primary for triodes, and one or two neutralising turns for screened valves, the optimum transformer ratio is given in column 7. Assuming a 68-turn secondary of Litz wire, the number of primary turns is shown in column 8, and the maximum possible stage amplification when using such a transformer in column 9.

It is somewhat intriguing to compare the figures of columns 9 and 12 for screened valves. Where the valve capacity is, say, over two hundredth of a micro-microfarad there would seem to be considerable advantage in neutralising if we grant that the slight added complication is compensated for by the extra percentage amplification. Alternatively, the table shows that when using coils of the *Everyman Four* type there is little to be gained as regards amplification by neutralising those screened valves which have internal capacities under one-hundredth of a micromicrofarad. If coils were to be designed with a dynamic resistance of something over 400,000 ohms, a valve like the AC/S, when neutralised, would undoubtedly give the unprecedented stage amplification of 400 or 500. Under these conditions the neutralising of a screened valve has a very real advantage.

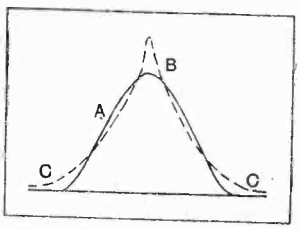


Fig. 1.—Having chosen a stage amplification for a screened valve which is a little below the point at which instability occurs when the valve is unneutralised, the resonance curve for the same stage amplification when the valve is neutralised is shown as A above. The resonance curve for the case when the valve is unneutralised shows a peak at B with likelihood of sideband cutting and the broad skirts at C suggest poorer selectivity.

With a valve like the Mazda S.G.215 we are in a position to attain an amplification of about 150, either neutralised or unneutralised, and it might be interesting to compare the type of resonance curve in each case.

In Fig. 1, A represents the neutralised case; the (dotted line) unneutralised curve, due to the assistance of valve capacity reaction, will have a peak as at B suggesting sideband cutting, while the somewhat broad skirts shown at C may cause the selectivity to be a little worse than that of curve A. It is probably unlikely that the effects of B and C would be aurally perceptible unless the threshold figure in column 13 were practically reached.

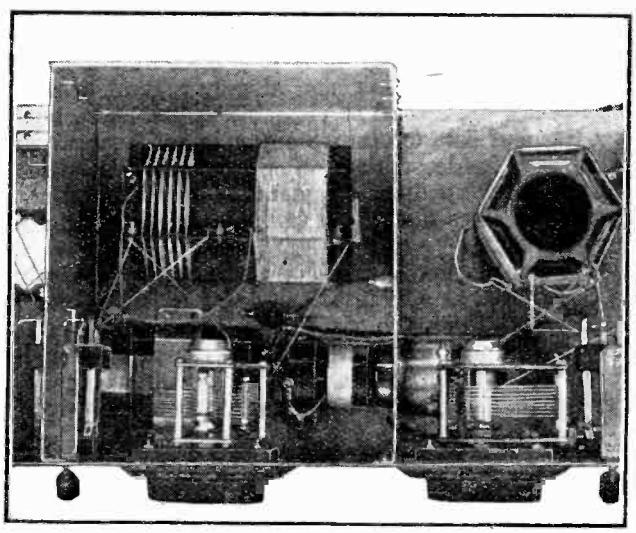
Selectivity and the Screened Valve.

We must now turn our attention to selectivity with screened valves. It has been shown by Dr. McLachlan[5] that in a high-frequency transformer the effective capacity across the primary is equal to the capacity across the secondary multiplied by the turns ratio squared. As screened valves demand a transformer of approximately one-to-one ratio for maximum stage amplification the selectivity will always be poor as compared with that of an *Everyman Four* type of receiver where, with a neutralised triode, the optimum turns ratio is, say, three- or four-to-one. The obvious corollary is to forgo a part of the amplification of the screened valve and use a transformer with a step-up ratio and regain our lost selectivity.

The important question now arises as to whether in obtaining this selectivity we have not reduced the amplification of the screened valve to the level of the cheaper triode. On the assumption that a three-to-one transformer adequately meets our needs, is the amplification reduced to one-third, a figure which in general would make the screened valve hardly worth while? Luckily, the answer is in the negative.

Modified Transformer Ratios.

In the appendix the expression (*d*) gives the stage amplification where any non-optimum turns ratio is employed with a screened valve when the primary dynamic resistance is *not* equal to that of the valve. In column 10 the stage gain with a three-to-one transformer is worked out, and can conveniently be compared with the figures for a one-to-one transformer in column 9. Presumably where the figures of column 10 are well below the threshold instability figures of column 12 neutralisation is unnecessary, but it must not be forgotten that column 12 refers to tuned plate circuits (or one-to-one transformers). It would be as well to point out that when really powerful interference from a local station is experienced, not only is a selective interstage coupling necessary, but a coupled aerial circuit is almost essential. These remarks will have more force when the transmissions from Brookman's Park commence.

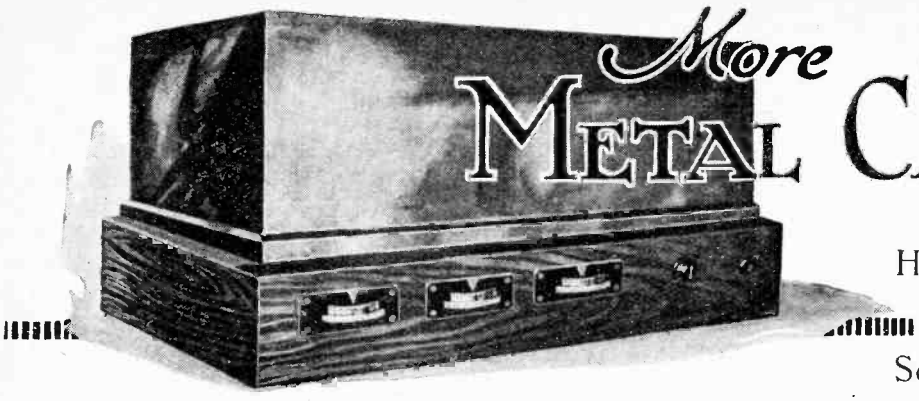


Completely screened H.F. stage with two-range switching and S.G. valve. An H.F. amplification of 50 can be readily obtained. (From the "S.G. Regional Receiver.")

If instability persists when the stage is unneutralised, and when a step-up transformer is being tried in order to gain the necessary selectivity, further turns should be removed from the primary rather than that any attempt should be made to damp the low-loss secondary.

(*To be concluded.*)

[5] *Experimental Wireless*, October, 1927, p. 600.



More about — METAL CABINETS

Hints on the Design of Screening Containers.

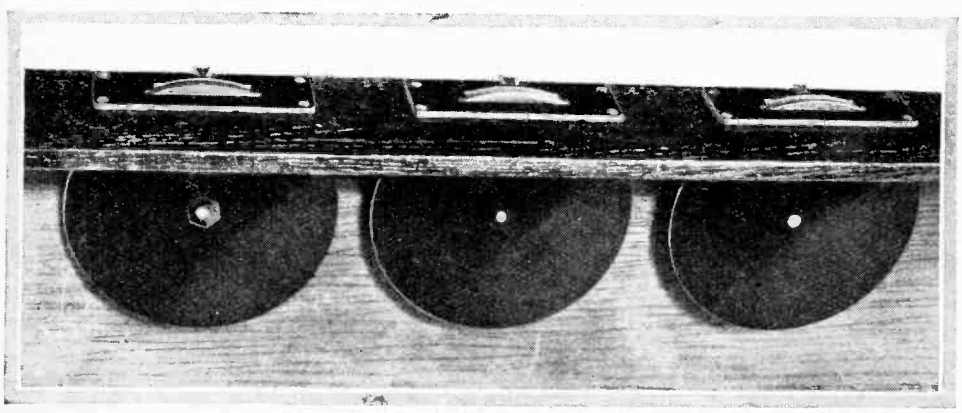
SETS with a single screen-grid high-frequency amplifying valve tend to become much of a muchness, or, at any rate, no particular design seems to manifest that clearly perceptible superiority in sensitivity and selectivity shown by, say, an " Everyman Four " type of receiver when compared with a more conventional arrangement of neutralised three-electrode valve. The set designer has more scope than ever for his abilities when dealing with the detector-L.F. part of a receiver, but with regard to the H.F. amplifier something approaching an *impasse* has been reached. In the case of ordinary S.G. valve circuits, it is comparatively easy to attain a certain level of amplification, which is limited to a value below the theoretical maximum mainly by two factors—residual capacity in the valve and interaction between circuits. The first is entirely a matter for valve manufacturers, and already a great deal has been done; the second is amenable to treatment, but it is a waste of time to observe any extraordinary precautions, say, in decoupling, when advantages so gained will be offset by direct magnetic or capacitative inter-circuit couplings due to the imperfect screening that is generally used.

When inter-circuit coupling through residual valve capacity reaches a high value, there is little point in taking special pains to avoid other linkages, but nowadays this capacity has, in nearly every case, been reduced to a very low figure, and valves with even greater merit in this respect are expected to be shortly available. In order to derive the fullest possible benefit from them, it will be essential to avoid interaction in every possible way, and there is certainly room for improvement in our present methods of screening.

An All-purpose Screening Case.

In an article in *The Wireless World* for July 10th attention was drawn to this matter, and suggestions were made as to the design of a metal screening case with a wooden base, suitable for housing modern receivers with one or two high-efficiency H.F. stages. That the subject is considered to be important is shown by the fact that this article has evoked a good deal of correspondence both from amateurs and from the wireless trade; both seem to be in complete agreement with the views expressed, and, as no really unfavourable criticisms of the design or demands for sweeping modifications to it have been received, it may safely be assumed that something on the lines suggested will meet the case, and, in consequence, some further hints are offered.

Although thorough screening is of such importance, it is well to dispel a prevalent illusion as to the benefit conferred by it. It is sometimes thought that the performance of *any* " H.F." set will be improved by completely isolating its circuits in separate compartments instead of using less-complete screening. If the receiver is so designed as a whole that its H.F. amplifier is normally stable, no improvement whatever is likely to be brought about by this alteration; indeed, it may be slightly less sensitive than before, due to a decrease in incidental reaction effects. Generally speaking, it pays to make the alteration in question only when the H.F. valve tends to oscillate under optimum operating conditions, or when a complete re-design of the H.F. portion, involving the use of more lightly damped circuits, is proposed.



View from below showing position of condenser drums inside the base. These are experimental dials turned from ¼in. sheet ebonite, with an over-all diameter of 5¼in.

As stated in the earlier article already referred to, tuning condensers must be

More about Metal Cabinets.—

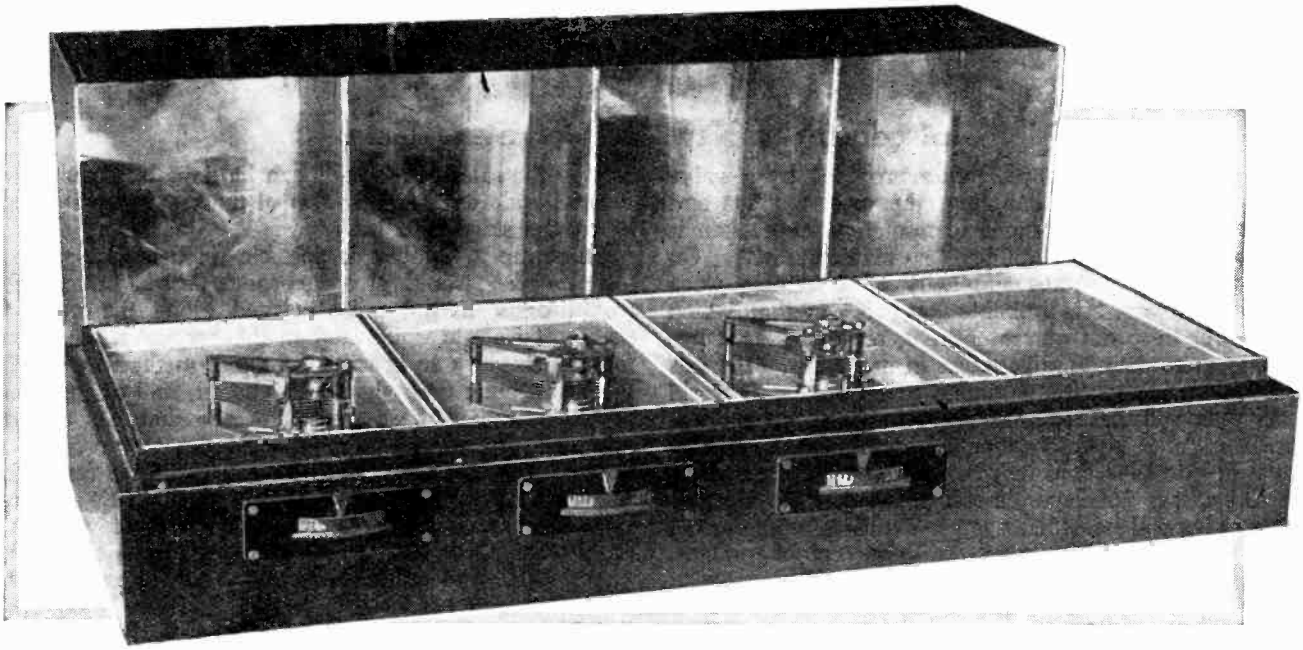
mounted with their spindles in a vertical plan, and consequently edgewise dials of fairly large diameter must be used. We may assume that the centre of the "one-hole fixing" bush will be located 1½in. behind the front edge of the screen (at least 90 per cent. of components on the market may be so mounted); allowing for the wooden base to project an inch beyond the front face of the screen, the control drums must be between 5½in. and 5¾in. in diameter. This seems large, but it must not be forgotten that very fine adjustments can be made on the knurled periphery of these drums, and that reduction gearing will no longer be necessary. In any case the designs of both cabinet and condenser drums are interdependent, and, if a smaller edgewise dial is preferred, it will be necessary that the projection of the wooden base be reduced.

There are almost innumerable ways of arranging for good electrical sealing at the junctions between the edges of the removable metal cover and its partitions and the metal base. Instead of using deep channels with spring edges—with or without braided metal tape gaskets or something similar—it is possible to make comparatively shallow depressions in the sheet of metal, and to fit strips of braided tape to the edges of the cover, which would be provided with brackets and screws or spring clips to hold it firmly into position, with metal surfaces forced into close contact. It will be obvious that the cover should be readily removable when interchangeable coils are used in the receiver, although this feature is of minor importance in "switch-over" sets. An electrical seal may be quite effective, even though there may be small imperfections or apertures at a number of points along the joint, but a lengthy seam with its surfaces apart or in imperfect contact must be avoided like the plague. It is always worth while to rub over the contiguous edges with emery-paper to ensure that they may be clean, and, of course, to remove any enamel, etc., from these points of contact.

It has already been suggested that tinned steel plate—to put it brutally, common or garden so-called tin—is quite suitable for these containers, especially if it is nicely finished. The cover should be made of a sufficiently heavy gauge to be self-supporting and rigid, but the base may well be of lighter material, as a number of holes are drilled through it—and through the ¼in. plywood sheet serving as a backing to it.

The Problem of Waveband Switching.

With the exception of the condenser dials already mentioned, no other non-standard components are needed beyond simple control devices for operating wave-changing switches, where they form part of the design. It might seem possible to mount them in the conventional manner on the front panel of the wooden base, but a moment's thought will show that this would not be sound practice; it would be illogical to take extreme precautions to isolate the various circuits and then to lead "danger" wires out from the interior of the screen. Instead of doing this, the switches should be mounted inside the screening boxes with their operating knobs or levers projecting into the base compartment. Where two or three separate switches are used, they may be coupled together as shown in the accompanying illustrations, which show simple methods of dealing with lever or rotary types. In the case of the first, a slot is cut in each metal knob, in which is pinned a link of strip brass terminating in a knob projecting through the side of the base. Knob switches are linked in a similar manner; existing pointers may be made to serve as radius arms. Needless to say, these are improvisations applicable to existing commercial



This view reveals the method of mounting the variable condensers while the removable top gives unimpeded access to all components.

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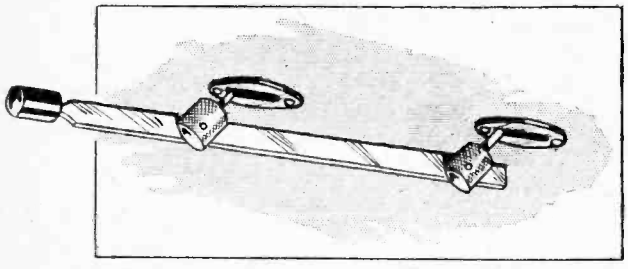
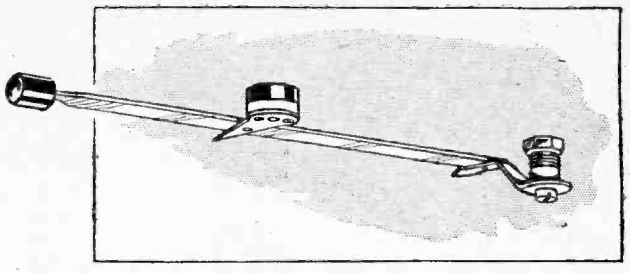
patterns; they are satisfactory enough in practice, but it is possible to devise other methods of greater mechanical soundness.

Emphasis has already been laid on the accessibility of a set constructed in this manner. This is a point to which all too little attention has been paid in the past, to the intense annoyance of those of us whose hands do not conform to the ideals of the lady novelist. By taking reasonable care in the disposition of components, both in the trays and in the base, it is easy to ensure that all their terminals are within easy reach, either during the initial wiring process or for subsequent alterations and experimental work.



Lever switches fitted to the underside of the baseboard. A link is fitted for simultaneous operation; the control knob projects through the side of the base.



Simple method of linking together two rotary switches of different patterns.

THE DECIBEL.

Introducing a New Unit of Stage Gain.

IN describing the amplification provided by a valve and its associated coupling, the most obvious and most fundamental mode of numerical expression is to say that the stage amplifies "so many times." On account of the extreme simplicity of describing stage gain in this way, it is probable that it is a method which will never drop out of use entirely, especially as it has certain quite definite advantages in its favour. It lends a great simplicity, for example, to estimating the grid bias that will be required for any given valve in a receiver, for if we know that the output valve takes 20 volts of grid bias, and that the stage before it amplifies 20 times, it is not very difficult to see that this penultimate valve will be called upon to handle a maximum of one volt, and so will be satisfied with one volt of grid bias.

Relative Amplification.

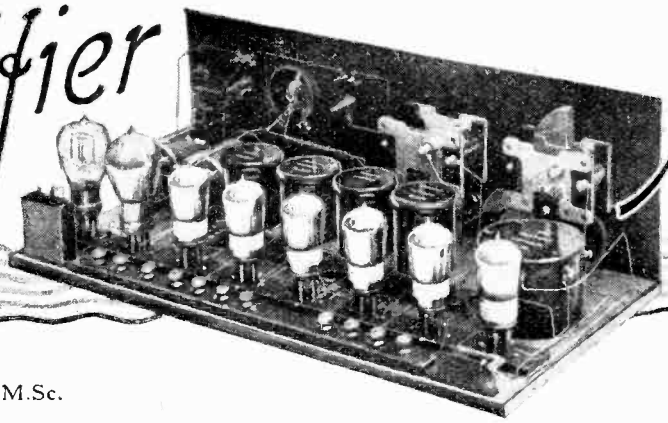
For other purposes, and especially in connection with measurements of various kinds, this simple expression of stage gain is not quite all that could be desired. If we plot the amplification-frequency characteristic of a stage of low-frequency amplification, obtaining a curve of the type published by the makers of low-frequency transformers, a unit of different type gives a more informative curve. The ear, as everyone knows, does not appreciate changes in *absolute* but in *relative* sound level, so that a variation of amplification (as between two different notes) from 60 times to 40 times would represent an aural effect exactly equivalent to a variation from 30 times to 20 times, for in both cases the second figure is two-thirds of the first. Plotted as "stage gain," the drop of the curve from 60 to 40 would occupy just twice as much vertical space as the drop from 30 to 20—which is absurd, seeing that the two drops sound exactly alike to the ear. Clearly, to fit such a case as this we need to introduce a new unit in which drops in the curve of equal *relative* magnitude occupy the same space; this can be done by basing the vertical scale on the *logarithm* of the stage gain instead of on the stage gain itself.

There are a number of possible ways of doing this, all of which would give the same curve, but which would differ in the units marked along the vertical scale. To attain uniformity in this respect it has been found necessary to specify the exact method in which the logarithmic units should be chosen, and of the proposals that have been made the one that has so far achieved the widest popularity is the "transmission unit." This is twenty times the logarithm, as found in the ordinary tables used to simplify arithmetic, of the stage gain. Reverting to the example already given, stage gains of 60, 40, 30 and 20 correspond to 35.56, 32.04, 29.54 and 26.02 transmission units respectively. The difference between 35.56 and 32.04 is 3.52, and that between 29.54 and 26.02 is also 3.52, showing that the requirement that equal percentage changes in amplification should correspond with equal changes in the height of the curve has been met.

It has long been felt that "transmission unit" is a clumsy, and even in some cases a misleading name, and the unit has recently been re-christened the *decibel*. The prefix "deci" implies that it is one-tenth of a larger unit, the Bel, so named in honour of Graham Bell, the inventor of the original Bell telephone. A stage gain of one Bel corresponds to an amplification of 3.16 times, or to an increase in power output of 10 times, while a stage gain of one decibel corresponds to an amplification of 1.122 times, or to an increase in power output of 1.259 times. These figures are the tenth roots of those corresponding to the Bel.

It is not difficult to show that in many other directions the decibel offers very considerable advantages over the simple numerical value of the voltage or power ratios involved.

Amplifier Noises



By A. L. M. SOWERBY, M.Sc.

Setting a Limit to Long-Distance Frame-Aerial Reception.

THE craze for portable receivers that is evident at the present day, more especially among those with no technical knowledge, has led many to look into the possibilities of reception on a frame aerial or other small-sized collector of energy. It is self-evident that if a frame or a short indoor aerial is used the signal-voltage available at the input end of the high-frequency amplifier will be much smaller than that which can be derived from a large open aerial, with the result that the sensitivity of the receiver has to be increased to a considerable extent to recover the signal strength sacrificed to the convenience of the small aerial.

When reception is limited to two or three stations, and these the ones best heard at the listener's location, the increase in the sensitivity of the receiver brings no appreciable disadvantage in its train, while in the immediate neighbourhood of a powerful transmitter the extra selectivity conferred by the conjunction of a small aerial and an extra tuned circuit or two in the receiver is of the greatest possible value. But if the listener's ambitions are greater and he wishes to be able to receive any station that is worth hearing, he is compelled, if he wishes to keep to his tiny aerial, to use a still more sensitive set, and he then begins to find that the process of cutting down the received signal voltage and then compensating by higher amplification is one that, though satisfactory enough up to a point, cannot be carried on indefinitely.

"Signal-mush" Ratio.

Those who have built for themselves amplifiers of really high sensitivity will not need to be told that there is a limit to the amount of amplification that can profitably be used in radio reception, but those who have not made experiments on these lines will perhaps wonder how the limit arises, and to what it is due.

If, for example, one sets up a powerful high-frequency amplifier containing perhaps three stages of reasonably good efficiency, one may expect signals to be amplified some 30,000 or 40,000 times at least before reaching the detector. The writer has played about a good deal with a receiver of this kind, and in common with many others has found that when such a receiver is worked "all out" on a very faint station there are subsidiary noises which are nearly as loud as the signal being received. These noises take the form of a loud rushing sound, as of many waters, and this is commonly punctuated at intervals with bangs and cracks of the most violent description. It is usual to refer to the continuous rushing sound as "mush," and to assume that it is picked up, along with the signal being received, by the aerial, and so delivered, after considerable amplification, to the detector valve.

Noises Originating in the Valves.

This explanation of background noise, like most other simple explanations, proves on closer investigation to be true in part, and in part entirely wrong. If one tunes in a station that is received strongly enough to enable the set to be worked at much less than its maximum amplification, it is found that both the continuous background noise and the intermittent louder noises are present, though the signals drown them out fairly completely. Suppose now that the aerial coupling is progressively loosened by some device or other, while a compensating adjustment is made to the sensitivity of the receiver—by control of the filaments of the H.F. valves, for example—so that the intensity of the signals remains unaltered while the input to the receiver is continuously decreased. It is then found that the intermittent loud noises remain at about the same strength throughout the process, showing that they are collected by the aerial at the same time as the signals. The continuous part of the background noise, on the other hand, is found *to grow steadily as the amplification of the receiver is increased.* If this noise also were being picked up by the aerial the increase in amplification would be exactly compensated by the decrease in input brought about by loosening the aerial coupling, since the volume of speech or music from the station to which the set is tuned has been kept at a steady level throughout. One can only assume, therefore, that the rushing sound is not picked up by the aerial after all, but originates elsewhere—and a moment's thought will indicate that the receiver

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itself must be responsible for this particular contribution to the total of noise.

That valves give rise to unwanted noise is not a new discovery, but it is not quite so generally realised as one might expect that the practical limit of amplification is set so low that at least in some unfavourable locations it is simply not possible to receive cleanly on a frame aerial any station other than the local and 5GB.

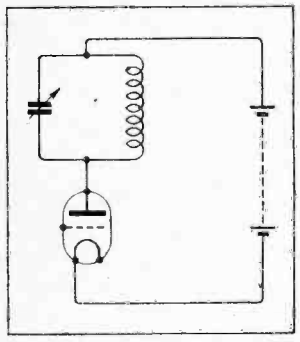

Fig. 1.—The arrival of each electron at the plate "shocks" the tuned circuit into oscillation. The total "shot-voltage" is the resultant of all the oscillations due to the separate electrons.

The writer lives in a London flat, which is believed to be something of a "blind spot," and it is found there that while 5GB can be received with a background of almost perfect silence when a short indoor aerial is used, there is an appreciable amount of background noise when a 2ft. frame is substituted. If an ordinary tuning-coil of 3in. diameter replaces the frame, and signals are brought up again to their normal strength, the background noise rises to a full-throated roar through which music is heard but dimly, while speech is so completely drowned out as to be almost unintelligible. This example of an actual experiment, described while it is fresh in the writer's memory, may help to drive home the unwelcome fact that "amplifier noises" constitute a very serious limitation indeed to the reception of distant stations on a small aerial.

Having made the unwelcome discovery that these amplifier noises exist, one is immediately faced with the difficult problem of finding some means by which the interruption due to this cause can be brought down to the irreducible minimum. Before we can hope to do this we must find the cause of the noise, and the factors upon which its magnitude depends.

The "Shot-effect."

The source of noise within an amplifier is not a mystery, but is quite well known. It was pointed out some years ago by W. Schottky that the emission of electrons from a heated filament could not, from the nature of the case, be a perfectly steady process, but must be subject to small random variations from moment to moment. As these electrons provide the plate current of the valve, this must also vary slightly about its mean value. These fluctuations would be far too small to be observable on any instrument that could be used to read the plate current, and the smaller fluctuations, at all events, would be too rapid to be followed by the needle of any instrument.

Electrons are emitted from a filament by a process roughly analogous to the boiling of water, and anyone who cares to watch a saucepan of rapidly boiling water will quickly realise that although, in the main, the flow of steam is steady, yet the number of bubbles arriving at the surface varies from moment to moment. Although the number of electrons leaving the filament of a valve is incomparably greater than the number of bubbles of steam in the crude analogy just suggested, yet this is to a great extent offset by the minute fraction of a second—a millionth, or less—which is the unit of time in wireless reception where the incoming waves have a time-period of that order.

The anode current of a valve, therefore, is not to be regarded as due to the steady drift of an "electric fluid" through the valve, but as the sum-total of the shocks resulting from the arrival at the anode of a perpetual stream of electrons, which pepper it like a bombardment from thousands of independently fired shot-guns. Since the variations arise from the fact that the current is carried by these separate shots, and not as a continuous flow, Schottky christened the variations the "shot-effect."

Noise Arising at the First Valve.

If a tuned circuit is connected to the anode of a valve, as in Fig. 1, the shocks due to these minute instantaneous variations in the plate current will start oscillations in that circuit at the frequency to which it is tuned, just as atmospherics "kick" an aerial into momentary oscillation. If the tuned circuit is in the plate circuit of the first valve of an amplifier, these oscillations are magnified up along with the signals by the succeeding stages, as shown in Fig. 2, and result, after rectification,

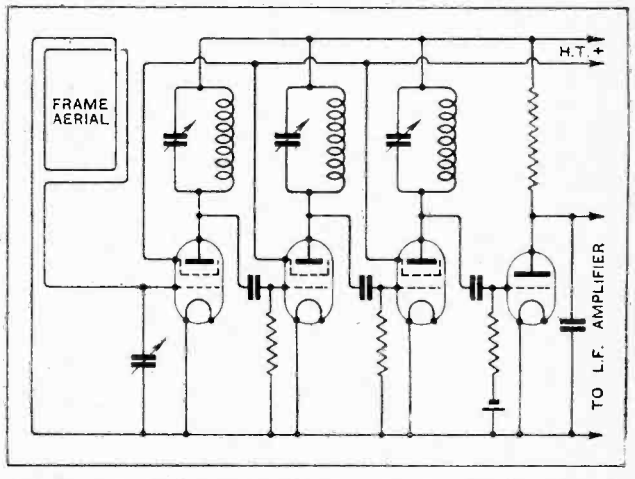

Fig. 2.—In such a receiver as this, the minute voltages due to "shot-effect" set up across the plate-circuit of the first valve are amplified by the remaining valves, and so are enabled to contribute a loud background noise.

in the toneless, rushing sound of which we have already made mention as "amplifier noise."

