SIZE *VERSUS* EFFICIENCY OF COILS

The Wireless World AND RADIO REVIEW

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The Paper for Every Wireless Amateur

Wednesday, January 29th, 1930.

No. 544. Vol. XXVI. No. 5.

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The Wireless World AND RADIO REVIEW

(17th Year of Publication)

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CONTENTS OF THIS ISSUE.

THE POST OFFICE AGAIN.

WE are glad to be able to publish in the Correspondence columns in this issue a letter from the Post Office which reassures us on the question of wireless licences in flats, to which we drew attention editorially in our issue of January 15th, under the title of "A Wireless Licence Scandal."

The Post Office reply is quite explicit and exonerates Post Office officials from all responsibility. The wireless correspondent of an important daily paper, whose published statement was so misleading, would not find it easy to excuse himself, for his statement read:—

> "The Post Office contended at the outset that one licence would not be sufficient for a big set like this at Baker Street, but they were convinced in the end that only one ten-shilling licence need be taken out, because there is only one set and one building."

We have no further comment to make on this question now that it has been satisfactorily cleared up, but another matter has arisen where the Post Office is concerned, to which we feel that attention should be drawn. Recently a very splendid piece of work was done by Mr. Cyril E. Baron, who during the recent gales picked up SOS calls from a ship in distress in the Channel, and, finding that the calls were not being answered, communicated the information by telephone to the North Foreland Radio Station, and by this action was the means of saving the ship and the lives of those on board. Following this action, Mr. Baron received a letter of thanks from the Post Office.

We consider that Mr. Baron's action was one deserving of high appreciation, and we are very glad to see that the Postmaster-General took what we consider to be the very proper step of making acknowledgment of the assistance which he rendered. This incident, however, provides the opportunity for drawing attention once more to the broadcast licence regulations printed on the back of the licence form which we have previously criticised in *The Wireless World*. Following upon the decisions of the Washington International Wireless Conference, certain changes were made in the conditions under which broadcast licences are issued, and the wording on the back of the form now states that the licensee may only use his receiver for the reception of

> "broadcast programmes and messages sent for general reception and messages sent from an experimental station in connection with experiments carried out by the licensee,"

and, further, that

> "The licensee shall not use or allow the station to be used for the receipt of messages other than messages intended for receipt thereby or sent for general reception."