Later valves than the first also contribute their share of noise, in exactly the same way, but since the noise to which they give rise has to pass through fewer stages of amplification it causes but small disturbance in comparison. From the point of view of practical receiver design, therefore, we will restrict ourselves to considering the noise introduced by the shot-effect in the first valve.

So far we have discussed the shot-effect from a purely

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qualitative point of view, and have gained only the vaguest idea of the probable magnitude of the resulting disturbances. For experimental figures of direct measurement of the shot-voltages developed across the tuned circuit of Fig. 1 we are indebted to Hull and Williams (*Physical Review*, 1925, p. 147). These experimenters embarked upon their measurements with the aim of developing a new and accurate method for determining the magnitude of the negative electric charge by each individual electron, comparing for this purpose the calculated magnitude of the shot-voltage, which involves for its numerical evaluation a knowledge of this charge, with those measured in the laboratory.

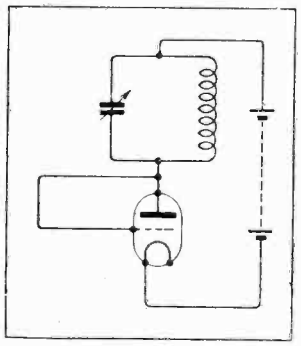


Fig. 3.—The circuit employed in making experimental measurements of the "shot-voltage." The effect is greater in this circuit than in an ordinary receiver.

For this purpose it was necessary for them to make their measurements under conditions which fitted in with those assumed in making the theoretical deduction of the shot-voltage, and one of these conditions was that all the electrons emitted from the filament should arrive at the plate. To ensure this they joined grid and plate of the valve together and connected both, through a tuned circuit, to "H.T.+," as shown in Fig. 3.

If the valve is connected in a more normal manner, with a small negative potential on the grid, some only of the total number of electrons emitted from the filament arrive at the plate, the remainder returning to the filament. Between the moment of their emission and the time when they return they form a kind of cloud round the filament (the "space-charge") and all the electrons that make up the plate current have to pass through this cloud on their way to the plate. As a result of this the fluctuation of plate current is smaller than the fluctuation in the number of electrons emitted, since some of these fluctuations are taken up in varying the density of the electron-cloud. In other words, the shot-voltage across the tuned circuit will not be so great as in the simpler case of Fig. 3.

A Value for "Shot-voltage."

Unfortunately for those who wish to apply the work of Hull and Williams to receiver-design, their measurements were primarily directed towards the evaluation of the charge on the electron, with the result that the effect of space-charge was not investigated very fully, and an exact prediction of the shot-voltage to be encountered in an amplifier cannot be made from their figures. Their measurements indicate, however, that one will be reasonably safe in assuming that a shot-voltage of the order of 250 microvolts will arise across any normal tuned circuit used to couple the first valve to the next.

Now 250 microvolts—one four-thousandth of a volt—does not seem a very large figure, but it must not be forgotten that we are discussing the problem as it arises in connection with highly sensitive receivers, where even so small a voltage as this is likely to be amplified into audibility. If the noise due to shot-effect is not to be great enough to cause serious annoyance, the minimum requirement is that it should at no time be louder than the signals, and on the basis of this very modest demand, together with the figure of 250 microvolts already mentioned, we will try to make an estimate of the minimum signal voltage that must be present in the plate-circuit of the first valve to ensure reasonably noise-free reception.

Relationship Between Signal and Noise.

In Fig. 4 the valve shown represents the first of two or more high-frequency amplifiers in a set working from a frame aerial. Across the tuned circuit LC there will arise a high-frequency shot-voltage of some 250 microvolts. This high-frequency voltage, since the oscillations start and stop intermittently, must be regarded as fully modulated, so that it contributes the maximum of noise after rectification. The same overall signal voltage, even in the loudest passages, would provide a little less noise, since the modulation from a transmitter seldom reaches the theoretical maximum. If we make the condition that the noise due to the shot-effect shall be the same as that due to signals at a moment when the carrier is modulated to the extent of one per cent. (quiet passages in music) we shall require a signal voltage, measured on the carrier, of one hundred times 250 microvolts, or 25 millivolts, across the tuned circuit.

Provided we can attain this minimum signal-voltage, it does not matter in the least whether we follow the valve shown in the figure with a modest receiver ending in a general-purpose valve and a pair of telephones, or whether we put on another couple of valves and

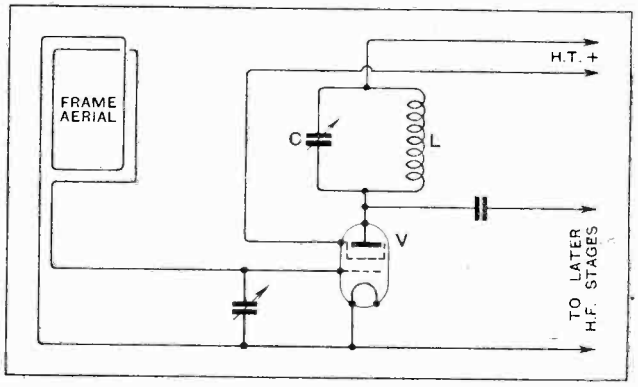
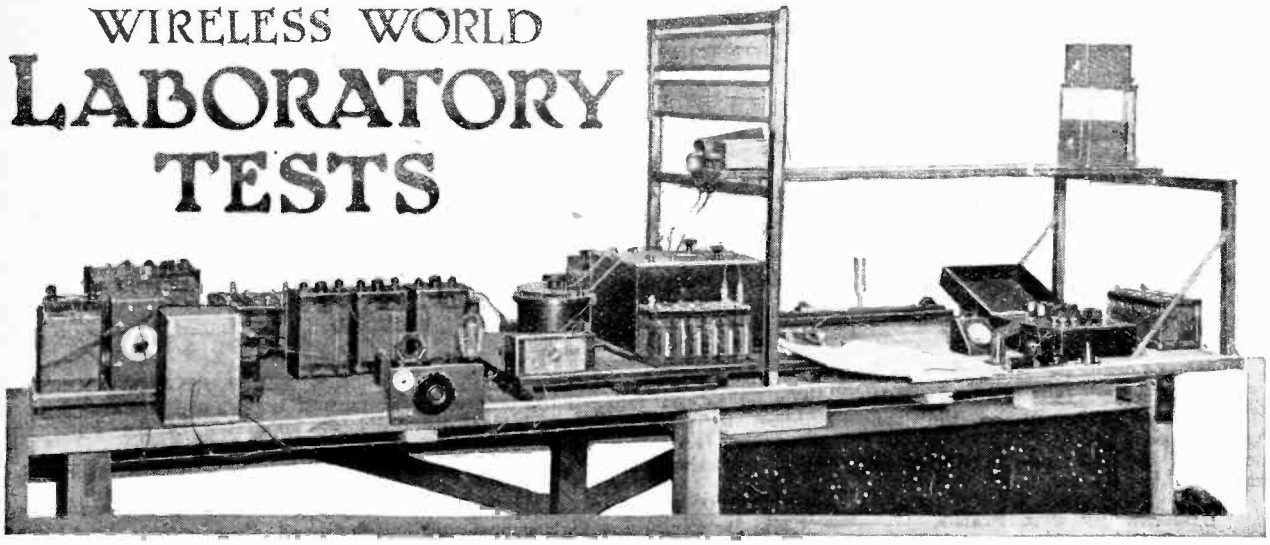


Fig. 4.—The "shot-effect" arises in the tuned circuit LC. For noise-free reception it is essential that the signal-voltage across LC due to the station being received shall be large compared with the "shot-voltage." This can only be done by making the frame aerial highly efficient and choosing the valve V with care.

end up with a moving-coil speaker that nearly lifts the roof. The conditions obtaining in the tuned circuit LC settle, once for all, the ratio between signal strength and noise, and the amplification that may follow can do nothing to improve, and but little to worsen it.

It will be seen that if we accept the figure of 25

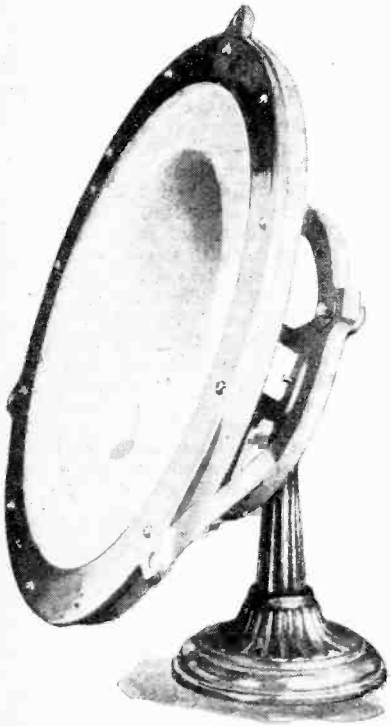
WIRELESS WORLD LABORATORY TESTS



A Review of Manufacturers' Recent Products.

"WHITE SPOT" CONE CHASSIS.

The "White Spot" cone chassis has been designed especially for use with the well-known "Blue Spot" loud speaker unit and is supplied either complete with diaphragm or as a skeleton frame only. The method of mounting the cone follows moving-coil practice in that a supple leather surround is employed. This is stretched tight and the cone carefully centred.



"White Spot" cone loud speaker chassis fitted with stand.

The chassis consists of a clean aluminium casting with an adjustable back plate for holding the unit, and a polished front ring provided with lugs for fixing to a baffle or in a cabinet. Although not essential, a baffle, or its equivalent, is desirable, as it is instrumental in bringing out the very low notes.

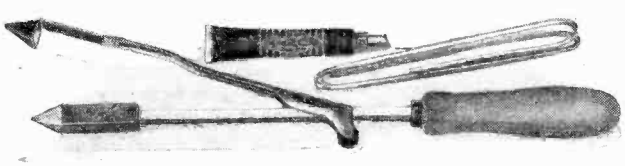
The chassis is available in three models: the "Popular," fitted with a fabric suspended cone at 16s.; the "Super," with gold-finished fabric suspension at 18s. 6d.; and a specially designed model for portable sets at 10s. 6d. Cast-iron stands for the "Popular" and "Super" models cost 2s. 6d. each.

The makers are the Wolverhampton Die Casting Co., Great Hampton Street, Wolverhampton.

"JUNIT" SOLDERING OUTFIT.

This consists of a soldering iron, a tube of non-corrosive flux, and a stick of solder, the outfit costing 4s. only. The main feature of interest lies in the soldering iron since the business end is indirectly heated and cannot, therefore, lose its "tinning." The copper bit is provided with a loose tinned copper cap, which is removed when the iron is placed in the fire. The cap, not coming in direct contact with the flame, will not require continual attention; it is certainly a labour-saving device, and should find a strong appeal among amateur constructors.

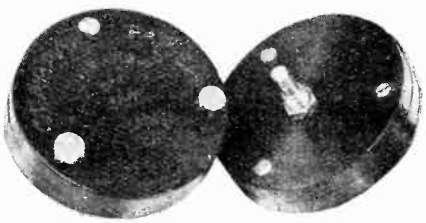
The makers are the Junit Manufacturing Co., Ltd., 2, Ravenscourt Square, London, W.6.



Junit soldering outfit including "Peerpoint" iron with removable cap.

"MICROFICIENT" VARIABLE CONDENSERS.

The main feature of these variable condensers is that a material resembling thin paxolin sheet is employed as the dielectric. Since the plates need not be self-supporting, thin brass foil is used; consequently the size, as regards depth from back to front, has been reduced to seemingly absurd proportions when compared with one of the usual type having air-spaced vanes.



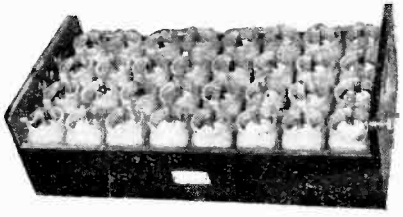
"Microficient" variable condenser with brass foil plates and paxolin dielectric. A Graham Farish product.

The condenser is housed in a neat moulded bakelite case measuring 3in. in diameter and $\frac{5}{8}$in. in depth. A single hole fixing bush is fitted. Two samples were submitted for test, namely, a 0.0005 mfd. and a 0.0003 mfd. capacity. The measured values were found to be 8 micro-mfds. minimum and 0.000753 mfd. maximum for the 0.0005 mfd. size, and 6 micro-mfds. minimum and 0.000281 mfd. maximum for the 0.0003 mfd. size. The plates are shaped, it is claimed, to follow a logarithmic law.

The makers are Messrs. Graham Farish, Ltd., Bromley, Kent, and the price has been fixed at 4s. 6d. for the 0.0005 mfd. size and 4s. 3d. for the 0.0003 mfd and 0.00015 mfd. sizes.

"STANDARD" WET H.T. BATTERY.

An H.T. battery consisting of the No. 4 size cells was submitted for test by the Standard Wet Battery Co., 184-188, Shaftesbury Avenue, London,



Tray containing 32 No. 4 size "Standard" cells. Nominal voltage 48.

W.C.2. The container holds 32 cells and gives a nominal voltage of 48. Since these cells are the largest size available and are recommended for use with super-valves, it was decided to commence the discharge test at about 30 mA. During the first few hours the current fell rapidly, but quickly reached a steady state, and thence onward was well maintained for a period of approximately 500 hours.

This represents actual working time, and to reproduce as near as practical considerations would allow the conditions obtaining during use, the battery was discharged for periods of 4 hours, with similar periods to recuperate. The recuperation periods have been omitted from the graph, and the actual working time only plotted. There would appear to be a natural "cut off" after the 500-hour mark is passed, since the current fell rapidly, so that this can be regarded as the useful life of the battery on one charge.

To renew the battery it is necessary to obtain new sacs, zincs, and fresh electrolyte. The jars should be well scoured in hot water before assembling the new parts. The price of the No. 4 size in trays containing 32 cells is £1 17s. 2d. Spare sacs cost 4s. 6d. a dozen, and zincs 1s. 6d. a dozen. Electrolyte chemical is sold in jars, and sufficient for twenty No. 4 size cells costs 2s.

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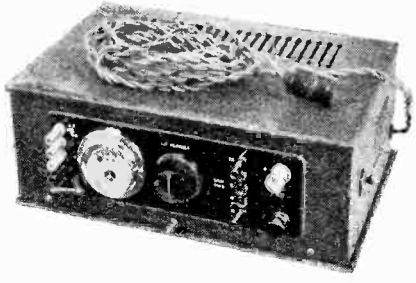
"EKCO" ALL-POWER UNIT FOR D.C. MAINS.

The model submitted for test is a C2A, which gives H.T., L.T. and grid bias when connected to D.C. mains of between 200 and 250 volts. No alteration whatsoever is required to the set, but the L.T. current consumed must not be less than 0.2 amp. or greater than 0.35 amp. Either 2-, 4-, or 6-volt can be used.

Three H.T. tappings are provided, one giving between 120 and 150 volts, one giving 60 volts nominal, and a tapping marked "SG" for the screen potential of screen-grid valves. In addition, grid bias voltages from 1.5 to 12 volts in five steps are available.



"Ekco" complete battery eliminator for use on D.C. supply mains.

Measurements showed that the marked H.T. voltages were obtained when 15 mA. at 140 volts were drawn from the 120-150-volt tapping and 2.8 mA. from the 60-volt tapping. The voltage available for the screen in the screen-grid valve under these conditions was found to be 70 volts. The current drawn from this tapping was limited to 0.4 mA.

Measurements of the L.T. current gave results sensibly in agreement with the maker's figures, provided suitable adjustments are made to the selector plug located in the base on the underside of the unit.

With the wander plug inserted in No. 1 socket, the maximum current that would pass was found to be 0.26 amp., but in No. 4 socket a current of 0.39 amps became available. Intermediate positions gave maximum outputs of 0.3 amp. and 0.35 amp. respectively. The grid bias voltages were measured and found to be in agreement with the marked values.

A practical test was made using a three-valve set fitted with a small-power output valve. There was slightly more hum than usual with H.T. eliminators, but this was not troublesome. Fastidious listeners, already possessing an L.T. accumulator, can reduce the hum to normal proportions by "floating" this across the L.T. terminals and adjusting the L.T. supply to balance the drain on the accumulator. A practically worn-out battery could be used for this purpose.

The unit is enclosed in a metal case adequately ventilated, and the price has been fixed at £5 17s. 6d. The makers are Messrs. E. K. Cole, Ltd., "Ekco" Works, Leigh-on-Sea, Essex.

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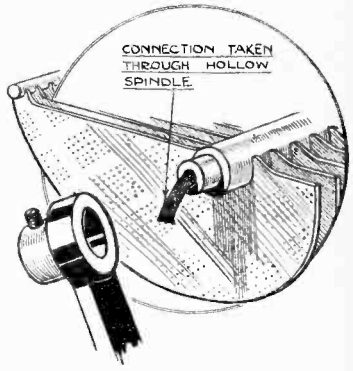
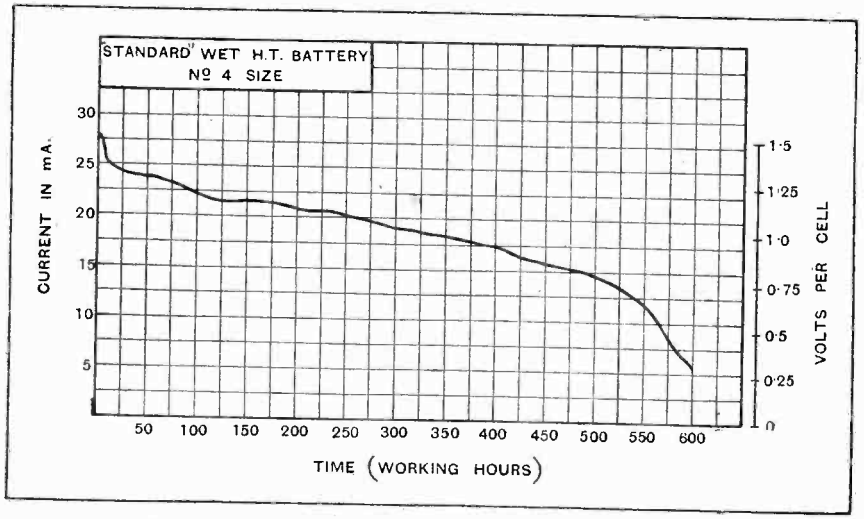
FORMO CONDENSERS.

When describing the condenser used in the Formo short wave outfit in the pages devoted to Laboratory Tests,[1] attention was drawn to the absence of a pigtail connector. It was pointed out, nevertheless, that a test revealed silent working. This



Internal braided connector fitted to Formo condensers.

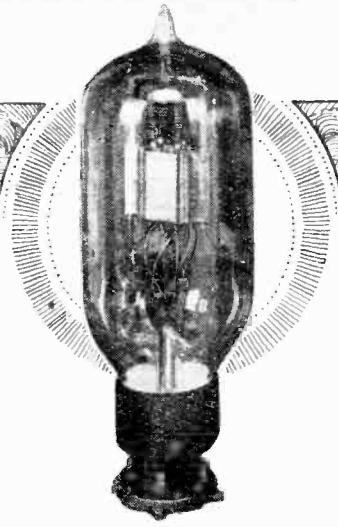
observation may have appeared inconsistent in the absence of the provision of a connector bridging the bearing surfaces. Subsequent examination involving the dismantling of the condenser has revealed a totally enclosed braided connector in the centre spindle passing out to a fixing on the bearing. This method of connection is to be particularly recommended, as it entirely avoids the changes in the constants of a circuit such as may arise with the use of the general form of spiral pigtail. Readers who may have been doubtful as to the suitability of the Formo condenser as the result of a perusal of the recent report will now appreciate that the design adopted is in every way reliable.



Discharge curve of "Standard" wet H.T. battery of No. 4 size cells.

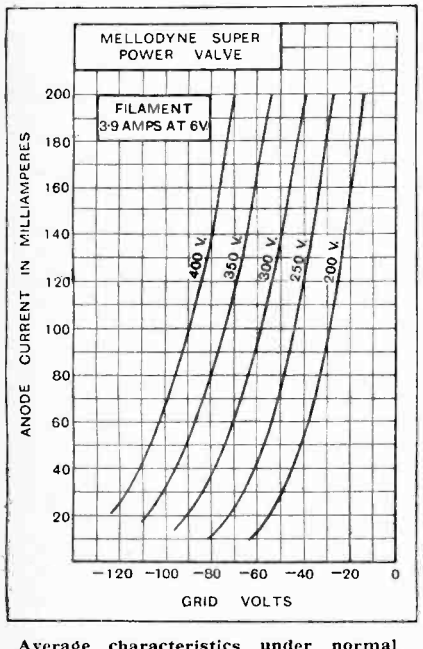
[1] July 3rd, 1929, page 17.

VALVES TESTED



A New Super Power Valve.

THIS is a super-power output valve designed especially for use where a large electrical output is required to operate a number of loud speakers. It is particularly suitable for use in the output position of a public-address amplifier; indeed, in slightly modified form it is being employed in certain amplifying systems in connection with talking films and gramophone reproducing equipment. The main features of the valve are: low A.C. resistance, comparatively high amplification factor, and exceptionally good mutual conductance. Furthermore, it operates without an excessively high anode potential.



Average characteristics under normal working conditions. A.C. resistance, 760 ohms; amplification factor, 33; and mutual conductance, 4.35 mA/volts.

This particular type is made by the North London Valve Co., Ltd., 22½, Cazenove Road, Stoke Newington, London, N.16, for Messrs. Pollock Bros., Royston Works, Putney, London, S.W.15, who have acquired the sole distributing rights. The rated characteristics of the "Mellodyne" are: A.C. resistance, 800 ohms; amplification factor, 3.8; and mutual conductance 4.5 milliamps per volt. This is an exceptionally good conductance for a valve of such low A.C. resistance. The normal working anode potential is 400 volts, and the optimum grid bias is of the order of minus 80 volts.

The construction of the valve differs widely from that generally adopted. Perhaps it can be described best as consisting of four sets of electrodes internally connected in parallel, but with a common anode. The anode is divided into two compartments, however, and in each is assembled two grids and two filaments. The glass envelope measures 6in. high by 3in. in diameter, and the overall height is 8¼in.

The valve is not "gettered," but the required hard vacuum is obtained by pumping for a long period. Each valve is tested finally by running for a definite period with normal H.T. and zero grid bias, and at the end of this it must pass satisfactorily a test for hardness before leaving the works.

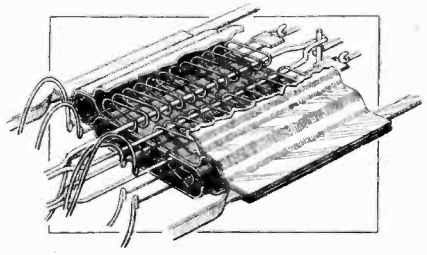
The average characteristics under normal operating conditions of the specimen tested were found to be: A.C. resistance, 760 ohms; amplification factor, 3.3; and mutual conductance, 4.35 mA. per volt. These figures are sensibly in agreement with the maker's rating.

The "Mellodyne."

The following table gives the anode current under various operating conditions:—

H.T.	Grid Bias.	Anode Current.
300 volts	— 60 volts	96 mA.
	— 70 ,,	63 mA.
350 ,,	— 75 ,,	97 mA.
	— 85 ,,	66 mA.
400 ,,	— 80 ,,	140 mA.
	— 90 ,,	100 mA.
	— 100 ,,	65 mA.

In view of the low A.C. resistance and, comparatively, high amplification factor, special precautions must be adopted when using this valve. There may be a tendency towards incipient H.F. oscillation at a very high frequency, and should this occur it will be traceable by a big increase in the anode current. Any tendency in this direction can be guarded against by fitting a resistance of a few thousand ohms in series with the grid. It would be advisable to regard this as an essential addition to the circuit, and it should be included as a precautionary measure.



Electrode assembly of the "Mellodyne" super-power valve.

The "Mellodyne" is being offered at £5 10s. A valve of similar construction, but having an A.C. resistance of 1,000 ohms, and amplification factor of 4.6, and a mutual conductance of 4.6 mA. per volt, is available also at the same price, but this particular type, known as "Leo the Lion," is supplied by the North London Valve Co., Ltd.

KIT CONSTRUCTORS' NOTES

Valve Filament Risks—and Some Safety Precautions.

IN descriptions of kit sets appearing in these pages mention has on more than one occasion been made of the fact that battery wiring is in many cases so arranged that the filaments of all the valves may possibly be burnt out should an accidental short-circuit occur between the positive high-tension lead and earthed metallic screening, etc. The why and wherefore of this state of affairs does not seem to be obvious to many readers, judging from correspondence, and it is thought that a short explanation of the matter, with a word of advice as to how the possibility of an accident may be prevented, will be of interest to many builders of these sets.

It seems that the designers of the sets in question have embarked on their task with the entirely commendable idea of arranging the on-off switch to disconnect both H.T. and L.T. batteries, and have accordingly inserted it in the common negative lead. If we study a theoretical circuit diagram of this form of connection it would at first appear that their object has been satisfactorily achieved, and that the negative pole of the H.T. battery is completely isolated from the set wiring when the switch is "off." At least, this will seem to be so if we draw our diagram in the conventional manner, with terminals for battery connections, but we must not forget that the L.T. cells will be permanently joined to their points of attachment; when the switch is opened the high-tension negative terminal is still connected to the filaments *via* the L.T. battery, which may be regarded as a conductor of negligible resistance.

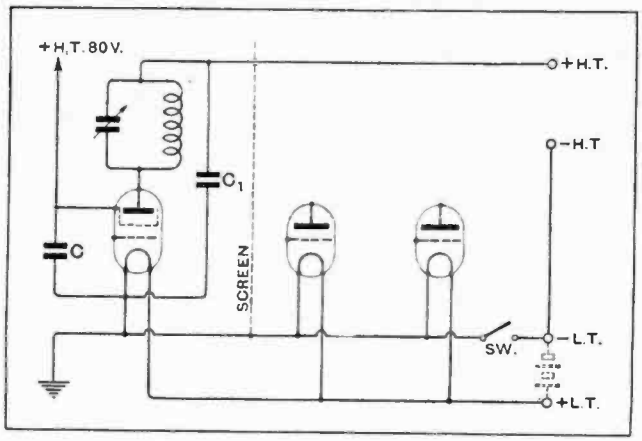


Fig. 1.—Showing how filaments may be damaged by an H.T. short-circuit to earth.

All this will be made clear from a consideration of Fig. 1, in which the filament heating cells are shown in dotted lines. It will be seen that with the switch open H.T. negative is connected to the positive side of all valves, and that an accidental contact between H.T.+ and *any* earthed point—screen, filament bus-bar, individual negative filament wiring, or external earth lead, etc.—will cause the circuit to be completed through the filaments, and, if the high-tension battery has a fairly low internal resistance, the valves will inevitably be burnt out.

It may be said that such short-circuits should not take place, but it is fatally easy to make accidental contact with large metal surfaces, and, even if the operator never makes a mistake, there is a remote possibility that one of the anode by-pass condensers, such as those shown in C and C_1 in the diagram, may develop a short-circuit, or even that the electrodes of the "S.G." valve may make contact. In either case the result will be the same, and one is forced to the conclusion that it is a mistake, or, rather, that it is impossible to make a simple single-pole switch serve the purpose of switching off both batteries. As frequently pointed out in this journal, it is generally safe to keep the H.T. battery permanently connected, because as soon as filaments are extinguished the flow of anode current will automatically stop, provided insulation is adequate—as it should be, in any case.

In many cases the sponsors of kit sets have issued instructions for connecting a flash-lamp fuse; this is satisfactory enough, but the amateur must not fall into the error of thinking that the ordinary lamp, which often carries a current of as much as half an ampere for considerable periods without fusing, will confer complete immunity; it certainly will not do so if only one of the valves is in position in the set, and it may even be inadequate when they are all inserted in their holders. Those who rely on this form of protection should be careful to choose bulbs with a low fusing point, or one of the special fuses designed to "blow" before the current rises to the value normally passed by a valve filament. There are several other ways of ensuring that a high-tension short-circuit will do no more damage than that inevitably caused to the cells through a too-rapid discharge, and it is certainly wise to consider making a minor modification to the switch wiring in the manner shown either in Fig. 2 (*a*) or (*b*). In the first diagram H.T.– and L.T.– are connected externally to their normal terminals, which are joined together internally, and also to the common filament bus-bar and to earth, while the switch is transferred to the L.T. positive lead, being inserted between the input terminal and

Kit Constructors' Notes.—

the feed leads to the various filaments. This is a form of connection advocated by the majority of contributors to this journal, but it is not possible in cases where a metal panel is used and when the switch is of the type in which one contact is in metallic connection with the panel. In such cases the very simple alteration shown in diagram (*b*) is to be preferred, and it involves no more alteration than can be carried out in a few moments. All we have to do is to remove the connection between the H.T. negative terminal and the L.T. negative terminal, and to join the former directly to the most convenient point on the common negative bus-bar. Either of these alterations confers complete immunity from the possibility of burn-outs in the manner described.

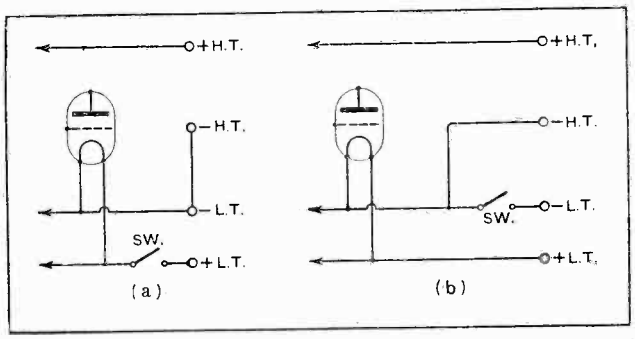


Fig. 2.—Simple alterations in switch wiring.

Those who do not wish to make any alterations to their sets should always remember that when making any experiments or tests involving the remotest possibility of "earthing" an H.T. positive connection it will be wise to set the switch in the "on" position, so that the filaments will be bridged by the L.T. battery, which will automatically prevent any serious rise in the voltage across them.

KIT CONSTRUCTORS' PROBLEMS.

The information Department Service has been extended to deal with problems encountered by builders of "kit" sets discussed in these pages. Receivers already treated are the "New Cossor Melody Maker," Osram "Music Magnet," Mullard "Master Three Star," Six-Sixty "Mystery Receiver," Ferranti "Screened Grid Three," Formo "Screened Grid Three," Dubilier "Toreador Screened Grid Four," McMichael "Screened Three," and the Mullard "S.G.P. Master Three." The service is subject to the rules printed in the "Readers' Problems" section.

Decoupling Precautions.

I am thinking of making an eliminator for my Osram "Music Magnet" set, and should like to know whether it would be an advantage to fit a decoupling resistance in the anode circuit of the detector—or anywhere else, if the addition is likely to do any good. S. V. C.

Although the circuit of this receiver is not particularly prone to L.F. reaction troubles, due largely to the fact that it employs but one L.F. stage, the fact remains that when *any* receiver is supplied with H.T. current from the eliminator, more or less complete isolation of the various circuits is likely to prove advantageous.

As a first step it is a good plan to include a choke filter output (of the type in which one side of the loud speaker is joined to the negative filament bus-bar). This in itself is likely to prove efficacious, but as a further precaution a feed resistance (with its associated by-pass condenser) may be connected in the detector anode circuit.

Lastly, it must not be forgotten that L.F. impulse can be fed back to the detector grid *via* the tuned anode coil, etc., and to be completely safe the plate circuit of the H.F. valve can also be decoupled. From the "L.F." point of view, there is no point in providing a resistance feed for the screening grid, although this addition (with, of course, a by-pass condenser) will certainly do no harm, and will help to ensure stability when the set is operated with maximum anode voltage.

A Hot Bulb.

The pentode valve of my "Mullard S.G.P. Master Three" gets very warm after the set has been in operation for a short time. This rise in temperature can be reduced by increasing negative bias, but quality is then not so good. Is it normal that the valve envelope should become hot? T. M.

Yes, this effect is quite usual, and if the glass bulb does not become uncomfortably hot to the hand you need not be perturbed. We do not consider that there is any need to operate it under conditions other than the best; by increasing negative bias beyond the optimum value you are, in effect, reducing the amount of energy dissipated in the valve, and it is consequently to be expected that the valve will run cooler.

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An Extra Valve.

In order to obtain a larger reserve of amplification (which is often necessary in this remote district) I am thinking of adding a resistance-coupled L.F. amplifier to my "New Cossor Melody Maker." Of course, this coupling will be between the detector and first L.F. valve; will you suggest a suitable value for the anode resistance? F. B. H.

In a case like yours, where a grid circuit detector with reaction is used, we think it is a mistake to use an excessively high value of anode resistance, and in any case there should be little need to strive for the maximum attainable magnification. We suggest a value of something between 50,000 and 100,000 ohms, depending upon the impedance of the detector valve.

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Trouble in the H.F. Amplifier.

My "New Cossor Melody Maker" has worked satisfactorily for some time, giving pleasing quality of reproduction. Lately there has been considerable deterioration in every respect, and quality is distinctly poor; I can best describe it by saying that there is a good deal of "woolliness" and that the upper frequencies seem to be almost entirely lacking. This falling-off in performance is coincident with the need for a good deal of reaction in order to obtain reasonably loud signals; originally the feed back condenser was set at zero for reception of my nearest station. From this information can you tell me what is wrong? H. T. M.

From the information you give we think it extremely probable that the poor reproduction of which you complain is largely, if not altogether, due to excessive use of reaction. The need for this, in turn, would appear to be due to a serious falling-off in the effectiveness of your H.F. amplifier, considered as a whole, and you should look carefully to all the components associated with this part of the receiver, not forgetting the valve itself. Needless to say, you should assure yourself that the voltages applied to filament, anode, and screening grid of the H.F. valve are correct, and, lastly, you would be well advised to look to your aerial-earth system.

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H.T. Current Consumption.

I am thinking of building the "Mullard S.G.P. Master Three." Using the recommended valves in the 6-volt range, will you please give me some idea as to the probable total anode consumption of the set? N. P. R.

A good deal depends on the actual H.T. voltages applied to the various anodes and, of course, on the grid bias pressure for the pentode. Current consumption may be reduced by over-biasing this valve and also by applying to its screen a voltage somewhat less than that impressed on the anode, but we do not think that the very best results of which the set is capable will be attained with a total consumption appreciably under 20 milliamperes.

Broadcast Brevities

NEWS FROM ALL QUARTERS.

By Our Special Correspondent.

A Champion for Scotland ?—The Television Impasse.—Gramophone "Effects."

A Scottish Governor ?

The B.B.C. Board of Governors has never pretended to represent any part of the country in particular, but in view of the growing dissatisfaction which has been lately expressed in regard to the future of Scottish broadcasting under the Regional Scheme there is a strong probability that before long a new member may take his seat at the Board with the exclusive intention of championing the cause of listeners over the Border.

In this connection the name of Mr. Hugh S. Roberton has been mentioned As conductor of the Glasgow Orpheus Choir, Mr. Roberton is known in most corners of Scotland.

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A Question of Numbers.

No limit is set in the B.B.C.'s Charter to the number of individuals who may comprise the Board of Governors, so that a new appointment or appointments might be made in the twinkling of an eye, and the country might wake up one morning to find that Wales and Northern Ireland were also represented, not to mention the Isle of Man.

"In a multitude of counsellors there is wisdom," runs the proverb, but, like most proverbs, it has an opposite number, relating in this case to a superfluity of cooks. The bigger the governing body at Savoy Hill, the greater the probability that the B.B.C. will develop into a vast Circumlocution Office with a minimum of personal responsibility. If new Governors are to be appointed it would surely be advisable to consider whether they should merely supplement the old or replace them.

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No Television Tests from Brookman's Park.

The breaking off of negotiations between the Baird Television Development Company and the B.B.C. is apparently judged of insufficient importance at Savoy Hill to justify a statement beyond the formula : "We have nothing to say."

It had been expected that television tests would begin immediately upon the opening of the new London Regional station at Brookman's Park at the end of this month, but I gather that the hitch occurred during negotiations concerning a possible contract.

The possibility that the advent of a new Postmaster-General might facilitate television transmissions from an independent station may not have been overlooked. The possibility seems rather remote.

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Noises Off.

One can fully sympathise with the B.B.C. Effects Department in their search for bigger and better noises without necessarily endorsing their latest enterprise in trapping genuine sounds by gramophone records. Mr. Lance Sieveking, who has already exhibited a staggering fecundity of ideas, is the originator of the plan, and proposes to use certain records made at Oxford Circus tube station for a series of "Intimate Snapshots" to be broadcast in the near future.

SUNDAY MORNING NOVELTY. At 7 a.m. on Sundays Hamburg broadcasts a church service, followed by an orchestral concert performed on board one of the ships in the harbour. The Hamburg announcer is here seen on board the "Cap Polonie."

The records are said to have given great satisfaction to the privileged few who have heard them; if so, they must surely be far superior to any noise records made in the past.

It has generally been conceded that the microphone is kinder to manufactured noises than to sounds which approach the real thing, and if "Intimate Snapshots" are a success they will reveal a surprising advance in gramophone technique.

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Preparing for Bank Holiday.

A special vaudeville programme is being arranged for August Bank Holiday. Among the items already fixed up are the following: A sketch entitled "Where Ignorance is Bliss," with Tommy Handley as compère; Burns and Allen, probably the best of recent comedy broadcasts; Teddy Brown; Stuart Ross and Joe Sargent. On the same evening Gordon McConnel will produce a "light-headed" programme.

○○○○

H.R.H. and the Chief Scout.

Speeches by the Prince of Wales and the Chief Scout, Sir Robert Baden-Powell, at the International Jamboree in Arrowe Park, Birkenhead, on August 2nd, will be relayed to 2LO and 5XX at 3.45 p.m.

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"O.B." Van at Tidworth.

From the grounds of Tidworth House, Tidworth, Hants, the Southern Command Tattoo will be relayed to 2LO and 5XX on August 3rd. Listeners will hear Part 1 from 9.30 to 10 o'clock, and Part 2 from 11.10 to 11.50. The greater part of the latter period will be devoted to a "Pageant of the Glorious Past," and will include reminiscences from the Napoleonic period to the Army of to-day.

As at Aldershot, the engineers will make use of the "outside broadcast" van, which contains all the heavy amplifying gear and a studio, and is, in fact, a control point.

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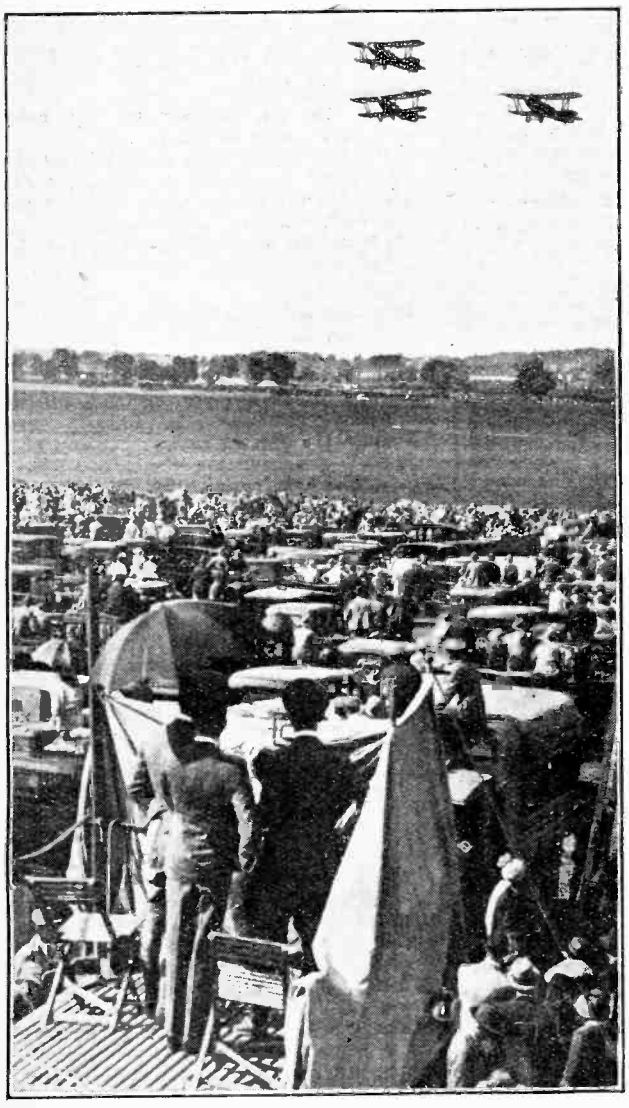
Are Long Plays Appropriate in Summer ?

In veneration for Greek drama in general and the plays of Euripides in particular, I yield place to none. But I doubt whether even the *Electra* kept many listeners indoors for an hour and three-quarters on that blisteringly hot evening of last week. And if it did not, surely the broadcast was a waste of splendid effort?

BEHIND THE SCENES AT HENDON.

Wireless and the R.A.F. Display.

IF a fiat had gone forth prohibiting the use of wireless and valve amplification equipment throughout Great Britain on Saturday, July 13th, the R.A.F. Display at Hendon would have lost half its effectiveness. But as no such spiteful edict was issued, it is probably safe to say that the great British public gave



A general view from the roof of the control room, showing the microphone in use.

little thought to the work which was going on in the little operating huts and control rooms behind the scenes. Presumably because wireless is now accepted as a commonplace, the R.A.F. refrained from "starring" the radio events, although radio played almost as big a part on this occasion as in years gone by.

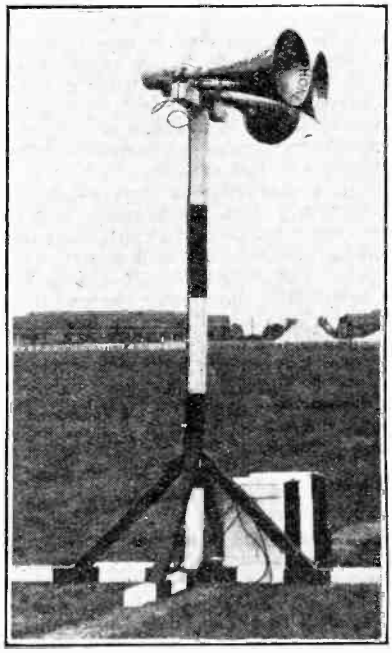
The most convincing demonstration of the value of radiotelephony control in the air occurred at the end of the programme, in the air battle which formed a suitable prelude to the attack on the fortified port. In this event the spectators were allowed to eavesdrop while telephony messages were exchanged between a lone reconnaissance 'plane braving the anti-aircraft fire from the quayside and a distant bombing squadron, which eventually came up in support in response to the wireless appeals. Telephony orders from the commander of the enemy fighter squadron were also received and reproduced for the public benefit.

Picking Up 'Plane Calls.

The messages from the air were picked up by short-wave receiving stations at scattered points outside the aerodrome and were relayed to the central control room, whence they were distributed to nearly sixty Marconiphone loud speakers. Engine noises naturally affected the clarity of the speech, but helped, possibly, by the knowledge that the forces of right would eventually triumph, listeners had no difficulty in gaining an intelligent idea of the progress of the engagement.

Wireless telegraphy, as distinct from telephony, was extensively used for the concentration of air units taking part in the Display, and without its aid, it would have been impossible to time the arrival of many units which arrived at Hendon from various aerodromes just at the moment when they were required.

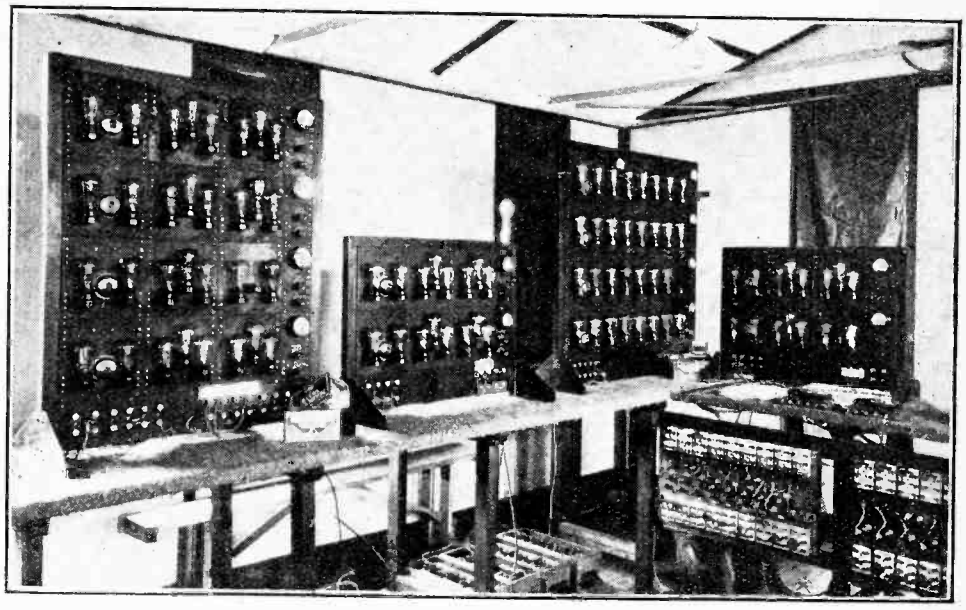
All records as regards public address systems in this country were eclipsed by the Marconiphone Company at Hendon on July 13th. The public enclosures were adequately "covered" by no fewer than forty-nine 2in. moving-coil loud speakers, in addition to which a number of smaller instruments of the indoor type



Nearly sixty moving-coil loud speakers reproduced band music and kept spectators informed regarding the progress of the Display. Beneath the loud speaker stand can be seen the line of turf covering the buried cables which totalled over twelve miles in length.

Behind the Scenes at Hendon.—were employed for announcing purposes in the neighbourhood of the Royal Enclosure.

To feed so many loud speakers, nearly 180 valves were necessary, the last amplifying stage comprising five banks of 32 valves each. The total H.T. consumption amounted to 6,000 milliamperes at 350 volts. On the L.T. side 350 amperes were taken at 6 volts. Energy was provided by a motor generator giving 350 volts and Exide accumulators aggregating 2,000 volts, the total weight of the power plant being nearly four tons. Twelve miles of heavy armoured cable were buried, and the task of preparing the complete installation occupied a large staff for more than a fortnight.



A corner of the Marconiphone control room, showing the power banks. Eight LS5A valves were used in each, the total number of amplifying valves amounting to 150

The loud speakers performed several useful functions besides keeping spectators informed as to the progress of events. Band music was relayed with excellent clarity, and tactful announcements were made regarding the control of traffic and the movement of the crowds.

When we recall, also, that a running commentary on the air battle was broadcast all over the country by the B.B.C., we can begin to assess how much would have been lost if wireless and valve amplification equipment had not been available.

CORRESPONDENCE.

The Editor does not hold himself responsible for the opinions of his correspondents.

Correspondence should be addressed to the Editor, "The Wireless World," Dorset House, Tudor Street, E.C.4, and must be accompanied by the writer's name and address.

5SW AND EMPIRE BROADCASTING.

Sir,—Through your Correspondence columns I should like to make a few remarks about 5SW. Letters are continually being published, from various parts of the Empire; but I have not yet seen a Rhodesian burst into print on this much discussed subject.

Officially, that is, as far as P.M.G. licences are concerned, there are only about fifty licensees in S. Rhodesia, including nineteen transmitters.

A transmitting permit costs 20s.—power allowed being 50 watts. I doubt, incidentally, if there is any country in the world where a better feeling exists between the P.O. and the amateur transmitter—or where the Post Office has shown greater consideration in technical matters.

I think that all of us here have the same grievance against the B.B.C as the rest of the Empire has.

The point is: Why is the evening "News Bulletin" still not allowed to be broadcast from 5SW?

Why has the Empire, those who live in far away and lonely places, to be denied an interesting fifteen minutes of Home News every night?

In any case, if the news is not broadcast, what about some music from 5SW?

Must we endure fifteen minutes of an unpleasant generator hum; nothing else being permitted to modulate 5SW's carrier.

Many of us would very much like to know *why exactly*, since 5SW is supposed to cater for the Empire and be used for a certain amount of Empire propaganda, the most important part of the programme is considerately omitted? This has gone on for two years now.

Someone may wish to hear London—he does so, and says "I should particularly like to hear the news, when it is broadcast"; one shrugs one's shoulders apologetically, and tells the listener that the "great powers that be" don't allow such a thing.

To turn to another point, we must give 5SW the praise due for at least being our star short-wave station, as far as Rhodesia is concerned.

None of the others is in any way as good—conditions here, throughout the whole year, are rather terrible. High speed fading on most short-wave transmissions makes them sound as if they were being put through a "washing mangle."

Rhodesian time being one hour ahead of B.S.T., 5SW comes on the air at 8 p.m. (S.A.S.T.)—remaining good till about 9.30 p.m. (S.A.S.T.), when it begins to fade too badly for further reception. At odd times one can listen for an hour longer, but generally the transmission goes to pieces. As a final remark one asks if Overseas listeners are not literally bored to tears by the dreadfully dry talks from 2LO, from 7 p.m. to approximately 7.40 p.m.

Who wants to hear an Italian lesson, for example, either in England or abroad? About 1 per cent., we imagine, of all listeners. One wants amusing, not educating, or boring.

With reference to 5SW being off the air on Saturday and Sunday nights, one can merely sigh resignedly.

Just the two nights when hard-working people get a chance to listen!

The powers who arrange the transmissions were obviously "born tired." G. G. LIVESEY (FO3SRB),
South Rhodesia. late of 2BZ and G6LI.

VALVE OUTPUT.

Sir,—The letter from "Keentono" indicates that he is not clear as to the use of the formula described in my previous letter on the above subject, when the output valves are arranged in push-pull.

To calculate the maximum undistorted power obtainable from an output stage consisting of more than one valve, it is simply necessary to calculate the power obtainable from one valve and multiply the result by the number of valves used. The reason for this becomes obvious from the following considerations.

Assuming the correctness of the operating figures given for a PX.650 valve in "Keentono's" letter, the output from one such valve will be :—

$$\frac{40^2 \times 3.5^2}{8 \times 1750} = 1.4 \text{ watts.}$$

When two valves are connected in parallel, the resulting impedance is half that of one valve, so the output becomes :—

$$\frac{40^2 \times 3.5^2}{8 \times \left(\frac{1750}{2}\right)} = 2.8 \text{ watts.}$$

With the push-pull arrangement, the impedances of the two valves are in series, so the impedance of the combination is twice that of one valve. The signals impressed on the grids of the two valves are 180° out of phase, from which it follows that the maximum A.C. voltage that can be applied between the two grids is twice that which can be applied to one valve. Before substituting in the formula for grid bias, therefore, this valve must be doubled.

Applying these considerations to the figures given, the output from two PX.650 valves in push-pull will be :—

$$\frac{(2 \times 40)^2 \times 3.5^2}{8 \times (1750 \times 2)} = 2.8 \text{ watts.}$$

From the above remarks it can be seen that the generalised formula becomes :—

$$W = \frac{(PG)^2 \times A^2}{8 \times \frac{PI}{N \div P}}$$

where W = Maximum watts undistorted power from output stage.
G = Grid Bias for each valve.
A = Amplification factor.
I = Impedance of each valve.
N = Total number of valves in stage.
P = 2 for push-pull arrangement or 1 for the single sided arrangement.

By cancelling, however, P disappears from this formula, which then becomes :—

$$W = \frac{G^2 \times A^2}{8 \times I} \times N.$$

It must be emphasised that G only equals grid bias when a valve is used for which grid current commences to flow at zero volts on the grid. If, as in the case of some indirectly heated valves, grid current commences at a negative grid potential, this potential should be subtracted from the grid bias to obtain the G for the formula. ED. A. H. BOWSHER.
Ilford, Essex.

AMATEUR STATUS.

Sir,—With reference to the letters published regarding the status of amateurs, may I say how sorry I am to see that you are again raising the question of amateur transmitters?

May I enquire what good these amateurs do?

One or two of them, I agree, are worth their salt, but the vast majority merely transmit for amusement, talk the most utter rot over the ether, and have no idea of experimenting, and could not if they tried.

No, sir, I think the transmitting amateur is best off the air, and as far as I am concerned I am pleased to say they appear to be petering out in my district, and I do not receive their bleatings and croaks on a Sunday when tuning in the foreigners. B. GLADSTONE.
London, W.14.

Sir,—I was extremely pleased to find you devoting two recent editorials to the cause of the amateur transmitter.

I should like to endorse most heartily the remarks of your contributor, "Interested Party"; I was particularly interested in this gentleman's suggestion that the amateur should press for the use of the 80-metre band allotted by the Washington Conference for the joint use of the amateur with mobile and point-to-point services. As one of the very few amateurs who have been allowed by the Post Office to make use of this band for experimental work in connection with the "R.S.G.B." Contact Bureau, I can say from personal experience of operating conditions in the new band that it appears to be almost neglected by non-amateur stations.

In my opinion, if the amateur were allowed to use the 80-metre band the interference caused to other services would be quite negligible. In any case, should the authorities be shy of opening the whole band for general amateur use, I can see no reasonable objection to the setting aside of a portion for the use of amateurs.

The acquisition of this band by the amateur would be more than a demonstration of interest, lack of which you lament in your editorial of July 3rd, for the value of these frequencies would undoubtedly be considerable.

I trust that your paper may be the means of bringing about some improvement in this matter, as it has so often done in the past in matters concerning the amateur transmitter.
London, E.11. R. A. FEREDAY.

Sir,—Heartiest congratulations on your leading article in the July 3rd issue of *The Wireless World*. I endorse every word of your criticism of the Radio Society of Great Britain.

LET US SHOOT THIS WHITE ELEPHANT!

It behoves all amateurs worthy of the name to join up with you in your campaign to make them, in your own words, a "first-class national asset"—which they will never be so long as the present régime exists HARRY E. SMITH.
Hackbridge, Surrey.

Sir,—We wish to heartily congratulate you on your leading articles in the June 19th and July 3rd issues of *The Wireless World*. We feel sure that all amateur transmitters will agree with the views expressed therein, and will feel deeply grateful to you for thus so ardently championing their cause, the more so as there is now no society in this country which is interested in obtaining extra facilities—or even consolidating those already held—for the amateurs.

To put the matter bluntly and in a nutshell, the whole trouble with the societies is that, so long as they can obtain special permits for certain members, then they are content to let the rest of the amateurs shift for themselves.

As an instance, the R.S.G.B. was satisfied in the past to be able to issue 32-metre permits to certain of its chosen members, who may have been—but in the majority of cases were not—capable of carrying out special research work. Any society with the interests of the amateurs of this country at heart would have insisted that if this "special" privilege was not to be available to every licensed transmitter, then they would have no use for it.

We are stressing this point because history is repeating itself, as we understand that permits to work in the 80-metre band are being obtained by the R.S.G.B. for certain of its members. Thus they are making no attempt to obtain the use of this band for the amateurs in general of Great Britain—who are as fully entitled to the use of this band as are the amateurs in the U.S.A.—but are content to sacrifice the interests of the many in favour of the few.

What is needed is a society which is prepared—and expects—to have to fight to secure reasonable rights for the amateur, and which to do so must have the confidence and respect of the amateurs of this country. As the officials of the R.S.G.B. have forfeited all claim to such, and as they have obviously no desire to undertake this task, we suggest that a complete reorganisation of the society is urgently required if the R.S.G.B. still wishes to claim that it represents amateur radio in this country. "THE C.G."
Croydon.

READERS' PROBLEMS

"THE WIRELESS WORLD" SUPPLIES A FREE SERVICE OF TECHNICAL INFORMATION

The Service is subject to the rules of the Department, which are printed below; these must be strictly enforced in the interest of readers themselves.

A selection of queries of general interest is dealt with below, in some cases at greater length than would be possible in a letter.

Simplified Pick-up Connections.

With reference to the simple method of pick-up connection adopted in the McMichael "Screened Three" described in your issue of June 19th, I have been studying the circuit diagram with a view to adopting this arrangement in my own set, and find that the 0.0003 mfd. grid condenser is, in effect, connected across the pick-up. Will this have any effect on quality of reproduction? W. P. A.

It is a fact that this condenser is connected across the pick-up (through the tuning coil), but we do not think that this should cause any falling-off in performance. Tests made with two or three of the better commercial pick-ups showed that the addition of this capacity has no detrimental effect on the output.

oooo

Too Many Turns.

I have fitted capacity-controlled reaction to a det.-L.F. set in which variable magnetic coupling was originally used, but results are disappointing, and it is impossible to prevent self-oscillation—even with the control condenser set at minimum—unless the reaction coil is mounted at an inconveniently great distance from the aerial-grid winding. Can you tell me how to put matters right? I should perhaps add that ordinary plug-in coils are used. S. d'A. B.

It is almost certain that your reaction coil is excessively large, and it would be wise to try the effect of using a smaller inductance; it is a good plan to remove turns progressively until good control is obtained.

Very possibly you have made some other alteration that increases the tendency towards self-oscillation; it may be that an H.F choke has been added, and is fitted in such a way that it is coupled magnetically to the grid coil. This point should receive attention if a reduction in reaction coil turns does not effect the desired improvement.

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The "Europa III."

Six-volt screen-grid valves are now available; I am thinking of obtaining one of these for my "Europa III," and realise that it will be essential to make some alteration to the aerial-grid circuit. Will you please give me a circuit diagram showing the necessary modifications? E. R. S.

It is assumed that you are at present using a 4-volt H.F. valve with 6-volt valves elsewhere in the set. When you make the change, it will no longer be possible to obtain "free" grid bias for the 6-volt S.G. valve from the drop in voltage across a filament resister in the negative lead, and consequently this scheme must be abandoned. A single dry cell will be required for bias purposes, and the connections will be as shown in Fig. 1.

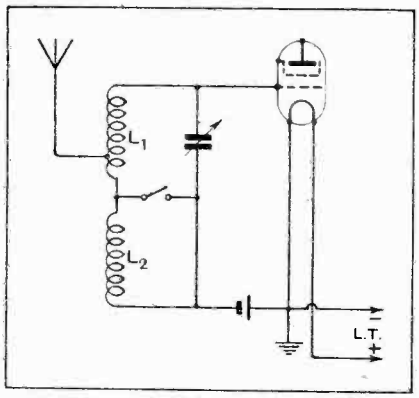

Fig. 1.—Substitution of grid cell for "free grid bias" arrangement when using a 6-volt S.G. valve in the "Europa Three."

Not Recommended.

I am thinking of building a set on the lines of the "Flat Dwellers' A.C. Three," but, with a view of reducing the number of tuning controls to one, I propose to omit the tuned grid circuit, replacing it by a simple choke coupling. Do you consider that the set modified in this way would give satisfactory results? A. C. R.

By making this alteration, the sensitivity of the receiver would be very seriously reduced, particularly on the medium waveband, and we have no hesitation in saying that in your locality—remote from broadcasting stations—you would not obtain satisfactory results from it.

There would also be a considerable falling-off in selectivity, consequent on the omission of the second tuned circuit, but probably this would not be so serious, as a frame aerial is used.

oooo

Anticipating Regional Transmissions.

Although the selectivity of my "Megavox" receiver is at present quite satisfactory, I expect that it may very possibly be inadequate in this respect when the Brookmans Park station begins operations. I believe that you have published instructions for improving the set in this respect; will you please give me a reference to the back number in which the necessary information was published? M. H. L.

A very satisfactory way of improving the selectivity of the "Megavox Three" was discussed in the "Readers' Problems" sections of this journal dated May 8th and June 5th. This involves the addition of an extra tuning condenser (for the aerial circuit), but we are afraid that there is no way in which a real and readily appreciable increase in selectivity can be made without adding to the number of controls.

oooo

Grid Leak and Tone Quality.

What should be the theoretical effect of reducing the value of a grid leak in a resistance-coupled L.F. amplifier?

I ask this question because, in my own set, the substitution of 0.5 megohm for one megohm (as specified by the designer and customarily used) does not seem to make any appreciable difference to tone, and hardly has any effect on the volume of reproduction. D. D.

The change you have made will bring about a reduced proportional amplification to the lower audible frequencies, but in all probability this change will not be appreciable by ear unless the performance of your loud speaker as a reproducer of low notes is well above the average.

If the resistance of the leak is in any way comparable with that of the anode coupling resistance, the substitution of a lower value will, as you seem to have observed, be responsible for a falling-off in overall magnification, and consequently in volume.

RULES.

(1.) Only one question (which must deal with a single specific point) can be answered. Letters must be concisely worded and headed "Information Department."

(2.) Queries must be written on one side of the paper, and diagrams drawn on a separate sheet. A self-addressed stamped envelope must be enclosed for postal reply.

(3.) Designs or circuit diagrams for complete receivers cannot be given; under present-day conditions justice cannot be done to questions of this kind in the course of a letter.

(4.) Practical wiring plans cannot be supplied or considered.

(5.) Designs for components such as L.F. chokes, power transformers, etc., cannot be supplied.

(6.) Queries arising from the construction or operation of receivers must be confined to constructional sets described in "The Wireless World" or to standard manufacturers' receivers.

Readers desiring information on matters beyond the scope of the Information Department are invited to submit suggestions regarding subjects to be treated in future articles or paragraphs.

Lack of Selectivity.

I am troubled by the fact that the tuning of my four-valve set (H.F.-det. 2 L.F.), designed with the help of information obtained from "The Wireless World" during the last six months, is anything but selective on the lower part of the normal broadcast waveband (on wavelengths in the neighbourhood of 200 metres), although no difficulty is experienced on this score in the middle and at the upper end of the band. Is this effect normal, or does it indicate that something is wrong with my set?

A. B. P.

It is quite natural that the apparent selectivity of your tuned circuits should fall off when the condensers are near their minimum capacity settings.

Every design must be more or less in the nature of a compromise, and it is often thought best to aim at high magnification and reasonable selectivity on the wavelengths occupied (generally) by the more important transmissions, and to leave the short wavelengths to look after themselves.

We should imagine that you are using tuning condensers of about 0.0003 mfd.: if you increase this capacity to 0.0005 mfd., making a commensurate reduction in the inductance of your tuning coils, you will find that selectivity is markedly improved, and that this improvement is most noticeable at the lower end of the band.

As an alternative, and if you are particularly keen to receive these shorter wavelengths, you might make or obtain a special set of interchangeable coils having slightly lower inductances than at present in use.

°°°°

The "Europa Portable."

I am proceeding with the construction of the "Europa Portable," but am in doubt as to the precise arrangement intended for the frame aerial and reaction windings. My difficulty has arisen out of the use of a home-built wooden frame in place of the adoption of the cabinet and frame specified.

E. C. M.

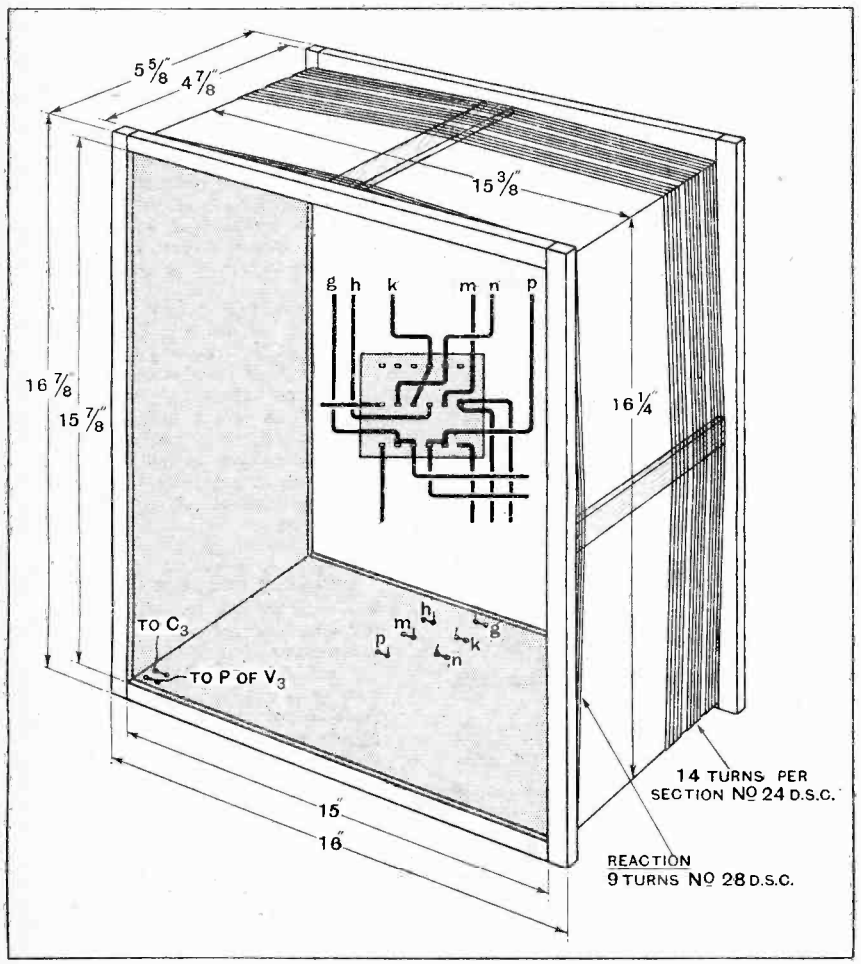

Fig. 2.—Frame aerial and reaction windings together with details of the switch connections of the "Europa Portable."

Complete details as to the method of winding the frame are given in Fig. 2. To avoid the possibility of error when making the connections between the frame and the tuning circuit, a rear view of the change-over switch has been reproduced from the practical wiring diagram and with the aid of which you will be able precisely to follow the bringing out of the frame leads. There is a space of not exceeding 3¼in. between the two windings, the turns of the reaction coil being in the same direction as those of the frame aerial.

°°°°

Frame Aerial Snags.

Would it not be possible to take advantage of the high selectivity afforded by the use of a frame aerial, and at the same time of the bette sensitivity offered by an elevated conductor, by mounting a very large frame either in an attic or on the roof, running extension leads from it to the receiver on the ground floor?

L. H. R.

Apart from the more or less obvious difficulties, there are several obstacles against the adoption of this arrangement. It would clearly be a difficult matter to arrange for rotation of the frame from a distant point, and unless special precautions were taken, it would certainly be found that the receptive powers of the frame, in association with its long connecting leads, as an ordinary aerial would almost completely offset its directional properties.

The latter disability can be largely overcome, but only at the expense of considerable complication.

°°°°

Moving Coil Loud Speaker.

With a view to decreasing the consumption of current by the pot winding of my moving coil loud speaker, I propose to reduce the gap (by fitting a new centre pin) to practically half its present length, at the same time arranging for accurate centring of the moving coil former. Is this in order?

P. S. C.

From the wording of the query, we rather fancy you are under a misapprehension with regard to this matter; the effect of reducing the length of the gap will not in itself have any bearing on the current consumed by the field winding, but it will enable you to obtain an equal flux density with the expenditure of less energy for feeding this winding.

°°°°

Most Sensitive Anode Bend Detector.

Will you please tell me the best type of valve to use as an anode bend detector, when the object is to obtain loud signals on weak inputs? I take it that the special high efficiency valves now on the market, which are generally recommended for this function, are not of necessity the most sensitive to small inputs.

C. W. M.

Your assumption is correct, and to meet your needs an efficient "R.C." type of valve, with a high value of anode resistance and the largest anode by-pass condenser that can be tolerated from the point of view of high note loss, is probably the best. But the fact must not be overlooked that the newer valves have important advantages when good quality reproduction, reasonable sensitivity, and the ability to handle large inputs are needed.

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(17th Year of Publication)

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CONTENTS OF THIS ISSUE.

THE B.B.C. AND RESEARCH.

AT a time when so many engineers of the B.B.C. are resigning their appointments for reasons which seem to centre round the main consideration of absence of prospects and consequent small remuneration, the question once more arises as to whether the B.B.C. is justified in retaining a staff of engineers carrying out research work of a kind which directly overlaps the work of commercial companies and Government Departments.

We will admit at once that there are certain peculiar problems of broadcasting in regard to which it may be desirable that the B.B.C. should carry on its own investigations, but we cannot believe that it is more economical or better for broadcasting that the B.B.C. should design or build its own transmitters when its requirements can be met by approaching commercial companies whose sole work it is to provide such apparatus of the most up-to-date and efficient kind.

It would seem to us that before any expenditure on research is authorised the B.B.C. should answer two questions. The first question would be: "Is this research necessary to further our job of supplying programmes?" The second question would be "Is there no other source from which we could obtain our requirements without ourselves undertaking the research?"

What purpose can there be in an expenditure of public money by the B.B.C. on an investigation, say, into the properties of loud speakers, or as to the best design of receiving set? The solution of these problems is not the function of the B.B.C., and is, moreover, being pursued by commercial organisations with facilities far better than the B.B.C. could hope to provide.

We are not disposed to blame the B.B.C. alone for the present state of affairs. The example has been set the B.B.C. by the Post Office and by the Services. We have always contended that there is room for complete reorganisation of our methods of dealing with the requirements of the various Government Departments utilising wireless. In our opinion research work on behalf of the Government, whether for broadcasting, for the Post Office, or for the requirements of the Services, should be conducted by one organisation, which would supply all the technical information required and undertake the design of apparatus for the needs of the various departments. There would, of course, still be work for the various departments in the way of adapting these designs or general technical information to their own peculiar requirements. The central research organisation would work in the capacity of consultants and practical designers to all departments of the Government utilising radio.

It seems difficult to believe that such an arrangement would not effect a substantial saving in expenditure and at the same time place at the disposal of all the departments of the Government a source of technical advice and direction vastly superior to anything which the funds available to individual departments could secure.

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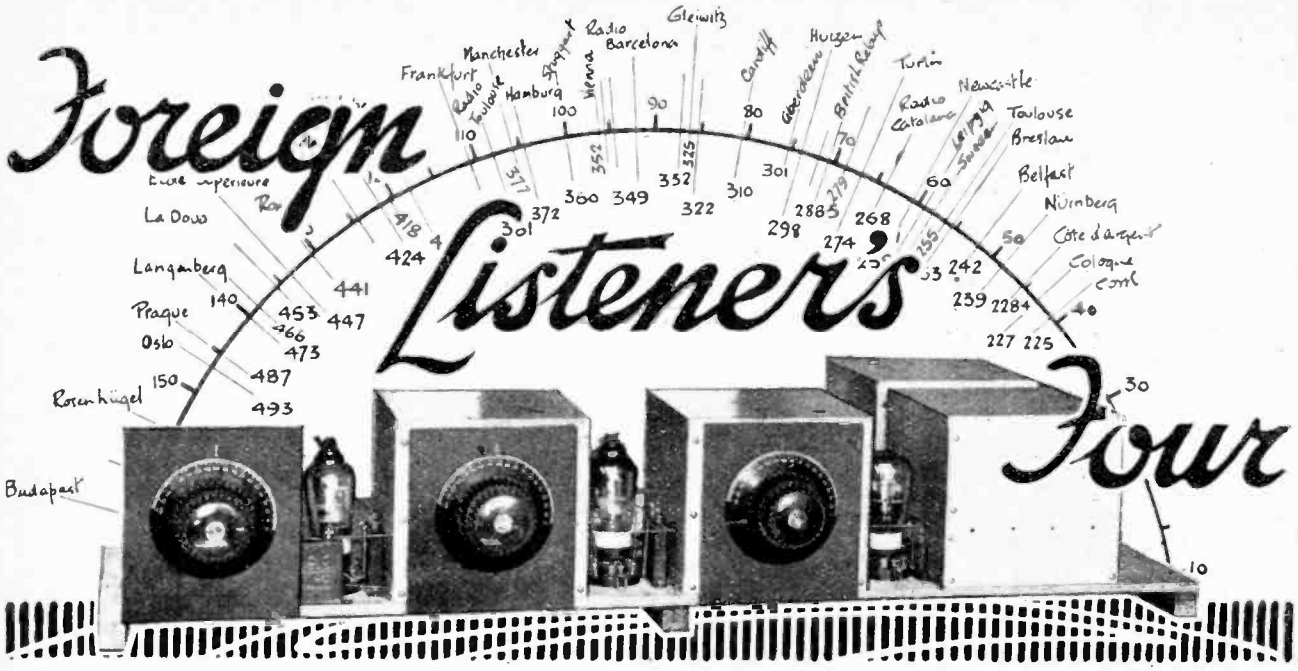
STANDARDISATION.

UNDER correspondence in this issue a reader urges that more attention might be paid by British manufacturers to the question of standardisation of mechanical parts in wireless apparatus.

Why, we might ask by way of example, when a standard British thread is adopted by most British manufacturers of valves for the terminal for screen-grid valves, should another manufacturer whose valves, we believe, are equally British, select to adopt a Continental thread uncommon in this country?

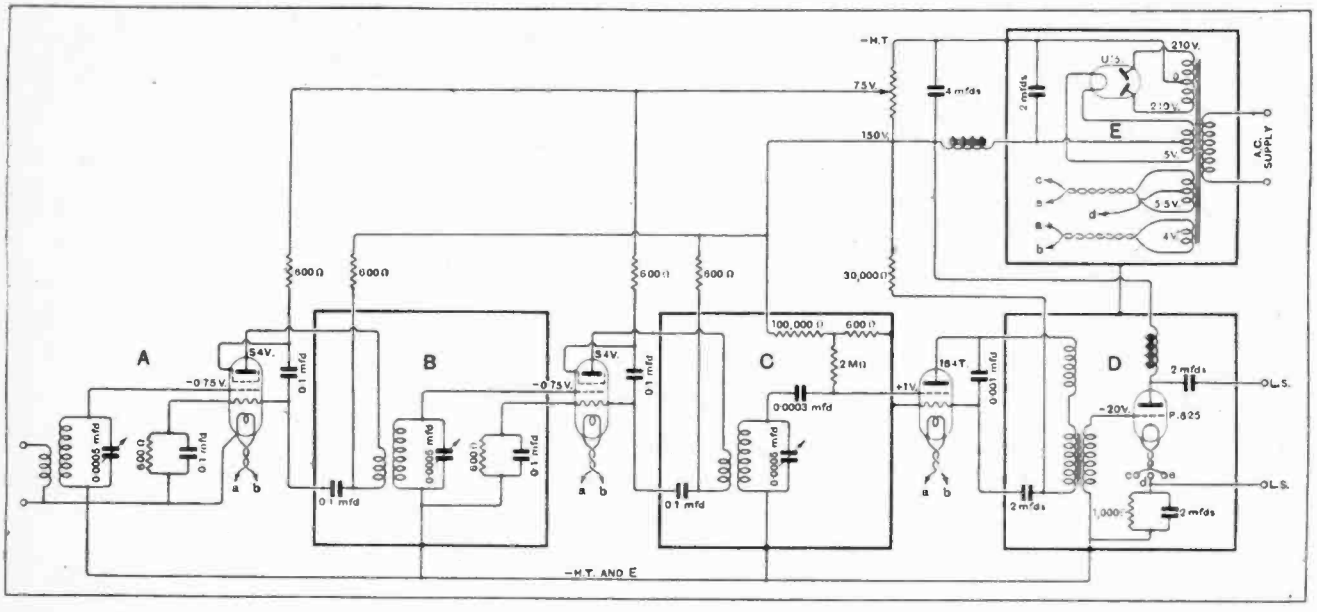


Selective Batteryless Set of the Simplest Design giving Loud Speaker Reception.

By F. H. HAYNES.

BRITISH listeners do not pay much heed to foreign programmes. Particularly is this statement true at this time of the year when the long hours of daylight limit the range of reception and atmospheric interference is prevalent. Details of foreign transmissions are rarely used for selecting programmes, but serve as a means of identifying stations which may come in uninvited in the course of swinging the dials. How many listeners are there possessing sets which will give a satisfactory rendering of, say, the programmes of Vienna, which uses 20 kW., or whose knowledge of foreign transmissions is such that they know the relative tuning positions of even the more powerful stations?

Much of the foreign reception tolerated to-day is

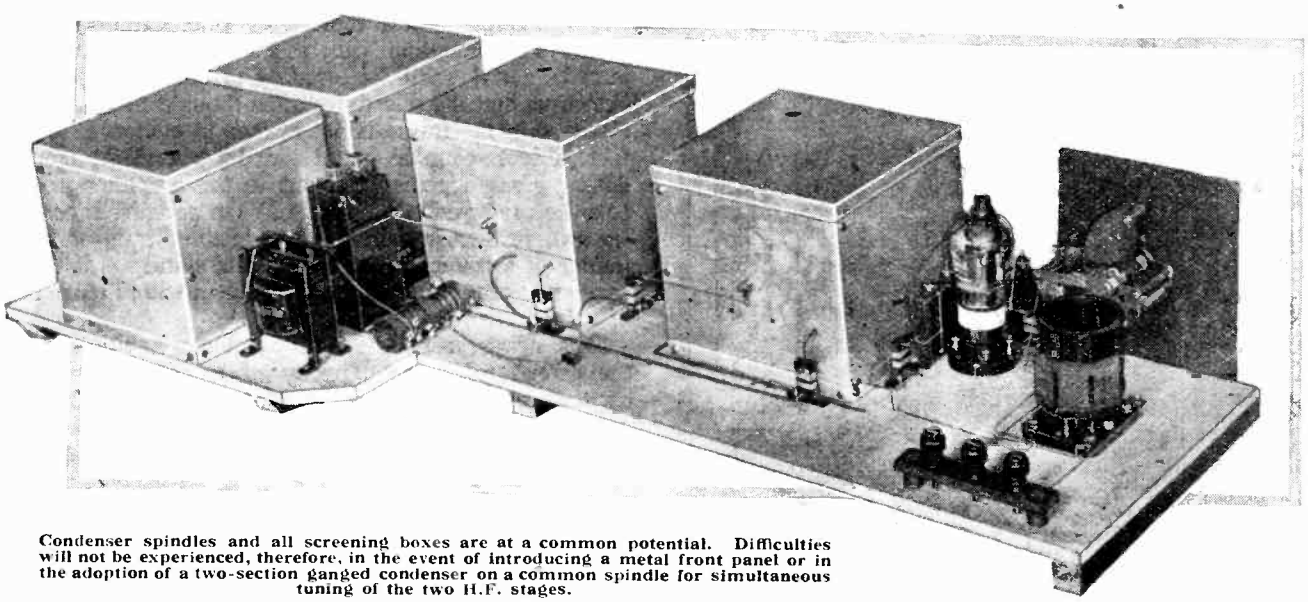


A.C. mains operated four-valve receiver incorporating two staple screen-grid H.F. stages. Negative bias is produced by the voltage drop across resistances. This diagram is arranged to provide short and direct leads, and the actual components in the set take up corresponding positions to the symbols in the circuit. H.F. valves are separated from their associated apparatus by the screens, while eddy current coupling is avoided by using spaced light metal boxes.

B 4

Foreign Listener's Four.—

achieved by the judicious combination of H.F. amplification and reaction, though there are many amateurs, and chiefly are they to be found among the readers of this journal, who have learned by experience that a non-oscillating H.F. amplifier makes the best long-range receiver. For some three years " range without reaction " has been the guiding slogan whenever possible behind *The Wireless World* designs. Reaction destroys quality, assuming that the loud speaker is in itself good enough to reveal faithfully the distortion which reaction introduces. Reaction produces instability and, while it undoubtedly gives enormous amplification, is of little help in eliminating interference, as is so often hoped. On the other hand, a set having a leaky grid detector may appear to gain in its selectivity by the application of reaction, as revealed by the need for critical dial settings, yet interference will still persist. Results with a receiver dependent upon reaction are inconsistent and no guarantee of performance can be given for such a set.



Condenser spindles and all screening boxes are at a common potential. Difficulties will not be experienced, therefore, in the event of introducing a metal front panel or in the adoption of a two-section ganged condenser on a common spindle for simultaneous tuning of the two H.F. stages.

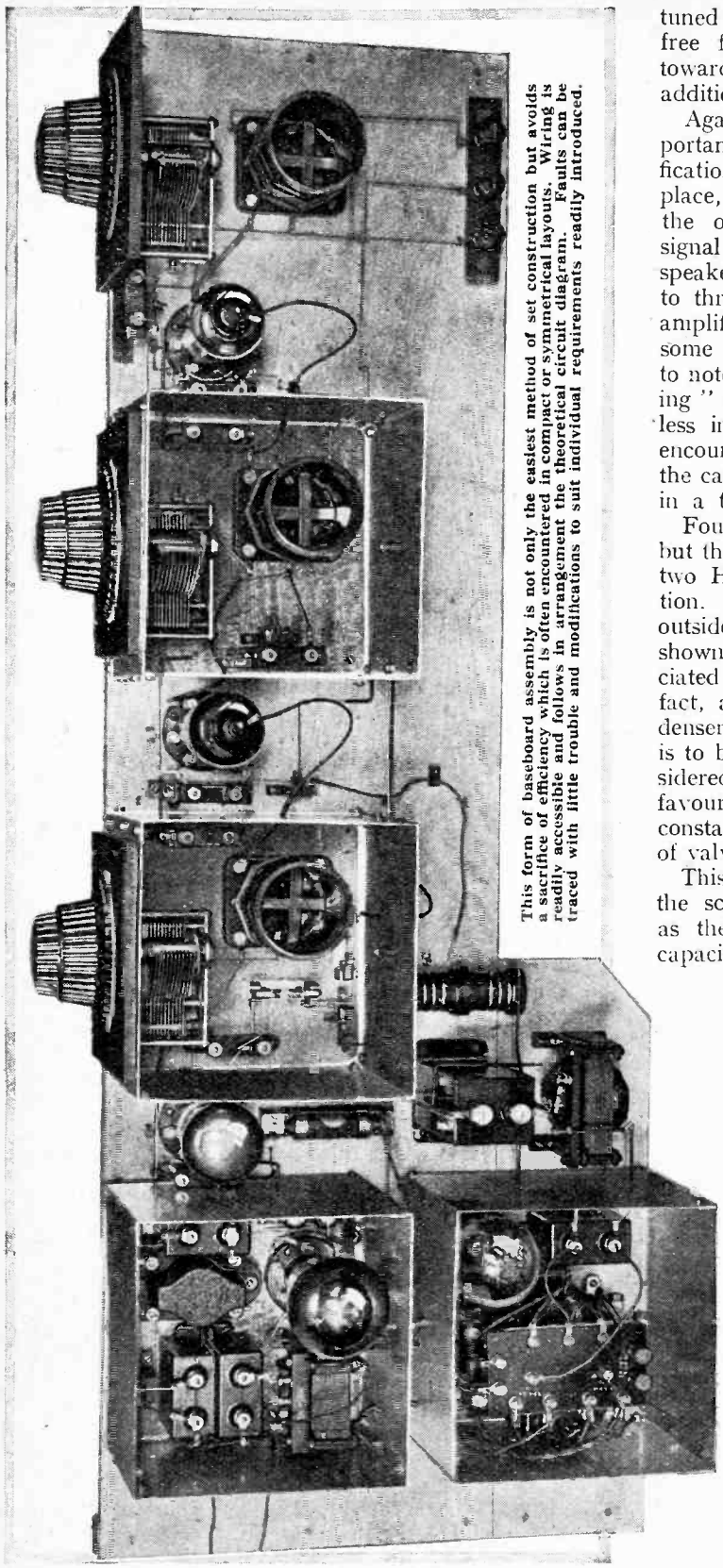
It is not because we do not want foreign programmes that we content ourselves with those sent out by an organisation which prides itself upon its own good fortune in being independent of box office receipts. The receiver to be described will release us from the transmissions of the dominant local station, and will bring in distant transmissions with such constancy and absence of interference that they retain their programme value.

To achieve sensitiveness combined with selectivity without self-oscillation demands an efficient H.F. amplifier. That a satisfactory amount of amplification for foreign station reception can be obtained with a single stage set is admitted, yet the resulting degree of selectivity is far too poor for our purpose. While the prospect of the coming Brookman's Park transmissions will compel London listeners to add selectivity devices to their sets in the form of wave traps, filters, and loose-coupled aerial circuits, it is wiser, perhaps, when building a new receiver, to associate the extra tuning dial thus required with an additional H.F. amplifying stage. By this means stage amplification can be kept within the limits of easy construction and freedom from self-oscillation, while the apparent sharpness of tuning as revealed when operating the dials is similar for each of the three scales.

Stable and Selective.

This receiver is designed for operation from A.C. mains and employs valves with which it is an easy matter to obtain a stage amplification of at least 40 times combined with the use of a stable and selective intervalve coupling. The valve used in the H.F. stages —the S4V—possesses a sufficiently low value of grid to anode capacity to avoid self-oscillation even when using an H.F. transformer ratio that will produce generous amplification. Assuming that stability is produced with a primary to secondary turns ratio of 3 : 4, we are forced considerably to reduce such a primary winding so that the ratio becomes practically 1 : 4 in order that a high degree of selectivity will result. This means a cutting down of amplification, yet owing to the remarkable performance of the indirectly heated screen-grid valve mentioned and the fact that two stages are employed, this receiver possesses extraordinary station-getting properties. In addition the transformer ratio has been so modified that no longer is the grid anode capacity of the valves appreciably assisting amplification by providing reaction. Consequently, amplification is not materially modified by the change of capacity to inductance ratio of the tuned circuits in the course of moving from zero to 180 on the dials.

Pursuing this argument, one might consider the use of still another H.F. stage in the hope that the three-valve amplifier will give the desired high selectivity. If yet another tuning dial is to be tolerated for this purpose it would be wiser to introduce an auxiliary tuned circuit in place of the additional H.F. stage. Such a



This form of baseboard assembly is not only the easiest method of set construction but avoids a sacrifice of efficiency which is often encountered in compact or symmetrical layouts. Wiring is readily accessible and follows in arrangement the theoretical circuit diagram. Faults can be traced with little trouble and modifications to suit individual requirements readily introduced.

tuned circuit unassociated with the valve and being free from valve loading would go much farther towards securing super-selectivity than would the addition of another H.F. stage.

Against the use of three H.F. valves is the important fact that the high degree of overall amplification introduces serious difficulties. In the first place, a frame would undoubtedly be substituted for the outside aerial, thus cutting down the initial signal voltage. Moreover, reaction between loud speaker leads and aerials would now be sufficient to throw the set into oscillation, while the limit of amplification at which valve noises become troublesome would have been exceeded. It is important to note that with indirectly heated valves the "rushing" noises arising out of excessive amplification are less in evidence. Another cause of noise may be encountered, viz., the A.C. of the heater modulating the carrier, although this is less likely to be met with in a two-stage amplifier.

Four dials would render tuning somewhat tricky, but the ganging of the unloaded tuned filter with the two H.F. stages is a thoroughly practical proposition. The intention with this receiver is that an outside aerial shall be used, and experience has shown us that the selectivity often thought to be associated with the frame is not always in evidence. In fact, a loose-coupled aerial tuned by a single condenser gives a generous input to the amplifier and is to be preferred to a frame. When ganging is considered, further support is given to the arguments in favour of a reduction in the primary windings if the constancy of tuning is to be maintained with a change of valve.

This arises from the considerable magnitude of the screen to anode capacity of a valve as well as the capacity between screen and grid. These capacities, which vary with different valves, are virtually connected across the primary winding and in the case of a 1 : 1 transformer are, in effect, added to the capacity of the tuning condenser across the secondary. A transformer of 1 : 4 transfers only $\frac{1}{16}$th part of this capacity across to the tuning condenser, so that the effect of a small difference in the screen to anode capacity will now vary the tuning positions only very slightly.

Reasons for Transformer Coupling.

The essential reason for using H.F. transformers as against tuned anodes tapped down to the required degree of selectivity is that the low capacity between the primary and secondary windings of the transformer, as compared with that of the coupling condenser in the tuned anode, avoids L.F. feedback and simplifies the precautions necessary to avoid L.F. oscillation. Some favour the choke-feed H.F. circuit owing to the convenience of wave-range switching which it affords. In this arrangement the merits of an efficient tuned circuit may be completely

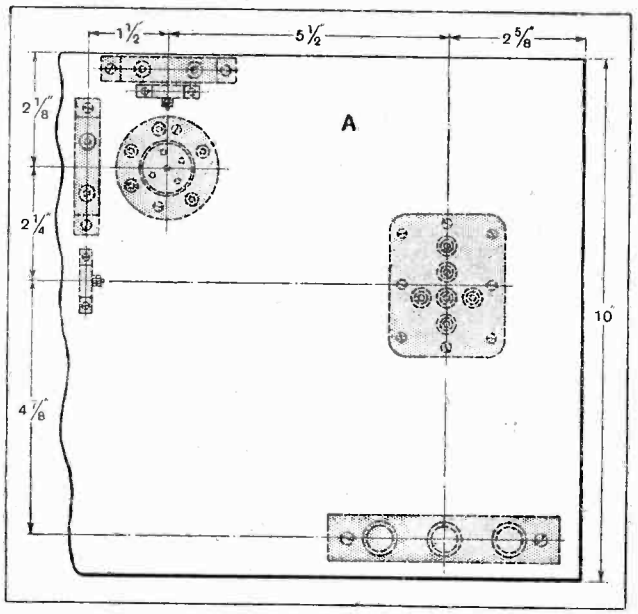
Foreign Listener's Four.—

thrown away by the use of a doubtful H.F. choke with which it is in parallel. Interchangeable transformers give the two wave-ranges, an arrangement adopted owing to its simplicity. To use fixed coils giving reception on the broadcast band only is a wise modification making for simplified construction.

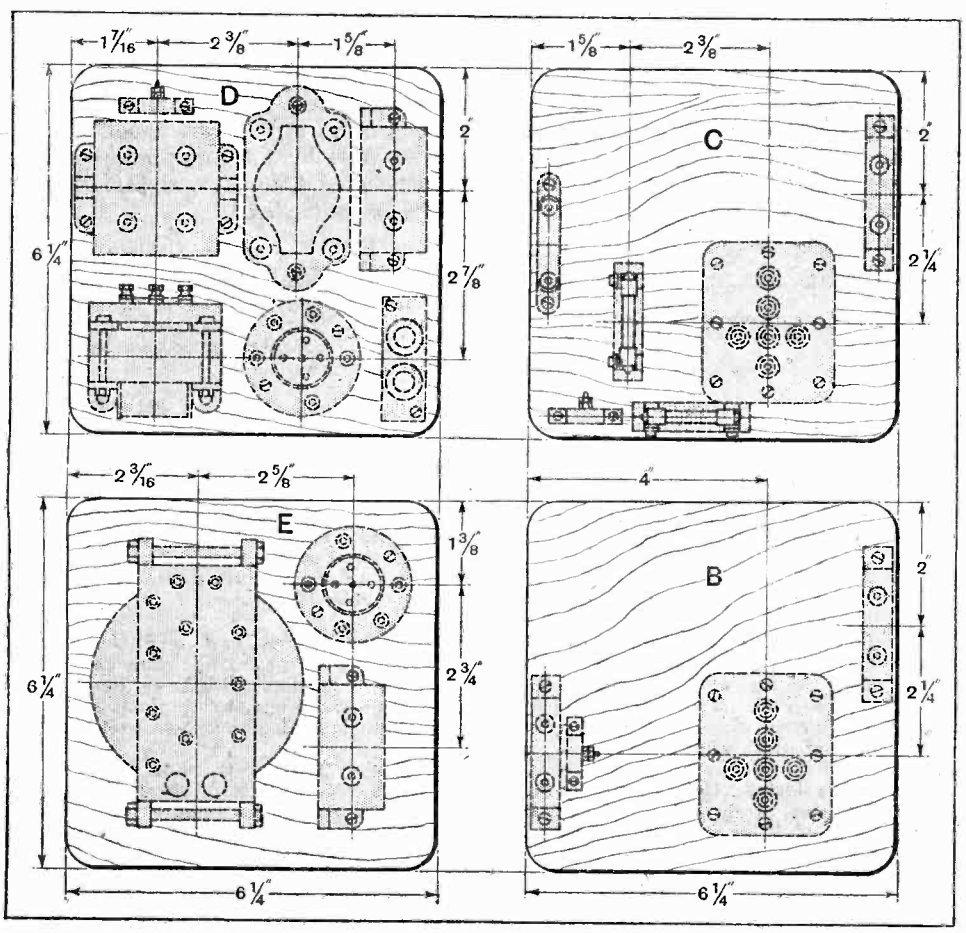
Grid Bias for Indirectly Heated Valves.

Reference to the circuit diagram will reveal the entire absence of grid cells and the substitution of the voltage dropping method of biasing. This is a new feature which has been brought about by the advent of indirectly heated valves, and would only be possible with battery operated valves, assuming the use of a separately insulated accumulator for each stage. It is worthy of note here that the dangerous back couplings through the L.T. accumulator which are so difficult to avoid with battery operated valves are not entirely removed. A negative bias of 0.75 volt is produced at the grids of the H.F. valves by interposing the 600 ohm resistances in the return path of the H.T. negative lead to the cathode.

Feed resistances in screen and anode circuits in association with condensers localise the H.F. currents to their respective stages. In this connection one should note the distribution of apparatus both inside and outside the screened units by which means stray couplings are avoided.



Plan showing the dimensional layout of the components forming the tuned aerial circuit.



Positions for attaching the components to the wooden baseboards which are supplied with the screening boxes.

Coming now to the detector, there may be doubt as to the wisdom of using a leaky grid arrangement following so generous an amplifier. The reasons for so doing are that the leaky grid is infinitely more sensitive to small inputs than anode bend, and with these small potentials there is reasonably linear relationship between input and output. Next, it is not permissible to follow an anode bend detector with transformer coupling, while to use resistance coupling with a single L.F. stage is to throw away amplification. In addition the anode load thrown back on to the tuned grid circuit is not serious in this instance, as the primary winding of the L.F. transformer is shunted by a condenser of 0.001 mfd. The presence of grid current loading is admitted, yet is not of excessive value in view of the class of tuning coil used. The generous value of the by-pass condenser permissible with the

LIST OF PARTS.

1 Baseboard, 38 × 11in. Preferably ⅜in. or ½in. plywood.
4 Screening boxes, 6½ × 6½ × 6in. (Bowyer-Lowe).
3 Pieces of Bakelite board or Ebonite, about 5½ × 6¼ × 3/16 in.
3 Variable condensers, 0.0005 mfd. (Lotus log. mid line).
5 Valve holders, 5-pin A.C. (Whiteley Boneham).
3 Slow motion dials (Ormond type R/137, order with ¼in. centre holes and ⅜in. hole in pin plate).
1 L.F. Transformer, 3 to 1 (Philips or R.I.).
1 H.F. choke (McMichael).
1 L.F. choke, 20 henrys (Magnum).
7 De-coupling resistance, 600 ohms (Groves Bros., St. Mary's Place, Shrewsbury).
1 De-coupling resistance, 1,000 ohms (Groves Bros.).
1 Resistance, 100,000 ohms (Loewe, grid leak type).
1 Grid leak, 2 megohms (Loewe).
2 Porcelain Grid leak holders (Bulgin).
1 Anode resistance, 30,000 ohms and holder (Ferranti or Varley).
1 Potential divider, 20,000 ohms (Climax).
6 Ribbed formers (Colvern new type) } Assuming that it is desired
3 Bases (Colvern, rectangular type) } to cover both wave-ranges.
4 Fixed condensers, 2 mfds. 400 volt D.C. test (T.C.C.).
1 Fixed condenser, 4 mfds. 400 volt D.C. test (T.C.C.).
6 Fixed condensers, 0.1 mfd. 400 volt D.C. test (T.C.C. type 28).
1 Fixed condenser, 0.0002 mfd. mica dielectric (T.C.C. type 34).
1 Fixed condenser, 0.001 mfd. mica dielectric (T.C.C. type 34).
1 Transformer (Radielle, type W.W.S., the Radielle Co., Ltd., 18a, Haverstock Hill, Chalk Farm, London, N.W.3).
1 Choke (Radielle type C.A.).
4 Ebonite shrouded terminals (Belling Lee).
Quantity of No. 24, 28 and 40 D.S.C. wire.
Systoflex, screws, wire, etc.

Approximate cost, £12 to £13.

In the "List of Parts" included in the descriptions of *THE WIRELESS WORLD* receivers are detailed the components actually used by the designer and illustrated in the photographs of the instrument. Where the designer considers it necessary that particular components should be used in preference to others, these components are mentioned in the article itself. In all other cases the constructor can use his discretion as to the choice of components, provided they are of equal quality to those listed, and that he takes into consideration in the dimensions and layout of the set any variations in the size of alternative components he may use.

transformer is far more effective as a stopper to H.F. than would be the condenser of one-tenth of this value as used with anode bend and resistance coupling. Furthermore, there is the ruling factor that the valve itself is intended for leaky grid detection, and would give only a small output when biased back as an anode bend detector. This being a long-range set, we are legislating for potentials of less than a millivolt across the aerial coil, so that grid swings must not be estimated from the point of view of local station voltages. A positive bias of about 1 volt is desirable for the correct working of the detector valve, and is produced in this instance by a high resistance potentiometer in association with the H.T. supply. A possibility of undesirable couplings arising by this method can be dismissed in consideration of the high values of the resistances.

The output valve is a P 625, which is fully loaded, as revealed by tests with microammeter in the grid circuit and milliammeter in the plate circuit. This valve is directly heated by A.C. There is no trouble by way of ripple. The passing of 20 mA. in the anode circuit produces a bias of 20 volts by the interposing of the 1,000-ohm resistance between filament and H.T. negative. (*To be concluded.*)

TRADE NOTES.

Loewe Resistances and Condensers.

The vacuum type resistances and condensers made by the Loewe Radio Co., Ltd., 4, Fountayne Road, Tottenham, London, N.15, are now supplied fitted with screw caps. This does away with the necessity of using clips. Prices have been fixed as follows: Resistances from 10,000 ohms to 10 megohms 2s. 6d. each, condensers from 0.0002 mfds. to 0.001 mfd. 1s. 5d. each, and from 0.002 mfds. to 0.05 mfd. 1s. 8d. each. The old types are not being withdrawn and are still available.

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Change of Address.

The Mullard Wireless Service Co., Ltd., announce that the Sales and Accounts departments have been transferred from Nightingale Lane, Balham, London, to the Company's new premises at Mullard House, Charing Cross Road, London, W.C.2. The telephone number is Gerrard 0767. Owing to the expansion of their business in Birmingham, new premises have been secured at 36-37, Dale End, Birmingham. The telephone numbers are: Central 4190 and 4191. Telegrams: Mulvalve, Birmingham.

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Owing to expansion of business in the Newcastle district, the Metropolitan-Vickers Electrical Co., Ltd., have moved into larger premises at Metro-Vick House, Northumberland Road, Newcastle-on-Tyne. The telephone numbers are: Central 6202-3-4 and 5. Until the end of August, 1929, however the showrooms will remain at Saville Row, Newcastle-on-Tyne, as hitherto.

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Catalogues Received.

Messrs. Ferranti, Ltd., Hollinwood, Lancashire. — Twenty-page illustrated book dealing with the Ferranti Multi-Range D.C. Test Set. Constructive broadsheets No. 1 and No. 2 giving details of H.T. eliminators.

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The Mainten Manufacturing Co., 126, Portland Road, Hove.—Illustrated catalogue of H.T. eliminators, loud speakers and metal cabinets.

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Philips Lamps, Ltd., 145, Charing Cross Road, London, W.C.2.—Descriptive folder of the Philips Current and Polarity Indicator.

Mullard Wireless Service Co., Ltd., "Mullard House," Charing Cross Road, London, W.C.2.—Illustrated leaflet of P. M. Mansbridge condensers for radio power circuits.

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The Aneloy Products, 36, Hindmans Road, East Dulwich, London, S.E.22.—Leaflet describing accumulator charging service recently inaugurated by this firm.

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Messrs. A. H. Hunt, Ltd., H.A.H. Works, Tunstall Road, Croydon.—Two eight-page catalogues dealing with electrical measuring instruments for wireless and kindred purposes.

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Messrs. Burne-Jones and Co., Ltd., Magnum House, 296, Borough High Street, London, S.E.1. — Descriptive leaflets of "Magnum" portable sets and all-electric radio-gramophone receiver.

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Radio Instruments, Ltd., 12, Hyde Street, New Oxford Street, London, W.C.1.—Descriptive folder of "Dual Astatic" H.F. choke—some interesting curves are given.

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Radi-Arc Electrical Co. (1927), Ltd., Bennett Street (Dukes Avenue), Chiswick, London, W.4.—Leaflet describing the "Liberty" moving-coil loud speaker.

In Search of Quality

The Construction and Performance of a 25ft. Logarithmic Horn.

By R. P. G. DENMAN, M.A., A.M.I.E.E.

A FEW months ago, when collecting material for a paper on Loud Speakers,[1] I obtained a long-wished-for opportunity to hear the loud speaker developed by Messrs. E. C. Wente and A. L. Thuras, of The Western Electric Company. One of these remarkable instruments, together with a 15ft. logarithmic horn, was kindly placed at my disposal by Standard Telephones and Cables, Ltd., and although I did not at that time fully realise the ability of this speaker to show up many traces of amplifier distortion which would pass unheard in a moving-coil instrument, the results created much interest. It is ill work prophesying in these matters, but after studying the work of Wente and Thuras[2] it is difficult to see how any further very marked advances can be expected to occur during the next four or five years, or until new mechanical and magnetic materials have been brought to light and their properties developed in the required specialised directions.

Readers of this journal do not need to be told that the moving-coil loud speaker can be made very good indeed, but even when the high-frequency peak in the neighbourhood of 3,000 cycles has been conquered, a few other defects remain, some of which I have not seen eliminated in any design. The " boom " tone, the small area of the source as compared with even a small group of performers, the amplitude distortion effect apparently produced by having too much speech-current in relation to the field strength, the uncertain nature of the output at very high frequencies—these are some

[1] Journal of the Royal Society of Arts, May 17th, p. 668.
[2] "Bell System Technical Journal," Jan., 1928, p. 135. See also *Wireless World*, June 6th, 1928, p. 599.

of the blemishes to which I refer, although fully aware of the truly excellent results that can be obtained despite these difficulties.

The superiority of the large horn instrument is indeed

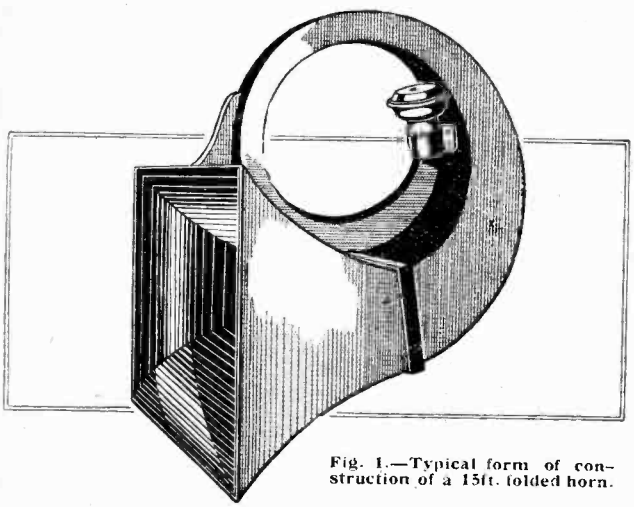


Fig. 1.—Typical form of construction of a 15ft. folded horn.

very apparent, but, as is well known, the radiation resistance becomes uneven in the neighbourhood of the cut-off frequency, and even in the case of the 15ft. horn, with a cut-off at 60 cycles, there was some "boominess." The problem of constructing a satisfactory domestic instrument was therefore by no means easy of solution, for the folded 15ft. horn measured 3ft. 6in. in every direction, and it was desired to construct and to *conceal* a larger one still.

An unused chimney was examined in the hope that this might be made to house the main body of the horn, with a right-angle turn near the mouth, which was to form the fireplace. The depth, however, turned out to be insufficient. For the ultimate solution of the problem in its practical aspect I am indebted to my friend, Mr. J. R. Benson, whose scheme was as bold in conception as it has proved effective in practice. The method he suggested was to treat the entire room as the mouth of a loud speaker placed above it, and the photographs show how this has been accomplished. The room in question is octagonal, and the ceiling consists of a horizontal rectangular section in the centre, measuring 9ft. by 3ft. 6in., with the eight sides sloping down to the walls. The plan was, therefore, to build the greater part of the horn above the roof (there being fortunately nothing overhead) so that after removing the flat centre portion of the ceiling these sloping octagonal sides would form a continuation of the mouth. The final cross-sectional area was thus to be the entire area of the floor, amounting to about 400 square feet, or 40 times the mouth area of the 15ft. horn used previously.

There were one or two drawbacks to the scheme. The slope of the ceiling was rather more gentle than the theoretically correct angle of 45 degrees that the sides of a horn mouth should make with the axis, and also some reflection was bound to occur at the mouth, due to imperfect absorption within the room. But after much discussion and a careful consideration of the pros and cons, I decided to make the experiment on account of its unique character and because a complete failure seemed very improbable. At the worst, one would probably achieve results comparable with those given by the 15ft. horn; with good fortune there was a chance of securing reproduction of an even higher standard.

Before the design was drawn a preliminary experiment was made to determine the performance of the 15ft. horn at the higher audio frequencies. This horn had a continuous bend of more than 360 degrees in the same direction (see Fig. 1), and it was thought there might be a considerable amount of interference between waves traversing inner and outer paths round this bend. The performance was, therefore, compared with that of a straight 5ft. exponential horn, and it was found that the relative cut-off frequencies of the curved and straight horns under identical conditions of operation were 6,000 and 8,500 respectively. This was rather alarming, so in order to avoid any serious losses of this nature it was arbitrarily decided that the radius of curvature of the bend should never exceed five times the diameter of the equivalent circular section at any point. Moreover, the bend was restricted to a single turn of 90 degrees (Fig. 4, see title illustration).

Design Data.

There are two fundamental constants in horn design. One is the rate of taper and the other the area of the mouth opening. Corresponding to each of these constants there is a lower cut-off frequency. The mouth area cut-off (which is not sharp) may be roughly taken *as that frequency for which the wavelength equals the periphery of the mouth.* Thus the cut-off frequency of the

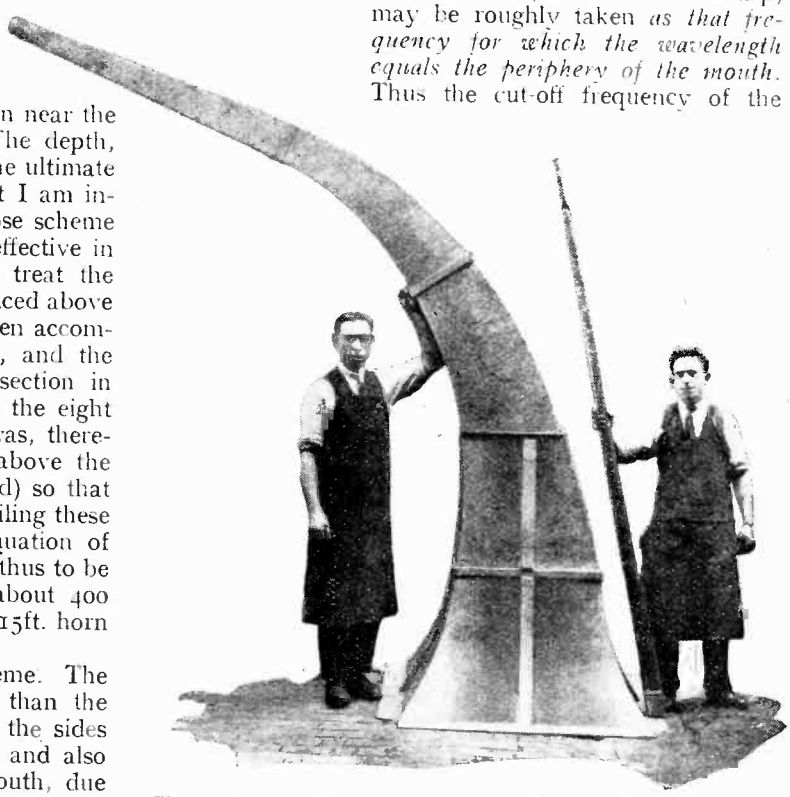


Fig. 2.—Metal portions of experimental 25ft. horn showing on the right the initial straight section which is 8ft. in length.

flat rectangular portion of the ceiling is $\frac{1{,}100\text{ft.}}{25\text{ft.}} = 44$. If the entire area of the room could have been considered as the mouth of the horn, and the rate of taper increased accordingly, the cut-off frequency would have reached the magnificent figure of 11. But, as previously stated, the ceiling was too nearly flat to be fully efficient as a horn mouth.

It was eventually decided that the horn should be

Fig. 3.—The final wood section. This is lined with sheet metal to preserve a uniform surface within the sound conduit.

given a rate of taper for which the cut-off frequency was 32.5. This figure was arrived at as follows:—

(1) It gave a length (25ft.) that enabled the horn to be bent round and the throat terminated at an accessible point.

(2) While quite well suited to the 44-cycle cut-off frequency of the mouth proper, it gave the ceiling mouth-extension an opportunity to radiate still lower frequencies, if so inclined. Any peaks occurring at 30 cycles or so would be quite harmless.

Materials Used.

Having settled the rate of taper and the resulting length, the curve to be followed by the horn was drawn to scale and the proper cross-sectional areas calculated for each foot-run. The initial length of 8ft. was constructed from 20-gauge copper sheet, rolled up into a conical tube, the maximum error introduced by this departure from the true exponential shape being of the same order as the errors involved in the actual work of construction. The next section of the horn was built of "terne-plate," or lead-covered sheet-iron. It is acoustically superior to zinc and is cheaper and easier to solder. This portion of the horn weighed no less than $2\frac{1}{2}$ cwt.

A change from circular to square section occupied the first eight inches of the centre section, this shape being continued round the bend until the sides of the square had been increased to 3ft. 6in. The final section was straight and was made of 1in. mahogany. Two sides of the 3ft. 6in. square forming the large end of the metal section were carried straight through the wooden portion, the other two sides being expanded more rapidly than before until the final area of 9ft. by 3ft. 6in. was attained. The appearance of the various sections at this stage of the work may be seen from the photographs (Figs. 2 and 3).

The entire 25ft. horn was now carried into the room and temporarily assembled for a trial, thick felt being wrapped round the metal portion. It was satisfactory to find at once that the precautions taken to preserve the high frequencies had been very successful. The horn showed a fine open tone and the constant tone record of frequency 8460 was reproduced as strongly as through the 5ft. straight horn. It was therefore decided to proceed with the work of erection, and the external appearance may be seen from the illustration on page 97 (Fig. 4). The input orifice is located just inside an upper room to the right of the horn. The "555W"[3] unit is screwed to the throat and is fed by two cables from the amplifier room, giving speech-current and the field current of 1.6 amperes at 7 volts (1.6 amps.).

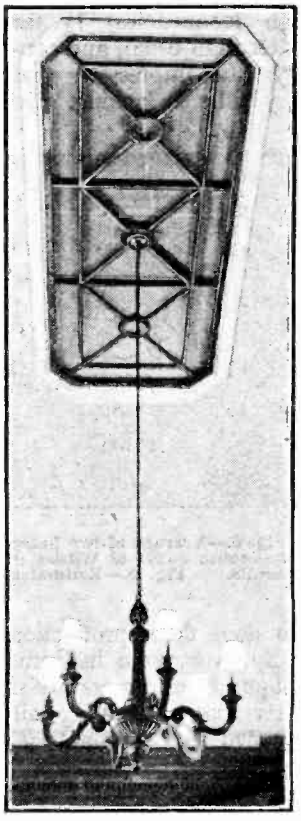


Fig. 5.—Appearance of horn mouth within the room, showing gauze-covered grille. The electric light conduit can be seen through the gauze.

The body of the horn is covered with four layers of pitch to a depth of about half an inch, about 1 cwt. being used for this purpose. This was found to be more than enough to extinguish the "tin bath" effect of the uncovered horn. Within the room a large grille measuring 9ft. by 3ft. 6in. is used to conceal the mouth of the horn proper. This grille only obstructs 10 per cent. of the mouth area, and is covered with white gauze. It is shown in Fig. 5. Although it is not without some slight effect in attenuating the highest tones, the impression of clarity and definition in the extreme upper frequencies is remarkable. There is some directional effect; the sound can be traced to its source and there is a concentration of the high frequencies about the acoustic axis. So far no sound-pressure measurements have been taken of this particular loud speaker, but the dotted portion of Fig. 6 is everywhere within 5 T.U. (transmission units or decibels) of two independent curves[4]

[3] A product of Standard Telephones and Cables, Ltd.

[4] The curves were for horns having cut-off frequencies of 40 and 112 cycles respectively. For the latter curve see Bostwick, "Bell System Technical Journal," January, 1929, p. 148.

In Search of Quality.—

of " 555W " units with large horns, and undoubtedly this curve shows the general trend of the response at a point some distance from the mouth of the horn and about 20 degrees off the axis. It will be understood that no attempt has been made to show minor resonances, which may be expected to vary widely in different cases. On the other hand, the curve corresponds very well with the results of actual experience in listening. It will be seen that the response falls noticeably in the bass but is fairly well maintained up to 6,000 or 7,000 cycles. The excellence of the high-frequency response is indeed the most striking property of this loud speaker. The tone of bowed strings (perhaps the best test for high frequencies) is far better than usual, and conveys the impression that very little is lacking. So also does the reproduction of the piano and of practically every solo instrument. Where, however, large groups of performers are present, the horn, while much better than a moving-coil cone, obviously cannot be regarded as a satisfactory substitute for the real thing, since the sound proceeds from a source of limited area. Judged aurally, the response at the lowest frequencies is just perceptibly deficient, and on the whole it is probably not worth while to construct a horn longer than 15ft. for an uncorrected " 555W " unit. The comparatively simple form of the response curve, however, suggests that the rising portion can be levelled up without much difficulty, and considerable success has been achieved in this direction. Inspection of Fig. 6 shows that the response is about 16 T.U. less at 100 than at 1,000 cycles. By shunting resistance and capacity in series across the anode resistance it is possible in effect to increase the amplification at 100 cycles relative to that at 1,000, so as to give about 4 T.U. more output at this frequency for each stage so treated. But since this method really involves suppressing the amplification in the unaffected region it means in practice that more amplifying stages are required, and in the present case only about 8 out of the lost 16 T.U. have so far been restored in this way. The result (with radio) is that one is still conscious of a certain weakness in the extreme bass. Accurate sound-pressure measurements are to be made, therefore, after which it will be possible to decide upon a suitable equalising network.

Gramophone pick-up design has been making great progress, and Fig. 7 is a response curve of a particularly ingenious pick-up due to Mr. P. Wilson. Lest it should be supposed that the curve is not very much better than those to which we are accustomed, I give also the curve of an average pick-up such as is at present on the market. The pronounced resonance at 2,200 cycles in my particular Wilson pick-up is due to the use of a Tungstyle needle, but fortunately it has been found possible to remove this by a rejector circuit consisting of a 150-turn honeycomb coil in parallel with condensers totalling 4.4 mfds. The rejector is placed in series with the secondary winding of the 25 to 1 Ferranti output transformer which feeds the loud speaker. Alternatively, fibre needles can be used, but they involve some sacrifice of high frequencies which can ill be spared.

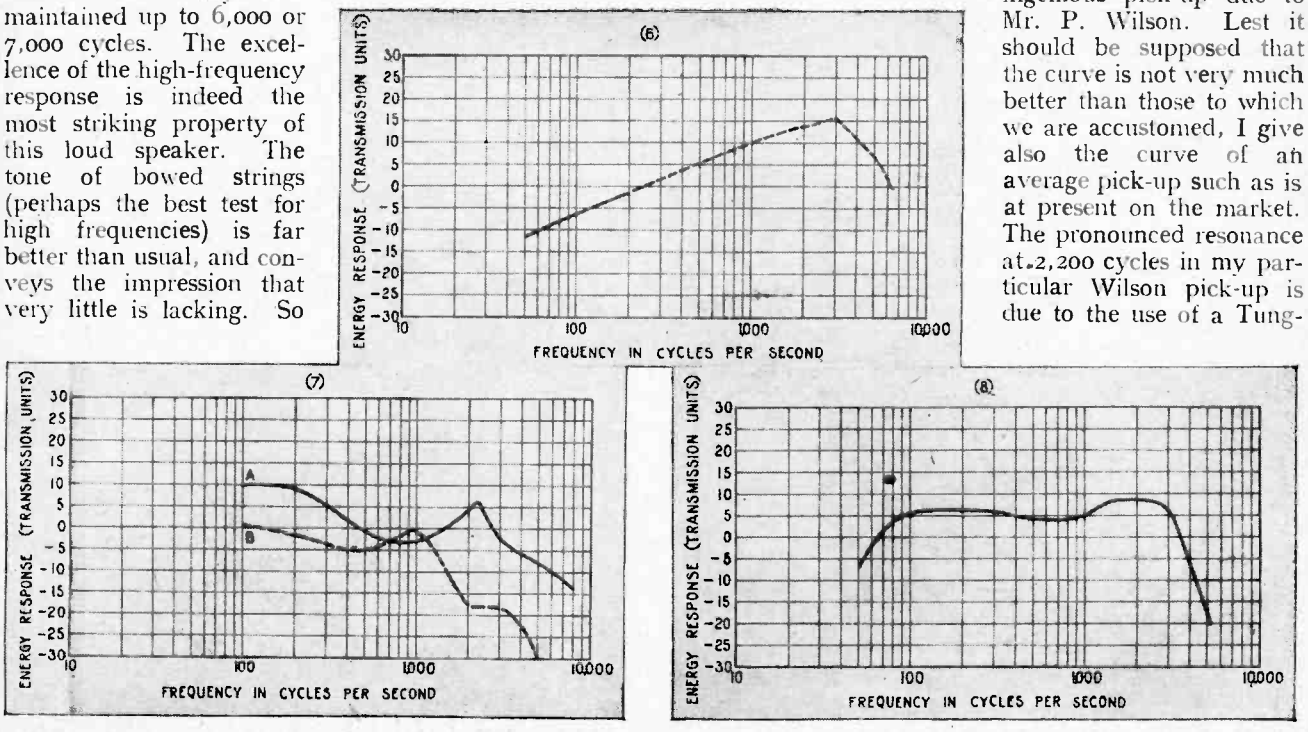


Fig. 6.—Average of two independent response curves of 555W units with large horns. Minor resonances are ignored. Fig. 7.—(A) Response curve of Wilson pick-up with " Tungstyle " needle. (B) Response curve of a typical commercial pick-up with similar needle. Fig. 8.—Estimated overall response to constant-tone records of the pick-up, amplifier and loud speaker combined, ignoring small resonances.

When the response of this pick-up to constant tone records is replotted and combined with the loud speaker response of Fig. 6 (the amplifier having been dealt with in the manner described above) the curve of Fig. 8 is obtained. The curve is within the limits of $\pm 7\frac{1}{2}$ T.U., between 40 and 4,000 cycles, and if it is only remotely accurate it is good enough to do some justice to present-day wax recording. That the overall response (whatever may be its exact shape) has been very much improved is made apparent by comparing the reproduction of an ordinary moving-coil cone loud speaker with that of the " 555W " before and after it has been matched up. In the former case it takes a few seconds to appre-

In Search of Quality.–

ciate that the horn really is very much better; in the latter case the difference is so great that one wonders what has gone wrong with the moving-coil. In some tests with a local microphone circuit, where speech reproduction could be rapidly compared with the original voices, no differences could be detected other than those which could reasonably be attributed to the difference in the acoustic surroundings of the microphone and the loud speaker. It seems probable, therefore, that the imperfections in the loud speaker and amplifier system over the range from 60 to 6,000 cycles do not greatly exceed the tolerance of the average ear. At the same time, it is obvious, from Fig. 6, that any equalising network should be designed to reinforce the extreme upper frequencies, and here much will depend upon the conditions of listening. The response at high frequencies falls off as one recedes from the horn axis, and it has been noticed that at points some distance from the axis a setting of the amplifier that gives good balance when the room is nearly empty results in insufficient high frequencies when twenty or thirty people are present, indicating selective absorption by clothing, etc.

The choice of a suitable horn must be left to the individual, but a minimum length of about 14ft. is recommended, and if it can be made quite straight, then so much the better. A straight 27ft. horn is being installed at the Science Museum, South Kensington; it is designed to have a cut-off frequency of 32.5, but it is rather unlikely that tones of this depth will be heard from it. The intention is rather to get the best possible results out of the " 555W " speaker, so that the reproduction down to 50 or 60 cycles will be free from boominess, and also to provide a margin for any further improvements which may ultimately be made in the design of horn type instruments.

COMPULSORY WIRELESS AT SEA.

British Practice Endorsed by Other Nations.

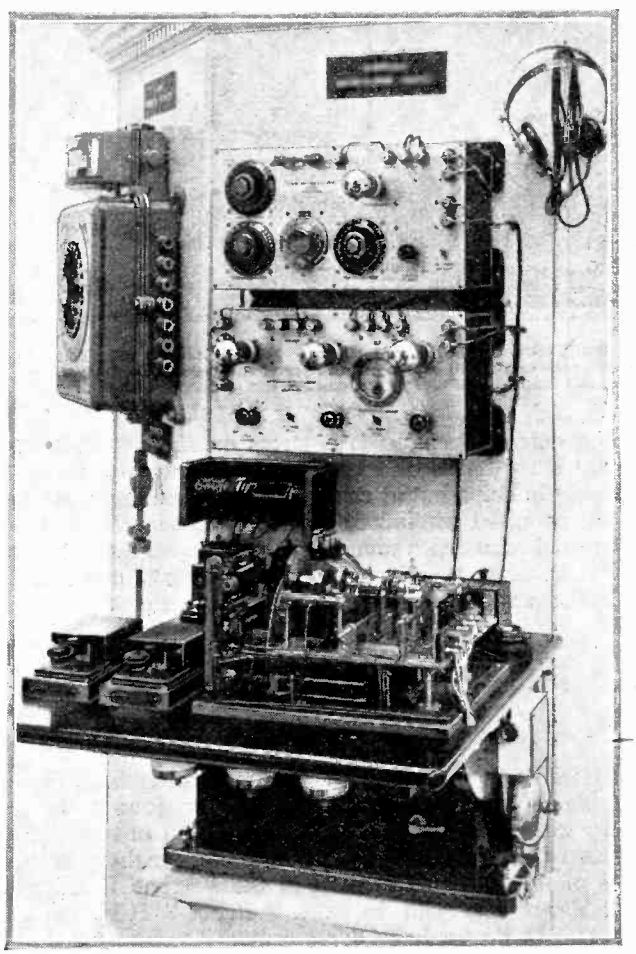
THE International Conference on the Safety of Life at Sea, which was held in London recently, has drafted a new International Convention which will, no doubt, be ratified in due course by all Governments concerned.

The last Convention, which arose out of the *Titanic* disaster, was drafted in 1914, but due to the War was never ratified. Since then, however, all countries have passed legislation in connection with the application of wireless to the safety of life at sea, and much of this legislation has been on the general lines suggested in the draft Convention. Great Britain has gone further than any other country in making regulations for the installation and use of wireless in this connection, and the new Convention will to a great extent ensure that other maritime countries come into line with the regulations already in force in this country.

In a few respects the new Convention goes further than the British regulations. At present it is not compulsory to install directional receiving apparatus in any ship, whereas the new Convention lays down that every passenger ship of 5,000 tons gross and upwards must be provided, within the next two years, with an approved direction finding apparatus or radio compass. Such apparatus enables a ship to obtain its bearing from any other ship or wireless station which is transmitting wireless signals. In the 1914 Convention there was no obligation of this sort as, at that time, direction receiving apparatus had hardly passed out of the experimental stage, and very few ships were fitted with it.

The Automatic Watcher.

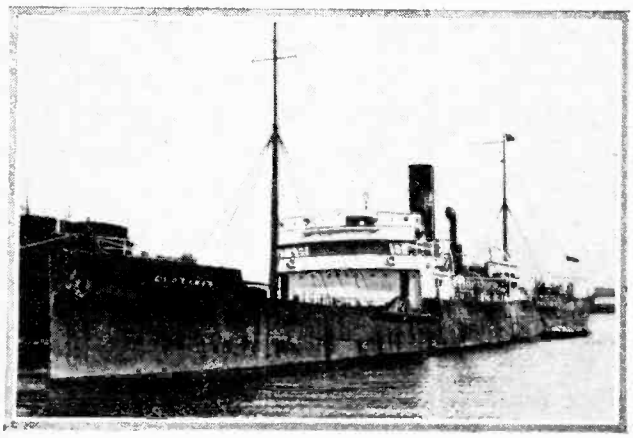
Another safety arrangement that has come into prominence since the 1914 Convention was framed is the automatic alarm. This apparatus consists of a receiving



AUTO-ALARM APPARATUS of the type which has been in use on a number of British ships for nearly two years. The International Convention recommends its general use.

Compulsory Wireless at Sea.—

set which responds automatically to the wireless Alarm Signal which is sent by a ship immediately before she sends the Distress Signal. When this signal is received on the automatic receiving apparatus it is made to ring a bell by which means the operator can be called to the wireless cabin in time to read the message from the ship in distress. Apparatus for this purpose was designed by the wireless companies which supply ships' sets in this country, and has been in use in many British ships for nearly two years. No other countries adopted this safety arrangement, but the new Convention recognises its great importance, and differentiates the watch-keeping required in future in ships fitted with this auto-alarm from that required in ships which are not so fitted. In other words, what was a purely British wireless device for increasing the safety of life at sea has now been officially recognised as a desirable arrangement by all other maritime countries.



DIRECTION FINDING GEAR will be required on all ships of 5,000 tons gross and over within the next two years. In the picture a small loop directional aerial can be seen above the ship's bridge.

The new Convention lays stress on the adoption of all the latest forms of scientific navigational apparatus, not only in ships but at coast stations, including the use of synchronised wireless and underwater signals for the latter, and echo depth sounding apparatus for the former, and it also lays down general rules for the international collection and distribution by wireless of meteorological data

The technical regulations laid down by the Convention as regards the minimum range of ships' apparatus and the type of ships on which wireless installations must be fitted are, generally speaking, in conformity with the regulations which have been in force in this country for many years. The main installation in a ship must be able to communicate over a range of at least 100 nautical miles to another ship fitted with the simplest receiving apparatus, and emergency installations must have a range of at least 80 or 50 miles, according to the type of ship. Certain of the lifeboats, too, in large ships must be fitted with wireless telegraphy. All passenger ships must be fitted, as must all cargo ships of 1,600 tons gross and upwards, with, of course, certain specified exceptions, an arrangement which has been in force in this country for the last ten years.

Duration of Safety Watch.

In effect, the Convention stipulates that safety watch, that is to say, watch by operator, watcher, or auto-alarm, shall be continuous in all passenger ships over 3,000 tons, and all cargo ships over 5,500 tons, and that at least eight hours watch a day must be kept in cargo ships between 3,000 and 5,500 tons. The watch in other ships is left to the Governments concerned, but it is laid down that there must be at least one qualified wireless operator in every ship compulsorily fitted with wireless telegraphy. In future a watcher must be able to read code groups at a speed of 16 groups a minute and be able to distinguish the alarm, distress, safety and urgency signals. Up to the present watchers have not proved to be of much use in practice, and this higher standard of qualification will be welcomed by those who are interested in wireless safety services.

No Telephony on 600 metres.

No regulations have been laid down as regards wireless telephony except that it should not be used on waves which approximate to the distress wave of 600 metres, as it would then have the effect of rendering inoperative the automatic alarm apparatus which would naturally be adjusted for the reception of the Alarm Signal by wireless telegraphy on that wave. Wireless telephony, indeed, is practically non-existent so far as ship working is concerned, as in ships where, by regulations, a competent operator must always be carried, communication by wireless telegraphy is much more efficient than by wireless telephony.

A "TWO-H.F." FERRANTI SET.

UNDER the heading of "Kit Constructors' Problems" in *The Wireless World* for June 10th, a query was published concerning the extent of screening necessary for a two-stage H.F. amplifier on the general lines of the single stage used in the Ferranti Screened Grid Three, and with an extra "R.F.2" H.F. transformer. In the reply to this question it was stated that a certain amount of experimental work would be necessary to determine whether simple vertical screens would be adequate, and the suggestion was made that to be on the safe side, it would be wise to provide complete screening for each stage.

A letter received from Messrs. Ferranti largely confirms the advisability of taking this precaution, but it is pointed out that, if the H.F. components of the receiver are very carefully spaced, it is possible to attain complete stability with the simple vertical screens as supplied. Of course, the reaction winding of the first "R.F.2" transformer is ignored, while that on the second coupling may be connected in the normal manner.

KIT CONSTRUCTORS' NOTES

Kit Set Circuit Diagrams—and How to Understand Them.

THANKS to the complete instructions and simplified diagrams supplied by the producers, all kit sets may be built and operated by those with no technical knowledge and something less than the average amount of manual dexterity. All may go well for a while, but sooner or later the time will come when some replacement or adjustment will be called for, and the constructor will realise the need for at least some understanding of the why and wherefore of the various components and connections. Still more will this knowledge be necessary when alterations are to be carried out; receiver design has not yet reached a state remotely approaching to finality, and, even if it had, changing methods of transmission may well render necessary some fairly extensive modification in order to provide greater selectivity than was required when the set was first built.

If the home constructor always thinks of his apparatus as a mere collection of components with lettered terminals linked together by numbered connecting wires of whose individual functions he is completely ignorant, he will always be in a weak position, and his set will be his master—a fearsome machine to be approached in fear of doing the wrong thing. On every score it pays to acquire knowledge of one's receiver; for one reason, *The Wireless World* Information Department staff (of which the writer is a member) find it impossible in all too many cases to give a definite and helpful answer to "Kit Set" problems, for the reason that the query is worded vaguely, and the fact that the answer must consequently be in general terms renders it almost valueless to the constructor who has no idea which components are associated with, say, the grid circuit of the detector valve.

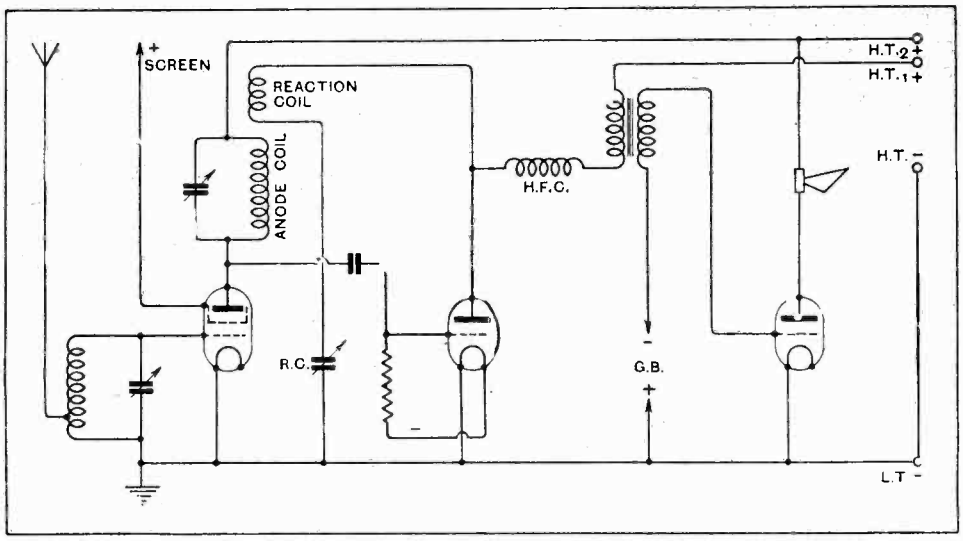


Fig. 1.—The basic circuit diagram of a typical three-valve receiver with an S.G. high-frequency valve.

Analyse the Circuit.

The ability to read theoretical circuit diagrams is a most useful foundation on which to build a deeper understanding of the working of wireless apparatus, and it is strongly urged that those who have not acquired this art should devote a few moments to the subject, checking their progress by tracing the connections of their own receivers. This article, it is hoped, will simplify the task; fortunately for our purpose, the basic circuits of all the popular three-valve H.F.-det.-L.F. kit sets are similar, and when the essentials are grasped it will be easy to understand the peculiarities of individual receivers.

Drawn in the conventional manner, the typical circuit diagram is shown in Fig. 1. It seems probable that the beginner's difficulty in mentally dividing this up into the numerous separate and simple circuits that go to make up the rather complex whole is aggravated by the fact that batteries (or other source of current supply) are common to a number of valves, and that all diagrams naturally indicate this fact. If we imagine that separate batteries are used, it becomes much easier to trace each grid and anode circuit, particularly if we always make a practice of starting at the negative filament terminal of the valve concerned. This holds good when the set is being considered "on paper." The circuit arrangement of Fig. 1, redrawn in this manner, is shown in Fig. 2, in which "starting points," common to both grid and anode, are indicated by heavy black circles, and the main circuits by thick, full lines. Subsidiary connections, not in the main grid and plate circuits, are in dotted lines, in order to avoid confusion. Incidentally, it is helpful to consider closed tuned circuits—coil and

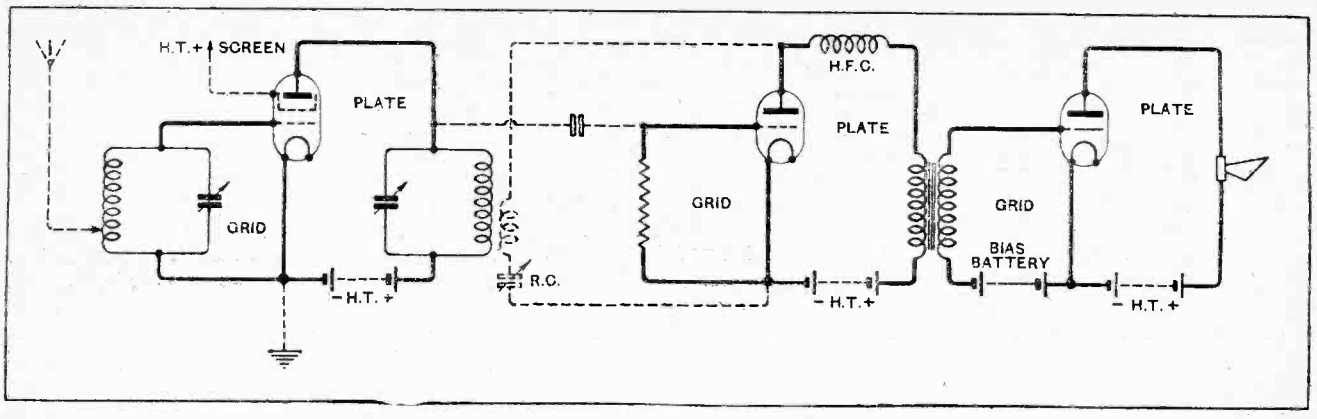


Fig. 2.—Individual grid and plate circuits of the receiver shown in Fig. 1. Filament heating connections are omitted, and subsidiary and parallel circuits are indicated by dotted lines.

condenser combinations—as a sort of resistance of a negligibly low value when out of tune with incoming signals, but of very high impedance at resonance; in the latter condition, a signal voltage will be built up across the resistance, and consequently across whatever may be in parallel with it.

Practical Details.

It is always easy to treat transformer intervalve couplings (whether H.F. or L.F.) in this way, as the primaries and secondaries are readily isolated; the first, of course, will always be in the anode circuit of one valve, and the latter in the grid circuit of its immediate successor. The majority of kit sets, however, include tuned anode H.F. couplings, and so it is simplest to regard the necessary coupling condenser (which generally fulfils the incidental and extra function of a detector condenser) as belonging to neither grid nor plate circuit, but as acting as a link between them.

Although the circuit drawn conventionally in Fig. 1, and in dissected form in Fig. 2, is typical of all 1-v-1 kit sets, it does not represent any one particular design. Taking the aerial coupling, we find that in many cases a double-wound aperiodic aerial-grid transformer, indicated in Fig. 3 (*a*), replaces the simple tapped connection. Turning to the H.F. intervalve coupling, several sets are arranged in such a way that one set of tuning condenser vanes may be "earthed" to the metal panel. This modification will be made clear by a consideration of Fig. 3 (*b*), from which it will be seen that the closed tuned circuit is completed through a large condenser in shunt with the H.T. battery.

Continuity Tests from the Grid and Anodes.

Mention has already been made of the use of H.F. transformer coupling, and of the ease with which the circuits may be dissected; this is shown in Fig. 3 (*c*). Here we may regard the grid leak as auxiliary to the main circuit, so its connections are dotted.

It will be observed that there is always a directly conductive path from grid and anode back to the negative side of the filament; it is useful to remember this when carrying out tests, but it must not be forgotten that this path will be of very high resistance in cases where a grid condenser and its associated leak are used.

Positive Bias from the L.T. Battery.

No mention has been made of filament heating arrangements. Although these circuits are essential for the functioning of a set, they are, nevertheless, subsidiary to the main grid and plate circuits, and it is safe, in the interest of simplicity, to omit them for our present purpose. It is only necessary to understand that each filament is connected across the L.T. battery, *via* a common master switch, and, occasionally, through an individual rheostat for regulation of heating current.

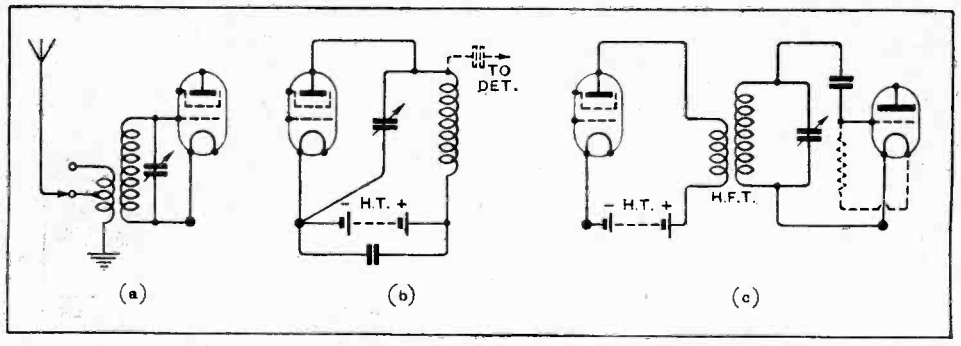


Fig. 3.—Details in which various kit sets differ from the typical example shown in preceding diagrams.

Although it has been said that grid circuits always return to negative filament, this statement should perhaps be modified by saying that in cases where leaky grid rectification is used, the leak is usually joined to L.T. positive. Our rule will still hold good, and we shall get back to our fixed starting point (negative filament) if we consider the L.T. accumulator as a bias battery which maintains the grid at a positive potential.

CURRENT TOPICS

Events of the Week in Brief Review.

NEARING THE 3,000,000 MARK.

The number of receiving licences current at the end of June was 2,791,717, making an increase of 16,009 over the previous month. During the corresponding period last year the increase was 12,000.

All the monthly increases of 1929 have exceeded those of the same months of 1928.

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FRENCH BROADCASTING UNDER THE MICROSCOPE.

All aspects of French broadcasting are to be minutely examined in November next at a *Congrès national de la Radiophonie* to be held in Paris. The French Postmaster-General has accepted the post of President.

Delegates will attend to give evidence on the technical, economic, intellectual, judicial, and legal phases of the subject, and it is hoped that an entirely revitalised broadcasting system will be the result.

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A SCOTTISH WIRELESS SHOW.

An optimistic belief that the Scottish regional station of the B.B.C. will be open by the end of next year has prompted the Scottish Radio Retailers' Association to make preliminary plans for a wireless exhibition to be held in Waverley Market, Edinburgh, from November 12th to 22nd, 1930.

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AERIALS AND ÆSTHETICS.

A Berlin Court has upheld the appeal of a listener against a police order for the removal of his aerial. The police acted on the grounds that a large number of similar aerials would disfigure the city, but the Court decided, says *The Times*, that the police were justified in taking action only when a disfigurement existed, and not in the case of a mere æsthetic probability.

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WHO *DID* INVENT THE "SUPERHET"?

The German Patent Office has recognised the priority claims of M. Lucien Levy, the French radio manufacturer, for the discovery of the superheterodyne principle, writes our Paris correspondent, who states that the decision of the German authorities is contained in an official letter received by M. Levy. Three other parties put in claims of priority, viz., the Telefunken Co., of Berlin; Etablissements Ducretet, Paris; and the Société des Marques et Brevets, Paris.

The German Patent Office holds that "the idea of an amplification of intermediate frequency—after the change of frequency has been effected—is clearly contained in the French patent 493,660" (M. Levy's) of August 4th, 1917, and rejects the argument that the principle was not patentable at the time the patent was taken out. The number of the German patent is 50,860, dated July 2nd, 1920.

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CLUB SECRETARIES, PLEASE NOTE!

The Radio-Club of Orly, France, makes the public announcement that one of its active members, a coal merchant, will allow discount on fuel prices to all subscribers who pay their subscriptions.

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WEATHER NEWS FROM THE ARCTIC.

According to a Moscow report, a Soviet expedition will shortly start for Franz-Josef Land, in the Arctic, to establish a meteorological and wireless station.

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ESPERANTO.

The Twenty-first Universal Esperanto Congress opens at Budapest on Friday next, August 2nd, and will continue for a week.

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HOW THE BEAM PROSPERS.

The Postmaster-General has informed Mr. Bowen, M.P., that up to March 31st, 1929, the Post Office beam services had earned gross receipts amounting to £813,100, at a cost of £538,850.

CHAMPION OF WIRELESS OPERATORS.

We regret to record the death, on Friday, July 19th, of Mr. E. R. Tuck, General Secretary of the Association of Wireless and Cable Telegraphists. Mr. Tuck, who was 56 years of age, had championed the cause of wireless operators since 1912, and was exceptionally popular with all grades in the service.

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INDEX AND BINDING CASES.

The index for Volume XXIV of *The Wireless World* is now ready, and copies are obtainable, price 3d. (post free 4d.), from the Publishers, Dorset House, Tudor Street, London, E.C.4. Binding cases for the volume can also be supplied, together with the index, price 3s. 1d., post free.

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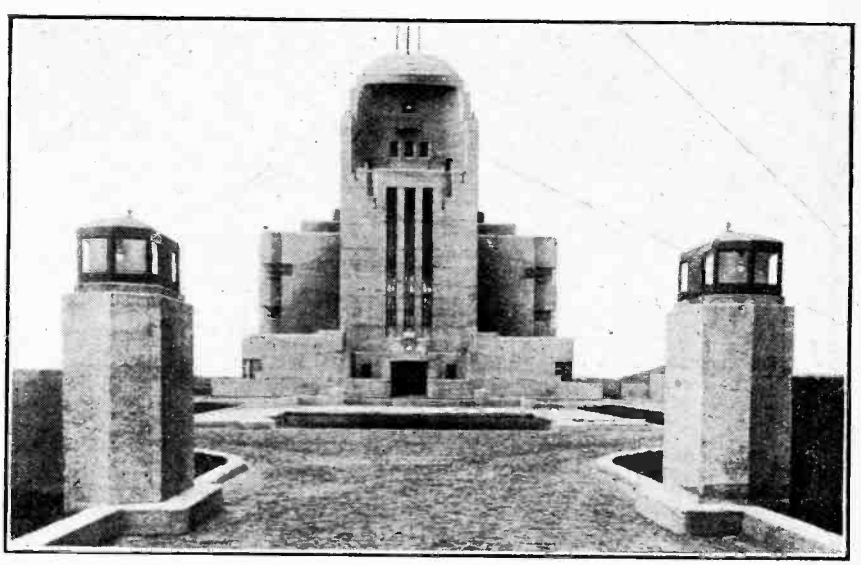
WIRELESS CHAIN FOR U.S. NEWSPAPERS.

Newspapers of the United States will shortly have the benefit of a short-wave wireless chain exclusively engaged on the distribution of news telegrams, says a Washington message. According to arrangements nearing completion by Press Wireless Inc., owners of the system, twenty short wavelengths are to be granted to them by the Federal Radio Commission for trans-oceanic communica-



RADIO AND THE MODERN ARCHITECT. A striking view of the Kootwijk (Holland) short-wave station, PCLL, used by the Government for communication with Java.

tion, and a further twenty exclusive wavelengths at a later date for trans-American traffic.

Receiving stations will probably be erected as follows: Three in New York, one in Boston, two in Chicago, and one each in San Francisco, Los Angeles, and New Orleans.

The newspapers forming the corporation are the *Chicago Daily News*, *Chicago Tribune*, *Los Angeles Times*, *San Francisco Chronicle*, the *Christian Science Monitor*, and the Gannett publications. The organisation will have headquarters in Chicago.

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PUBLIC 'PHONES ON A LINER.

Seven short wavelengths have been granted by the U.S. Federal Radio Commission to the American Telephone and Telegraph Company for experiments towards the inauguration of a ship-to-shore wireless service on the *Leviathan* similar to those conducted recently on the *Berengaria* between that ship and Paris. Four of the allotted wavelengths will be used by the shore station at Deal Beach, New Jersey, the other three being for the use of the *Leviathan*.

Of the 750,000 dollars to be expended on the scheme, writes a correspondent, the greater portion will be utilised in the linking up of the American domestic telephone net to the short-wave transmitter. All staterooms on the s.s. *Leviathan* will be connected to the liner's central switchboard, and by this means will enable any passenger to receive or send a call, whether the steamer be in dock at New York, in the middle of the Atlantic, or at Southampton, some 3,600 miles away.

The tests on the *Berengaria* have proved so successful that the Cunard Steamship Company has decided to install similar equipment on the *Aquitania* and *Mauretania*.

THE TELEVISION SITUATION.

Replying to Mr. Malone and Major Church in the House of Commons last week, the Postmaster-General (Mr. Lees Smith) said that he had received representations both from the Baird Television Development Co. and from the British Broadcasting Corporation concerning the facilities offered for the use of a broadcasting station for experimental transmissions of television, but was not yet in a position to make a statement.

A B.B.C. OUTPOST. This photograph, taken last week, shows the newly completed buildings at Tatsfield, Surrey, which will house the B.B.C. receiving apparatus now in use at Keston.

MARCONI ROYALTIES ON SETS.

THE outline of a proposed agreement between Marconi's Wireless Telegraph Co., Ltd., and the Radio Manufacturers' Association in regard to royalties payable to the Marconi Company in respect of broadcast receivers sold to the public was discussed at a meeting held by the Radio Manufacturers' Association at the Hotel Cecil, London, on Wednesday last, July 24th.

FUTURE HOME OF BROADCASTING. Work has now begun on the erection of Broadcasting House, Portland Place, London, W. The photograph shows the preliminary excavations in progress. Part of the Queen's Hall can be seen in the background on the right.

The following text embodies the terms of the suggested agreement:—

(*a*) A new agreement, dating from August 28th, 1928, to August 28th, 1933, covering patented and non-patented goods for the field of broadcast reception.

(*b*) The new licence shall cover the existing patents set out in the schedule to the A2 licence, the eliminator patent (148,129, at present the subject of their D licence), all other present and future patents controlled by the Marconi Co. and their associates, the Gramophone Co., in the field, as defined in Clause (*a*).

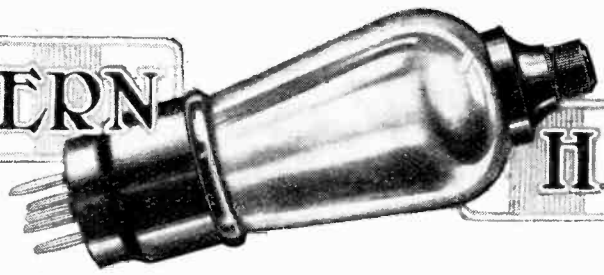
(*c*) Licensees shall give to the Marconi Co. (and to its associate company, the H.M.V.) the free use of any patents they may possess dealing with the field as defined in Clause (*a*). In respect of the eliminator patent the actual royalty in respect of this patent shall be 5s. per apparatus when embodied in a receiving set. The charge when the apparatus is not so included shall be 6 per cent. of the retail list price.

(*d*) The Radio Manufacturers' Association will call the attention of the Marconi Co. to any cases of infringement of the patents, with a request that such infringers shall be prosecuted. Should the Marconi Company not be prepared to undertake such prosecution, the question of the prosecution shall be referred to the arbitration of the President of the Law Society, whose decision shall be binding on both sides.

(*e*) The royalty to be 5s. per valve holder, the term valve holder to have the meaning attached to it in the A2 licence.

Note.—Application for licences under this arrangement must be made to the Marconi Co. not later than August 24th, 1929.

The MODERN H.F. VALVE

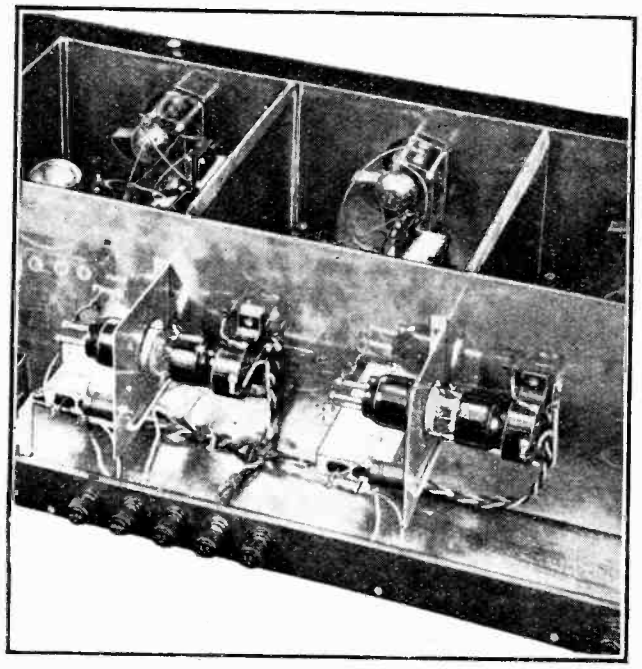


High Stage Gain and Adequate Selectivity with Screened Valves.

By W. I. G. PAGE, B.Sc.

(*Concluded from page 71 of last week's issue.*)

THE reader can now state his requirements and examine the table to see whether they can be fulfilled. For example, let us suppose that it is desired to build a receiver having a single stage of screen-grid amplification of a little over one hundred times, having a selectivity of the order of that in the "Everyman Four" type of receiver; reference to Column 10 shows that at least two of the new S.G. valves for A.C. mains will



Two-stage H.F. amplifier giving a total amplification of over a thousand. Amplification is limited by the value of the residual grid to plate capacity of the valve. (From the "Kilomag Four.")

be suitable. If lighting mains are not available, and we do not feel inclined to feed the one-ampere filament of the A.C. valve from an L.T. accumulator, we must be content with a stage amplification of about 70 or 80 and use a battery-fed screened valve (see Column 10 for valves marked S.G. in Column 3). On the other hand, if the demand for selectivity be not so exacting, the figures of Column 9 for S.G. and S.G./A.C. valves can be more nearly approached by using a two-to-one step-up transformer (see (*d*) in appendix for stage amplification), but the amplification would be likely to reach or exceed the instability figures of Column 12, and either neutralisation or a reduction in the number of primary turns might be required.

If, owing to locality, indifferent selectivity can be tolerated, screened valves can be used with neutralised transformers having an approximate ratio of one-to-one and enormous amplifications up to about 300 obtained (Column 9) when using a standard coil with a dynamic resistance of 250,000 ohms.

Practical Application.

It would now be as well to take each important column of the table and give such detail as is necessary for the amateur to work out the various factors for new valves not included.

Column 3.—It should be noted that S.G. means a battery-heated screened valve, S.G./A.C. an indirectly-heated screened valve for A.C. mains, T a battery-heated triode, T./A.C. an indirectly-heated triode, and P a pentode. The efficient H.F. characteristics of a pentode are extremely interesting in view of the large grid swing which it will handle. Second H.F. valves, where large stage gains are concerned, may require a larger signal-handling capacity than hitherto.

Column 5.—The A.C. resistance of the valves is given at zero grid volts and 100 volts H.T. It is important to note that when an H.F. valve is worked under optimum conditions of, say, minus $\frac{1}{2}$ or minus $\frac{3}{4}$ volt bias and 150 volts H.T. the working impedance is considerably lower than that given. When we come to consider that a typical modern detector valve will not accept more than, say, 20 volts total grid swing (bias $10\frac{1}{2}$ volts) it will be clear that with single H.F. stage amplifications of about 80 or 100 the grid swing on the H.F. valve must not exceed $\frac{1}{5}$ volt, otherwise detector distortion will ensue. Why, therefore, bias the screened valve to minus $1\frac{1}{2}$ volts ready to accept a signal of 3 volts? The mutual conductance, and hence signal strength, increases as the valve is worked nearer and nearer to zero grid volts, and provided the region of grid current is avoided the greatest efficiency will result from a bias of under a volt. Suggested methods of biasing 2-, 4-, and 6-volt valves are given in Fig. 2.

Column 6.—The true comparative figure of merit for

The Modern H.F. Valve.—

H.F. valves when transformer-coupled is $\frac{\mu}{\sqrt{R_0}}$; since this generally comes to less than unity, we have multiplied by 100 in each case. Where there are H.F. performance factors of 50 and 100 respectively the H.F. output in the second case will be double that of the first. The neutralised stage gain of Column 9 will be found to be directly proportional to the column now under consideration. Stage gain where optimum transformer ratios are used is $\frac{1}{2}\mu \times \sqrt{\frac{R}{R_0}}$ from which it can be seen that the valve contributes $\frac{\mu}{\sqrt{R_0}}$ and the coil $\frac{1}{2}\sqrt{R}$. The latter can conveniently be called the "coil factor." In the case of an "Everyman Four" type of Litz coil the expression $R=\frac{L}{Cr}$ equals approximately 250,000 ohms for the medium broadcast band, therefore the coil factor is $\frac{1}{2}\sqrt{250,000}=250$. Column 9 is got by multiplying the coil factor by the valve's H.F. performance factor divided by 100. In a cheaper coil of the type just specified, but wound with the same number of turns of 22 S.W.G. solid wire (D.C.C.), R would be about 180,000 ohms and the coil factor $\frac{1}{2}\sqrt{180,000}=212$. By computing the coil factor and multiplying by one-hundredth of

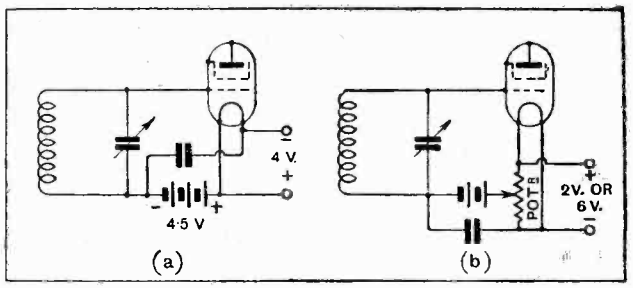


Fig. 2.—With most screened valves there is very little "straight" in the anode current-grid volts curve, and the best mutual conductance (and hence signal strength) can be obtained with less than 1½ volts negative bias. A bias of −½ volt can be obtained with 4-volt valves by connecting a 4½-volt bias battery as in (a). For 2- and 6-volt valves a potentiometer is required (b).

H.F. VALVE STATISTICS

1	2	3	4	5	6	7	8	9	10	11	12	13
VALVE	MAKER	TYPE	AMPLIFICATION FACTOR	A.C. RESISTANCE	H.F. PERFORMANCE FACTOR	OPTIMUM TRANSFORMER RATIO	NO. OF PRIMARY TURNS	MAXIMUM STAGE AMPLIFICATION NEUTRALISED	STAGE AMPLIFICATION WITH 3:1 RATIO TRANSFORMER	VALVE CAPACITY ANODE-GRID ($\mu\mu f$)	MAXIMUM STAGE AMPLIFICATION UNNEUTRALISED	LOWEST LOSS COIL FOR COL. 12 DYNAMIC RESISTANCE (ohms)
AC/S.	COSMOS	S.G./A.C.	1200	800,000	132	1	68	290	121	0·006	208	165,000
AC/G.	"	T/A.C.	35	17,500	26	3·8	18	66	—	—	—	—
SP/610G.	"	T.	19	11,000	18	4·8	14	48	—	—	—	—
220 S.G.	COSSOR	S.G.	200	200,000	45	1·12	61	112	73	0·023	75	—
41.M.SG.	"	S.G./A.C.	400	200,000	89	1·12	61	224	146	—	—	—
41.M.HF.	"	T/A.C.	25	14,000	21	4·2	16	52	—	—	—	—
610 H.F.	"	T.	20	20,000	14	3·54	19	35	—	—	—	—
H.F. 610	EDISWAN	T.	25	21,000	17	3·45	20	43	—	—	—	—
S.215	MARCONI AND OSRAM	S.G.	170	200,000	38	1·12	61	95	62	0·014	81	184,000
S.625	"	S.G.	110	170,000	27	1·2	57	66	46	0·022	55	—
DEH.610	"	T.	40	60,000	16	2	34	40	—	—	—	—
HL.610	"	T.	30	30,000	17	2·9	24	43	—	—	—	—
DE5.B.	"	T.	20	30,000	12	2·9	24	29	—	(10)	3·4	—
S.G.215	MAZDA	S.G.	300	270,000	58	1	68	144	84	0·005	153	280,000
PM.16	MULLARD	S.G.	200	200,000	45	1·12	61	112	73	0·015*	88	160,000
PM.S4.V.	"	S.G./A.C.	1000	1,330,000	87	1	68	158	61	0·015*	98	—
PM.354.V.	"	T/A.C.	35	14,000	30	4·2	16	73	—	—	—	—
PM1.H.F.	"	T.	18	22,500	12	3·3	21	30	—	—	—	—
PM5.X.	"	T.	17·5	14,700	14	4·1	17	36	—	—	—	—
PM.26	"	P.	50	25,000	32	3·2	21	80	—	—	—	—
SS.215.SG.	SIX-SIXTY	S.G.	190	220,000	41	1·07	64	102	64	—	—	—

* *Subject to confirmation by the valve manufacturers.*

The Modern H.F. Valve.—

the valve's performance factor as given in Column 6, the stage amplification can be obtained for various coils.

Column 7.—The optimum transformer ratio is $\sqrt{\frac{R}{R_0}}$. Taking R, as before, to be 250,000 ohms for 68 turns of 27/42 Litz on a 3in. Paxolin former, it is clear that when R_0 is less than 250,000 ohms the expression $\sqrt{\frac{R}{R_0}}$ is greater than one and the transformer must have a step-up ratio. There are three screened valves where R_0 (Column 5) is greater than 250,000, and theoretically a step-down ratio is indicated. Were we to wind a primary of more than 68 turns, the selectivity would be extremely bad, and, owing to the fact that the screen-to-anode valve capacity of, say, 10 $\mu\mu$F. is shunted across this winding, there might be trouble due to resonance and curtailment of wave range. With the three valves concerned, therefore, a one-to-one transformer has been specified as being a compromise between tolerable selectivity and signal strength.

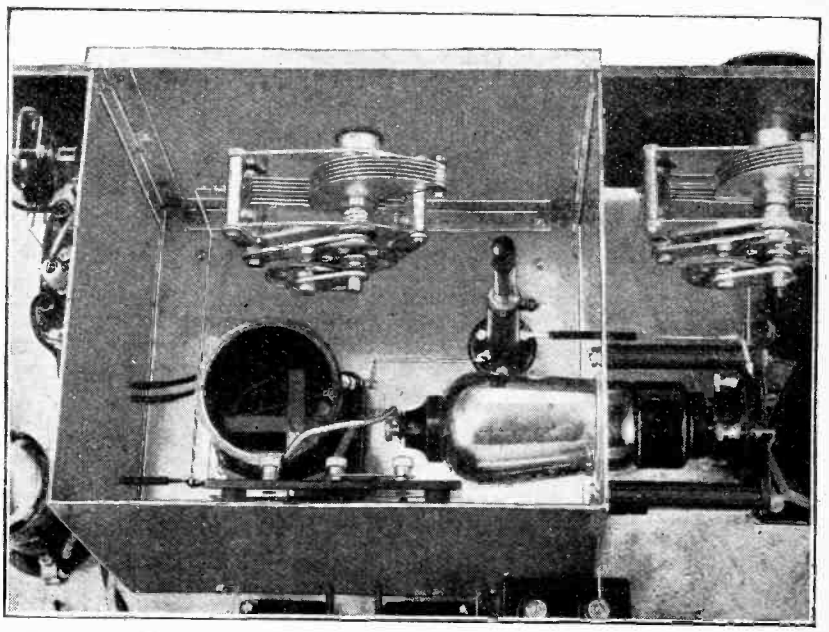
Column 8.—The number of primary turns given assumes a 68-turn secondary. To realise a coefficient of coupling of about unity the primary must be wound very close to the secondary and turn for turn with that winding. Fine wire should be used and the winding started over the low potential end of the secondary.

Column 9.—Only in one case can a modern screened valve theoretically be used with a coil where R = 250,000 ohms with stability without neutralisation. The stage amplification in this column is therefore for valves when neutralised. The figures are obtained from the expression $\frac{1}{2}\mu \times N$ where $N = \sqrt{\frac{R}{R_0}}$, except for the three screened valves already discussed, in which case the expression (*b*) in the appendix applies.

Column 10.—As explained before, these figures for a non-optimum step-up of three-to-one obtained from (*d*) in the appendix for screened valves, do not show a reduction of amplification to one-third. Compare Columns 9 and 10.

Column 12.—Calculated from expression (*c*) in the appendix. It has been considered fair to take the amplification at 200 metres, since absolute stability will exist up to 600 metres. If we made the threshold instability at 300 metres the receiver would be unstable at 200 metres, but the amplification over the stable range of 300 metres upwards would be considerably greater. The magnitude of the figures in this column depend a great deal upon the valve capacity as given in Column 11.

All the stage amplifications quoted are for the high-frequency amplifier *per se*, but no account has been taken of the anti-phase feed-back due to an anode bend detector valve. It may, no doubt, be of interest to give a numerical example. If the anode detector is followed by L.F. transformer coupling with, say, 0.0003 mfd. across the primary, the load thrown back on to the H.F. transformer is equivalent to about 10 ohms,[1] which must be added in series with the high-frequency resistance already existing in the tuned secondary circuit. In assuming that a typical "Everyman Four" type of transformer secondary has a dynamic resistance of 250,000 ohms, we have taken the high-frequency resistance at 300 metres as 10 ohms, for



By means of interchangeable coils and a change-over lever a neutralised triode may be substituted for the screen-grid valve. Stage gain and selectivity can be readily adjusted to suit requirements. (From the "Schools' Demonstrative Receiver.")

$R = \frac{L}{Cr} = \frac{250\mu H}{0.0001\ mfd.} \times 10\ ohms = 250{,}000\ ohms$. What is the effect on stage amplification of an increase from 10 to 20 ohms? Taking the case of a neutralised H.L.610 valve, the optimum transformer ratio will be reduced from approximately three-to-one to two-to-one, and the stage amplification from about 43 to 31. When the anode bend detector is followed by resistance coupling the effective load thrown back is considerably less.

Column 13.—Here the lowest loss coil is shown which will just make the unneutralised valve on the verge of oscillation at 200 metres. The figures are worked out from (*a*) in the appendix when H = 2 at 200 metres. It would seem that Litz coils (except in one case) are hardly necessary when a screened valve is not neutralised and when a tuned anode or one-to-one transformer is used.

In Conclusion.

Summarising, we can say that the new range of S.G. valves for A.C. mains, giving stage amplifications of 100 to 300, are unprecedented in their performance. The

[1] "Improving Detector Efficiency." *The Wireless World*, May 22nd, 1929, p. 524.

The Modern H.F. Valve.—

indirectly heated triodes come very close to the battery-heated S.G. valves when the latter are used with suitable step-up transformers to give equal selectivity, but the battery-heated triodes still fall in a class wherein the maximum stage amplification is about fifty times, using standard coils and components.

APPENDIX.

The expression which gives the value of the maximum dynamic resistance (lowest loss) of coils which can be used before instability, due to anode-grid capacity, sets in for any valve is as follows (a one-to-one transformer—or tuned anode—is assumed, together with perfect external screening) :—

$$H = \frac{C_0 \omega g}{\frac{1}{R}\left(\frac{1}{R} + \frac{1}{R_0}\right)} = 2 \quad .. \quad .. \quad .. \quad (a)$$

Having obtained the value of R which makes the expression H=2 at 200 metres, the stage amplification A is obtained by the usual formula for resistance-coupling :—

$$A = \mu \frac{R}{R + R_0} \quad .. \quad .. \quad .. \quad .. \quad (b)$$

If it is required to arrive at the maximum stage amplification A in one expression without the intermediate step of finding R, the following formula is used :—

$$A = \frac{-1 \pm \sqrt{1 + 2 \mu R_0 \omega C_0}}{\omega C_0 R_0} \quad .. \quad .. \quad (c)$$

In order to obtain really sharp interstage tuning with screened valves, H.F. transformers with step-up ratios of 2, 3 or 4 to 1 can be used instead of the value of approximately one-to-one (see Column 7), which gives optimum stage gain. To find the decreased stage gain resulting from any non-optimum step-up ratio the following expression is used :—

$$A = \frac{N \mu R}{R + N^2 R_0} \quad .. \quad .. \quad .. \quad .. \quad (d)$$

In all the above formulæ it is assumed that we are dealing with the medium broadcast band (200-600 metres), and that the dynamic resistance of a coil is substantially constant over this range. Furthermore, if expressions (*a*) and (*c*) are solved for threshold instability at 200 metres ($\omega = 10^6 \times 2\pi \times 1.5$) the receiver will be increasingly stable up to 600 metres.

A = stage amplification.
C_0 = anode-grid capacity in farads.
g = mutual conductance in amps/volts.
μ = amplification factor of valve.
R_0 = A.C. resistance of valve (ohms).
R = dynamic resistance in ohms.
$\omega = 2\pi \times$ frequency.
N = step-up turns ratio of H.F. transformer.

[*Erratum.*—In Part I the reference to "column 13" on page 71 should read "column 12."]

KIT CONSTRUCTORS' PROBLEMS.

Advice on the Practical Operation of Some Popular Sets.

The Information Department Service has been extended to deal with problems encountered by builders of "kit" sets discussed in these pages. Receivers already treated are the "New Cossor Melody Maker," Osram "Music Magnet," Mullard "Master Three Star," Six-Sixty "Mystery Receiver," Ferranti "Screened Grid Three," Formo "Screened Grid Three," Dubilier "Toreador Screened Grid Four," McMichael "Screened Three," and the Mullard "S.G.P. Master Three." The service is subject to the rules printed in the "Readers' Problems" section.

Semi-ganged Control.

In your published description of the "Dubilier Toreador Screen Grid Four" you make mention of the fact that the three condenser control drums are mounted side by side and that two of these controls may be actuated together over a certain band of wavelengths. The operation of the third condenser is not discussed; should it be worked simultaneously with the others? A. A. C.

Two of the variable condensers in this set are for tuning purposes, while the third is for reaction. This latter control is more or less independent of the setting of the tuning dials, and purely from the operating point of view there is no advantage in its dial being mounted adjacent to the others.

When searching for distant transmissions it is advisable to operate the two tuning controls proper with one hand (indeed, over a limited wave-band with one finger), while the reaction control is actuated by the other hand.

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Pentode and Loud Speaker.

I am taking my "Osram Music Magnet" to the west coast of Ireland, and in order to obtain the extra sensitivity which it seems will be necessary propose to replace the present triode output valve by a pentode. Do you think that my cone loud speaker will give good results with this valve, or would it be necessary to obtain a special output transformer? R. H. R.

In all probability your present loud speaker will work well with the new valve, particularly if its windings are of fairly high impedance, but, if you are not satisfied with the quality of reproduction, you should try the effect of shunting a comparatively large fixed condenser across the loud speaker terminals. We suggest a value of about 0.002 mfd.

Changing the Detector Valve.

I am building the "Home Constructor's Screened Dimic Three," and as I do not intend to use the set for gramophone reproduction should be glad to know if any increase in range could be obtained by using a detector valve of higher amplification factor than that specified. A. T. S.

Yes, this deviation from the specification is permissible, but in order to attain any sensible increase in range, combined with good quality reproduction, you will be well advised to use an L.F. coupling transformer with a high primary inductance.

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A Safety Precaution.

I have obtained some H.T. fuses and intend to add them to my Mullard "S.G.P." with the idea of protecting both valves and battery in the event of a short-circuit. Will you please tell me where the fuses should be connected? E. P.

A single fuse joined between the H.T. negative terminal and the battery itself should be sufficient for all practical purposes, but, to be absolutely safe, it would be better to connect separate fuses in each of the three positive feed leads.

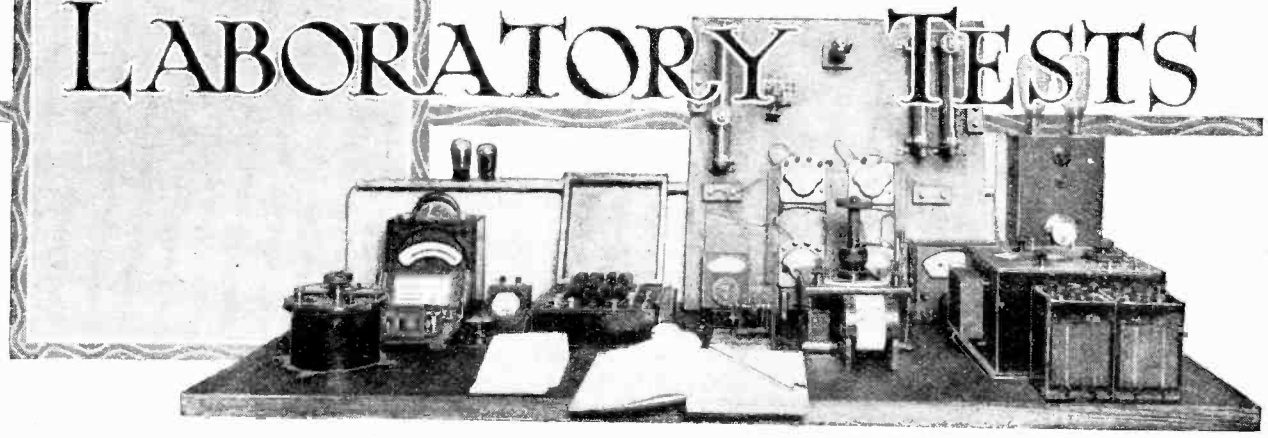
o o o o

Incorrect Inductance.

My "Dimic Three" is giving good results on the long waves, but on the medium broadcast band its performance is anything but satisfactory; in fact, the left-hand tuning condenser has little effect and must be set at zero for the reception of 5GB and 2LO—the only two stations I have been able to receive. Does this symptom convey any indication to you as to what is wrong? M. R. S.

It seems almost certain that you are using the wrong type of coil in the aerial-grid circuit, and we are inclined to think that you have probably inserted in this holder a coil of the same inductance as that used in the detector grid circuit. If you consider Fig. 1 of our descriptive article, which appeared in the issue of June 19th, 1929, you will see that the variable condenser is shunted across the whole of the aerial-grid coil L, while the tuning capacity is in parallel with one half only of the corresponding detector-grid inductance L_{2a} and L_{2b}. Consequently, a smaller winding is required for the first position.

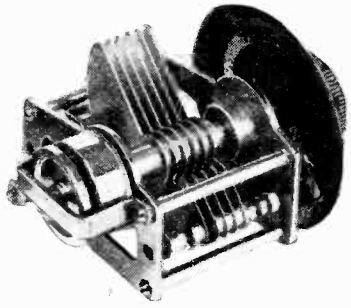
WIRELESS WORLD LABORATORY TESTS



A Review of Manufacturers' Recent Products.

DUBILIER VARIABLE CONDENSER.

A new product of this company is a 0.0001 mfd. variable condenser designed to meet the special requirements of short-wave reception. Wide spacing between the vanes is adopted, but the feature of particular interest is the provision of a small glass ball, in place of the steel ball usually fitted, in the slow-motion drive.



Dubilier special short-wave receiving condenser.

This, it is claimed, eliminates those noises to which a metal-to-metal drive so often gives rise. Single-hole fixing is adopted, and the reduction ratio is approximately 200 : 1.

The measured maximum capacity was found to be 0.000099 mfd., and the minimum capacity 5 micro-mfds. only. The price is 12s. 6d.

The "K.C." drum control triple condenser assembly consists of three "K.C." type condensers—without special slow-motion device other than that obtained by virtue of the large drum controls—mounted on a substantial aluminium frame. The three drum controls are sufficiently close together to enable simultaneous, or independent, control of the three condensers. This is achieved by passing the operating spindle of the extreme outside condenser through the hollow shaft of that adjacent to it. The drum operating this condenser is therefore the centre one of the three.

Normally each condenser has the same capacity, either 0.0005 mfd. or 0.0003 mfd., but for a small extra charge combinations of these capacities can be supplied. The sample tested comprised three 0.0005 mfd. condensers, and measurements made showed that they were for all practical purposes satisfactorily matched. The measured minimum capacity of each was 25 micro-mfds. (this rather high figure is due to the mass of metal comprising the frame and adjacent condensers), while the maximum capacities were found to be 0.000475 mfd., 0.000478 mfd., and 0.000487 mfd. The price is 38s. 6d. in either 0.0005 mfd. or 0.0003 mfd. capacities.

The makers are the Dubilier Condenser Co. (1925), Ltd., Ducon Works, Victoria Road, North Acton, London, W.3.

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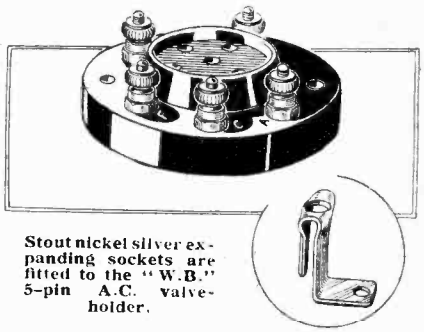
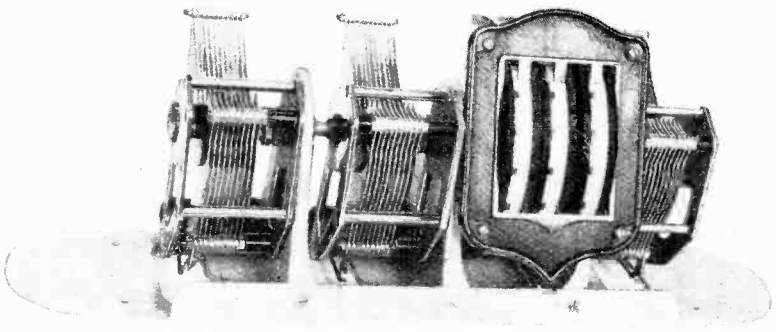
"W.B." 5-PIN A.C. VALVE-HOLDER.

Shortly a new range of indirectly heated A.C. valves will be appearing on the market having a modified arrangement of the pin connections in the base. Four pins are spaced in the orthodox way, whilst the fifth is central. This demands a special base fitting, which is met by the "W.B." 5-pin A.C. valve-holder now on the market. It consists of a moulded bakelite shell with five sockets arranged to take both the new and the present type valves; a similar number of terminals is fitted and appropriately marked. The holder is of the rigid type, not anti-microphonic. Nickel silver expanding leg sockets are fitted. The makers are Messrs. Whiteley, Boneham & Co., Ltd., Nottingham Road, Mansfield, Notts, and the price is 1s. 6d.



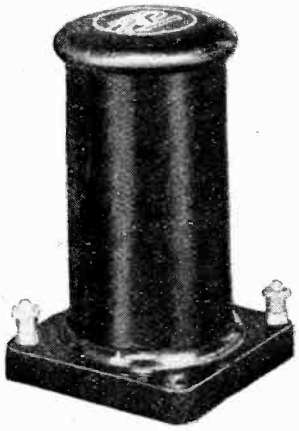
Stout nickel silver expanding sockets are fitted to the "W.B." 5-pin A.C. valve-holder.



"K.C." drum control triple condenser—a Dubilier product.

R.I. DUAL ASTATIC CHOKE.

The parallel-feed method of coupling screen-grid valves, in which an H.F. choke is used in conjunction with a coupling condenser to pass on H.F. currents to the tuned grid circuit of the succeeding valve, has had the effect of



The R.I. "Dual Astatic" choke; D.C. resistance 660 ohms.

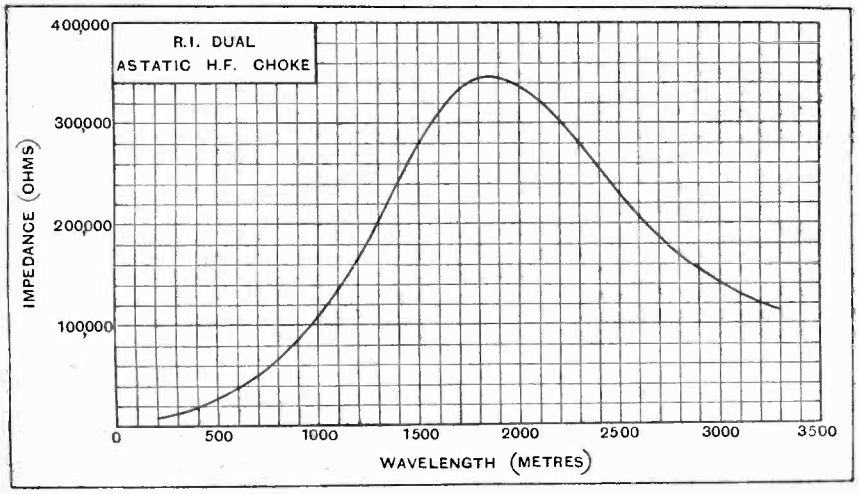
bringing to light serious defects in certain types of H.F. chokes which give satisfactory results in other circuits. The trouble is due to subsidiary resonances, particularly in the region of 200-500 metres, which causes absorption and, consequently, inequalities in the amplification curve of the H.F. stage.

Messrs. R.I., Ltd., have given this problem their special attention, and have succeeded in producing a choke which does not suffer from these defects. The impedance curve shows that it is entirely free from subsidiary resonances and can therefore be used in screen-grid valve couplings without producing absorption or "blind spots." Under the conditions of the test with an associated capacity of 8 micro-mfd. the maximum impedance is obtained at 1,800 metres, which indicates that the choke can be used for all broadcast wavelengths in common use without the slightest possibility of self-oscillation. Impedance values at a few important wavelengths are as follows:—

Wavelength (metres).	Impedance (ohms).
200	8,020
500	41,500
1,500	280,000

The windings are air-spaced and wound astatically, so that the external magnetic field associated with the choke is reduced to negligible proportions and the possibility of coupling with other coils in the circuit is minimised. The standard choke is 3½in. in height and is mounted in a base 2in. square. A modified design suitable for portable sets is also available.

Naturally, the qualities which make for success in the screen-grid circuit are also advantageous in other circuits, such as the detector with capacity controlled reaction, and the choke can be recommended for universal application. The price is 7s. 6d.



Impedance curve of the R.I. "Dual Astatic" choke; external capacity 8 micro-mfd.

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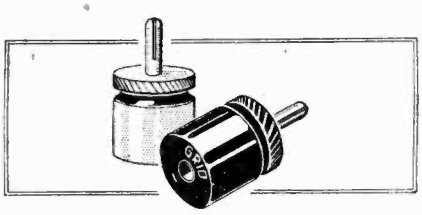
BELLING-LEE WANDER PLUGS.

The main feature of this wander plug is that provision is made for gripping the silk covering as well as the wire when ordinary lighting "flex" is used. The result is a neat and tidy termination to the H.T. and grid bias leads. To attach the wander plug unscrew the cap, thread the flex through, and pass the bared wire through the small hole in the loose washer. When the head is replaced, the wire and covering will be firmly gripped and no frayed ends visible.

An improvement of no less importance is the nature of the prongs. These are not turned and split, but are made from "D"-section hard-drawn brass wire, and it is claimed that this method of construction imparts to the prongs greater resiliency, since the springiness of metals is largely due to the hard crust which is generally removed in the tuning process.

The plugs are small and particularly suitable for use in portable sets where the clearance above the top of the battery is not too great. Indicating lettering is engraved on the caps, and fifteen variations are available.



Belling-Lee indicating wander plugs.

The makers are Messrs. Belling and Lee, Ltd., Queensway Works, Ponders End, Middlesex, and the price is 4½d. each.

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"SINQUERS."

The introduction of small floats into accumulator cells provides a visual indication of the state of the battery, but hitherto these have not been available to the public. Messrs. Fiddian, Bawtree and Co., Gem Works, Oakhill Road, Sutton, Surrey, have recently placed on the market a special compound from which small balls to act as charge indicators can be made quite easily. The compound is supplied in the form of discs 1½in. in diameter and ¼in. thick. These are supplied in red and blue colours, and when placed in warm water become sufficiently soft to work into balls.

A small pellet of each colour, dropped into a fully charged accumulator, will float on the surface of the acid, but if the cell is half discharged the red ball only will float, while the blue will sink. Should both balls sink, the battery requires charging forthwith.

Tests made with this compound showed that the makers' claim is fully substantiated by hydrometer readings of the acid strength at various positions of the pellets. The blue ball commenced to sink when the S.G. of the acid dropped to 1,215 (corresponding to half charge with a cell filled with normal strength acid). The red commenced to go down when the S.G. of the electrolyte was down to 1,175.

It will be necessary to raise the acid level in some types of cell so as to leave at least half an inch above the top of the plates for the "Sinquers" to perform in.

The compound is supplied in small cartons, each containing a red and a blue disc, at the price of 1s., or by post 1s. 3d.

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CORRECTING NOTE.

When referring to the products of the Concordia Electric Wire Co., Ltd., in the issue of July 17th, the address was given in error as nr. Birmingham. It should have been New Sawley, nr. Nottingham.

News from All Quarters: By Our Special Correspondent.

A Hard-worked Announcer.—Trials of Programme Preparation.—Describing a Car Race.

A Visitor from Denmark.

A stir was created among the announcing staff at Savoy Hill last week by the arrival of Mr. Carl F. Schionning, nor did the commotion subside when Mr. Schionning passed a few remarks on what he saw. Mr. Schionning, who is the chief announcer in the Danish broadcasting service, expressed amazement at the general efficiency of British broadcsting, but he stated in no uncertain terms that he envied the British announcer.

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The Day's Work.

From Mr. Schionning's account of his own duties, it would seem that when he tumbles into his bed in the small hours he has every right to "call it a day." Every day, Sundays included, he begins work at 9 a.m. and, on alternate days, continues his announcing duties until midnight. He can call every second day his own after 5 p.m.

In addition to announcing, he conducts rehearsals and auditions, engages artists, assesses their respective programme value and pays them accordingly.

All this work is carried out at the headquarters at Copenhagen, whence all Danish programmes are broadcast or relayed to Kalundborg and other relay stations.

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A Comparison.

Beside this prodigious output of individual effort, the job of the B.B.C. announcer is undoubtedly a "walk-over," but there must be very few listeners who would claim that the payment of their annual licence fee entitled the public to extract so much daily toil from one person.

A B.B.C. announcer averages eight hours daily, and even if he is not fully occupied all that time, it is worth remembering that the work is irregular and calls for a good deal of private inconvenience to keep up the flow of programmes at hours which in most businesses would be regarded as "unreasonable."

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Plans That Go Awry

By the way, the Programme Department, probably suffering from the effects of the heat wave, has had an attack of statistical fever. An average has been struck over the past two or three months showing that every week approximately 111 alterations are made in the programme list as it is originally conceived.

This means, in effect, that 16 "best-laid schemes . . . gang agley" every day, and may serve to explain why members of the Programme Department nearly always wear a hunted look just before the programmes go to press.

FUTURE FEATURES.

London and 5XX.

AUGUST 4TH.—Boy Scouts' Association World Jamboree, Thanksgiving Service from Arrowe Park, Birkenhead. Addresses by Archbishop of Canterbury and Sir Robert Baden-Powell.
AUGUST 7TH.—Sing-Song relayed from Duke of York's Camp, New Romney.
AUGUST 8TH.—"The Fountain of Youth," comic opera by Alfred Reynolds.
AUGUST 10TH.—Opening Night of Promenade Season, Queen's Hall.

Daventry 5GB.

AUGUST 6TH.—"Wurzel-Flummery," a comedy by A. A. Milne.
AUGUST 7TH.—Military Band Concert from Leamington Spa.

Cardiff.

AUGUST 7TH.—Two plays relayed from Citizen House, Bath.

Manchester.

AUGUST 5TH.—Running Commentary on Yorkshire *v.* Lancashire County Cricket Match, by Mr. F. R. Stainton.
AUGUST 8TH.—Eisteddfod Concert from Liverpool.

Newcastle.

AUGUST 8TH.—Band from North-East Coast Exhibition.

Glasgow.

AUGUST 6TH.—Scottish Orchestral Concert.

Aberdeen.

AUGUST 7TH.—"Wi' the Jocks in France," by Arthur Black.
AUGUST 9TH.—Song and Story of the Gael.

Belfast.

AUGUST 6TH.—Irish Variety Programme.

Seeking Fresh Talent.

A more harassing job, though than that of "Programmes" belongs to the Booking Department, whose members go out at the behest of the Programmes Department to tap fresh sources of talent. This calls for resource, discrimination and moral courage, particularly the last, as there are certain sources of talent which have to be dammed, not tapped.

By Air to the Microphone.

Mr. S. C. H. Davis, of *The Autocar*, will broadcast from a Glasgow studio an eye-witness account of the International Motor Road Race for the R.A.C. Tourist Trophy, which will be run in Ulster on August 17th. The description will be sent out from all stations except 5GB at 10 o'clock on the evening of the 17th.

Mr. Davis is competing in the race, and in order that he may reach Glasgow station in time to broadcast on the same day, the B.B.C. has arranged with the Scottish Flying Club for an aeroplane to fly him from Belfast to Renfrew aerodrome, whence a car will convey him to Glasgow. Mr. Davis, who will leave Belfast immediately after the race, will prepare his broadcast while flying across the Irish Sea.

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A Cricket Commentary.

County cricket does not usually lend itself to the broadcast commentary, but an exception is to be made in the case of the Yorkshire and Lancashire match on August 5, when a running commentary by Mr. F. R. Stainton will be relayed from the Bradford cricket ground to all stations in the Northern region.

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A Shakespeare Night.

A broadcast version of Shakespeare's "King Henry VIII," in seventeen scenes, will be heard from 2LO and 5XX on August 14. The play, which will occupy two hours, has been adapted by Dulcima Glasby and will be produced by Howard Rose, who forsook the legitimate stage some three years ago to join broadcasting, and whose productions for Savoy Hill now run into several hundreds.

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National Programme from the North.

A musical feature of outstanding importance is being contributed by the North Region to the national programme on August 7th, when listeners to London and Daventry, as well as to Northern stations, will hear a Symphony Concert, conducted by Sir Hamilton Harty, from the Main Studio at Manchester. The programme includes a concerto for violin and orchestra, written by Sir Hamilton himself. The solo part will be played by Alfred Barker, with the Northern Wireless Orchestra accompanying.

The Editor does not hold himself responsible for the opinions of his correspondents.

Correspondence should be addressed to The Editor, "The Wireless World," Dorset House, Tudor Street, E.C.4, and must be accompanied by the writer's name and address.

AMATEUR STATUS.

Sir,—As a regular reader of your valuable paper may I be allowed to say a few words on the question of status? It is assumed by the majority of your correspondents that the amateur generally is in no way to blame for the present state of affairs, which, in my opinion, has been brought about largely by at least 50 per cent. of the present-day amateurs not truly realising what they are granted their licences for.

The so-called experiments relating to this 50 per cent. consists of, mainly, "brass pounding," with no real object in view, collecting childish "QSL cards," generally making uncontrollable nasty noises, or attempting to send wheezy gramophone records. I therefore support the authorities in their administration which will probably not be relaxed until the amateurs as a whole do something useful. I am not, of course, referring to pioneers, but more to the younger members of the fraternity. It is pleasing to see, however, that certain responsible men are at last getting together for serious work. *This only will help to raise the amateur status.* "AN OBSERVER."

London, N.17.

Sir,—Having held the position of Hon. Secretary to the Incorporated Radio Society of Great Britain during the negotiations with the Post Office authorities regarding the application of the Washington Report, I feel that I should be permitted to reply to your correspondents who have communicated with you upon this matter.

The existing conditions for amateur transmitters were agreed after prolonged exchange of views between a special committee appointed by the R.S.G.B. and the Post Office, and finally resulted in practically every point of the Washington Report being conceded, the only point not allowed being an application for reduction of the tolerances or safety limits upon the various bands. The negotiations resulted in the free transmission of "unimportant private messages" and the use of the 21- and 4-metre bands by all transmitters, the use of the very short waves having only previously been enjoyed by a few. In effect the R.S.G.B. were quite satisfied with the result of the discussions.

It must be remembered that the law regarding amateur transmissions is very different in this country to elsewhere. Here the provisions of the Telegraph Act are in force to preserve the Crown monopoly of the sending of all messages from one party to another. The facilities granted to amateurs can therefore be regarded as concessions for experimental work under the Act. The sending of free traffic messages, as in the U.S.A. and as suggested by one of your correspondents, would be an impossible grant even for the Postmaster-General without the Act being repealed. Consequently the complaint of the correspondent should be directed rather against the Government than the Postmaster-General, who is in reality only administering the powers vested in him to guard.

Nobody would envy the Postmaster-General in his work concerning the issue of licences. He has to use every precaution within his power to preserve his rights and to grant concessions only to those whom he has good grounds to believe will not abuse them. In this respect obviously such organisations as the A.B.R.S. and the R.S.G.B. must be of great assistance to him upon account of the assurance they can give, being in close touch with their members.

Applications to the R.S.G.B. for recommendations for special facilities have always been considered by a special committee, and in very few cases have they been rejected. In most instances the applicant failed to supply evidence warranting the use of the special powers sought, while in others the Society felt that endorsement would jeopardise the trust imposed in them.

In conclusion, I can only state that all negotiations with the Post Office authorities which passed through my hands were conducted in the most friendly spirit and with the utmost courtesy. H. BEVAN SWIFT,

Act. Vice-president, Inc. Rad. Soc. of Great Britain.

Sir,—We wish to show our appreciation of the stand you are taking for amateur radio.

We cannot help thinking how much better it would be on both sides if the amateur radio movement was given recognition by the Government, and an emergency network of stations built up, ready to deal with traffic when required.

Controlling regulations would, of course, be drawn up, and if the Government was afraid that transmitters were avoiding paying for telegrams in this way, traffic forms could be issued or sold, a check being made in this way of the traffic dealt with. This system is, we believe, carried out with success by the A.R.R.L. in America.

Another point is that the standard of amateur transmissions in Britain is as high, if not higher, than in any other part of the world, and for reliability cannot be beaten. When one hears so-called mobile or emergency stations sending out A.C. signals on any frequency they wish to use one wonders what the amateur has done to warrant the treatment that he is given in this country.

Trusting that you will continue to give the matter prominence, as you successfully did Empire broadcasting,

CYRIL S. HUNT, G6NT.
R. A. MINTER, G5RM.

JUNK.

Sir,—Mr. Kendall's suggestion is excellent.

I am sure that there are any number who would be only too glad to give their discarded apparatus for the furtherance of hospital work.

Any quantity may be addressed to King's College Hospital, London, S.E.5. C. E. A. BEDWELL,

House Governor.

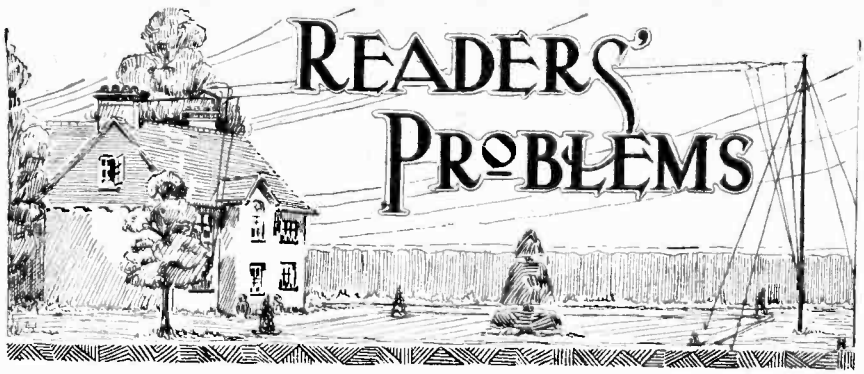
A NUT CONVENTION.

Sir,—Might I take the liberty of suggesting that your esteemed journal would earn the gratitude of all set builders if you would arrange with the component manufacturers to use standard sizes of hexagon nuts for terminals, instead of the multitude of various forms and sizes of milled edge round terminals and nuts.

From a manufacturing point of view this matter contains no difficulties; nuts can be cut off from ordinary hexagon rolled brass stock cheaper than they can be shaped up from round stock.

If we had standard nuts we set makers could then obtain special tools that would enable us to tighten up our out-of-the-way connections without any loss of time or temper.

Alexandria, Egypt. "MAHANDIS."



"The Wireless World" Supplies a Free Service of Technical Information.

The Service is subject to the rules of the Department, which are printed below; these must be strictly enforced, in the interest of readers themselves. A selection of queries of general interest is dealt with below, in some cases at greater length than would be possible in a letter.

Too Much Magnification.

I am sending you a circuit diagram of my proposed A.C. mains receiver, and should be obliged if you would let me have your comments on the general suitability of the arrangement. In several articles in "The Wireless World" stress has been laid on the fact that it is often unwise to strive after maximum amplification from the L.F. side of the average set; with a view to avoiding risk of L.F. oscillation, I have decided to use choke coupling between the detector and first L.F. amplifier, as this will give less magnification than a transformer. It is with regard to this part of the circuit that I should especially appreciate any criticism. B. S. R.

The diagram of a four-valve mains set submitted by our correspondent shows a single transformer-coupled H.F. stage (S.G. valve) followed by an anode bend detector and two L.F. stages, choke and transformer coupled (in that order). Cosmos A.C. valves are to be used throughout, and the diagram indicates that both screening and decoupling are to be unusually complete.

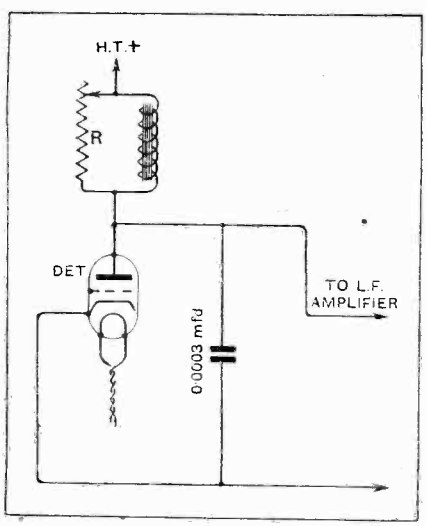


Fig. 1.—Resistance volume control for L.F. choke coupling.

While choke coupling will give less magnification than a transformer, it should be pointed out that the overall magnification of the L.F. side of the receiver with the modern valves specified will be very large; in spite of this, stability may be achieved, thanks to the elaborate precautions taken, but there is some possibility of another trouble against the occurrence of which no measures seem to be proposed. This is associated with the anode bend detector; a rectifier working in this way, as is well known, requires a large input for its satisfactory operation, and consequently it can hardly be followed by a high magnification L.F. amplifier in which the voltage-handling capabilities of the output stage are more or less limited. As frequently pointed out, in these circumstances it is essential to provide some means whereby surplus amplification of signals of great or medium strength may be thrown away—when listening to really distant transmissions, "quality" considerations generally fall into the background—and we suggest that you should fit a variable resistance of some 200,000 ohms' maximum value across the choke. This form of control, which is nowadays generally recommended for L.F. transformer coupling, is quite satisfactory in this particular case. The method of connection is shown in Fig. 1.

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Compromise in Design.

Although my "S.G. Regional" provides amply loud signals from Daventry 5XX, I find that volume from several of the other long-wave stations is hardly adequate. Is there any simple way of increasing its sensitivity on this band? I should make it clear that only a small increase in magnification is necessary. F. S. W.

It should be possible to make an appreciable increase in H.F. magnification on the long wave side—but, of course, at the expense of some selectivity—by increasing the number of primary turns on the long-wave transformer. Instead of winding this section in three slots only, we suggest that you should deepen the fourth slot (counting from the low-potential end), and in the lower part of this deepened slot will be wound another primary section identical with the others. A small loss in selectivity should not trouble you in your (wirelessly) remote situation, and in any case interference between long-wave stations is not so severe as at the time when the set was designed.

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Faulty Insulation?

My "Kilo-Mag Four" receiver, after working satisfactorily for some time, seems to have developed a fault. The set has been modified by the insertion of a low-reading milliammeter in series with the detector anode circuit in the manner suggested in recent articles; normally, the meter indicates a reading of about 0.25 milliamps when bias is set for best rectification. Now, with the same bias, current is increased to about 2 milliamps (not constant), and the signals from distant stations are almost unreceivable.

The great increase in detector anode current is observed whether or no signals are coming in, and the usual tests fail to reveal any fault; batteries are in order, and the valve itself functions properly in a similar set. Can you suggest what is wrong? P. S. C.

This is a puzzling fault, but we are fairly certain that there is a simple explanation. You have probably omitted to test the insulation resistance between the windings of your second H.F. transformer; we think it likely that you will find that this has become defective, and that there is a considerable leakage to earth from the source of H.T. supply. Current flowing through this leakage path will give rise to a difference of potential across the ends of the decoupling resistance in the grid circuit, and consequently a positive voltage in opposition to that impressed by the grid battery will be applied to the detector grid, giving rise to the effect you describe.

RULES.

(1.) *Only one question (which must deal with a single specific point) can be answered. Letters must be concisely worded and headed "Information Department."*

(2.) *Queries must be written on one side of the paper, and diagrams drawn on a separate sheet. A self-addressed stamped envelope must be enclosed for postal reply.*

(3.) *Designs or circuit diagrams for complete receivers cannot be given; under present-day conditions justice cannot be done to questions of this kind in the course of a letter.*

(4.) *Practical wiring plans cannot be supplied or considered.*

(5.) *Designs for components such as L.F. chokes, power transformers, etc., cannot be supplied.*

(6.) *Queries arising from the construction or operation of receivers must be confined to constructional sets described in "The Wireless World" or to standard manufacturers' receivers.*

Readers desiring information on matters beyond the scope of the Information Department are invited to submit suggestions regarding subjects to be treated in future articles or paragraphs.

Heat-resisting Former.

I am about to make a wire-wound voltage-reducing resistance for accumulator charging purposes, and, in the interests of economy, propose to use a gauge of wire that, according to data issued by its manufacturers, will become quite hot. Will you recommend a suitable heat-resisting material for the former on which the coil will be wound? M. S. G.

A number of substances specially made for this purpose are available, and we suggest that you should consult your dealer. If he has nothing suitable, you might use a length of metal tube wrapped over with sheet-asbestos. A former of this sort is quite satisfactory and safe, and the materials for it are readily obtainable

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Valve Characteristics.

A certain valve is rated as having an impedance of 12,000 *ohms at "anode volts* 100, *grid volts* 0." *Does this imply that these voltages represent its best working conditions? I was under the impression that grid bias —either positive or negative—is always necessary in modern circuits.* R. P.

No. Many manufacturers have adopted these conditions as a standard on which to base their "impedance" and "slope" ratings, but nowadays a valve is seldom operated with a zero grid—except in case of special valves, in which grid current starts "late."

Generally speaking, the effect of applying grid bias will be to raise impedance, but it must be remembered that a considerably higher anode voltage than 100 is generally used, with the result that impedance is again brought down to something approximating to the rated figure, which is consequently a useful guide.

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A Super-selective Set.

My four-valve receiver, with two H.F. stages, has never given really satisfactory results, and after careful consideration of its design I am forced to the conclusion that it has several grave shortcomings, and have decided to rebuild it entirely. My main object in writing to you is to ask whether you recommend the use of a separately tuned aerial in a "2 H.F." set; I have recently been trying a two-circuit tuner in a considerably less ambitious receiver, and am greatly attracted by it. Will you please give me a circuit diagram showing the simplest possible method of switching the aerial tuner (if my proposed plan is approved), and also giving the complete connections of the H.F. amplifier? A. C. P.

A separately tuned aerial circuit will better the selectivity of any set, although your 2-stage H.F. amplifier will stand less in need of improvement in this way than an arrangement with a lesser number of tuned circuits. Accordingly your proposed scheme is to be recommended (if you do not object to four tuning controls), and we give in Fig. 2 the circuit diagram you require. We have indicated a simple but quite effective method of arranging the tuned aerial and secondary circuits, in which wave-changing is effected by a three-pole switch, the left-hand blade of which is arranged to short-circuit the long-wave loading coil L_1 when the switch is in the short-wave position.

L_2 and L_3 are, respectively, short-wave and long-wave grid coils, to which the tuned aerial circuit is coupled by the well-known auto-transformer arrangement.

We fear that it would be beyond the scope of the Information Department to go thoroughly into the question of the complete H.F. amplifier; the receiver you propose to build is ambitious, but sufficient information has been published in recent articles to enable you to make a satisfactory choice of values and layout.

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Relative Cost.

Is it more economical to feed a receiver from an eliminator supplied through A.C. or D.C. mains? It seems to me that the latter should provide a much more economical source of supply, as no energy is taken from the mains for heating the filament of a rectifier valve. S. F. J.

If your query relates to the supply of both H.T. and L.T. current, there can be little doubt that with the arrangements customarily used an A.C. supply is much more economical. We believe, however, that you have in mind only the question of anode current feed; in this case, speaking generally, the efficiency of the D.C. supply is slightly higher, but this is a very small matter, as the energy required for heating a rectifying valve filament or that lost in other types of rectifier not requiring heating is extremely small

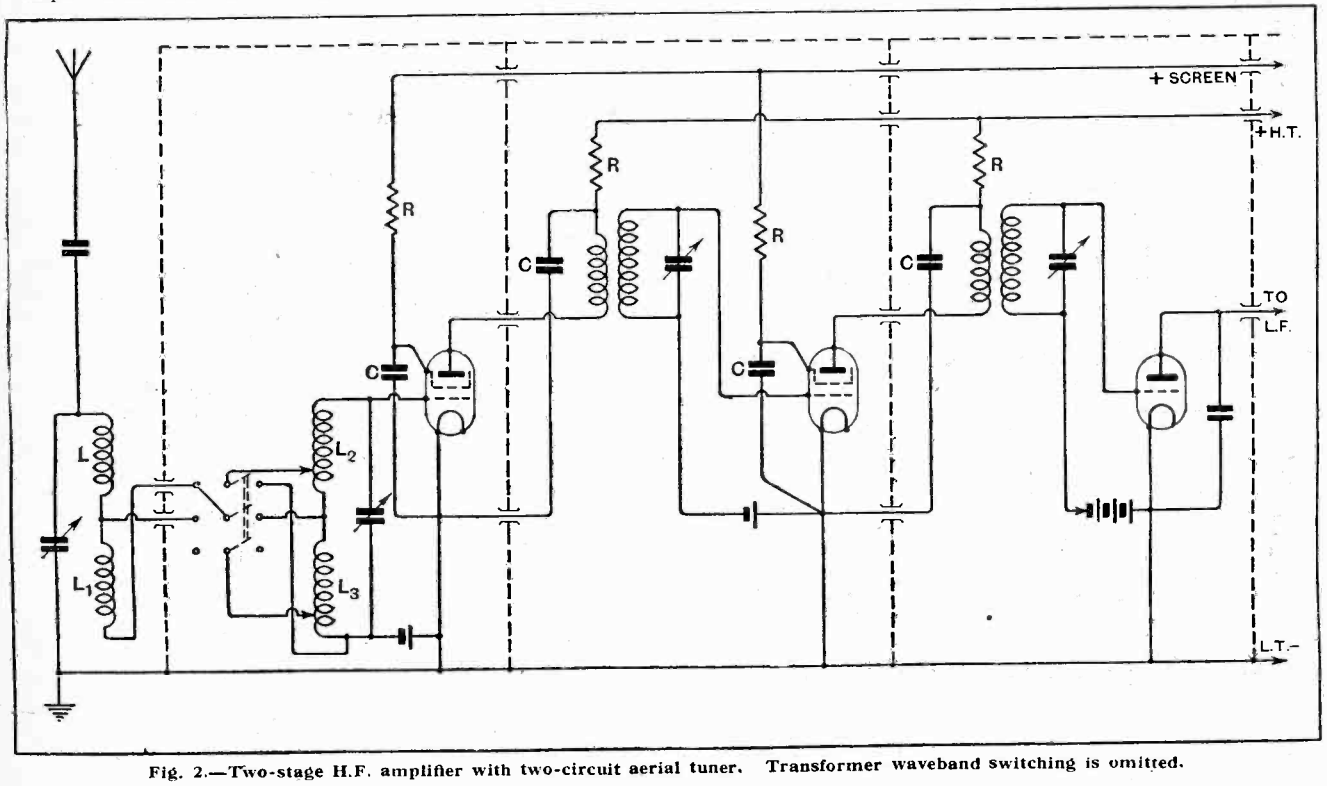

Fig. 2.—Two-stage H.F. amplifier with two-circuit aerial tuner. Transformer waveband switching is omitted.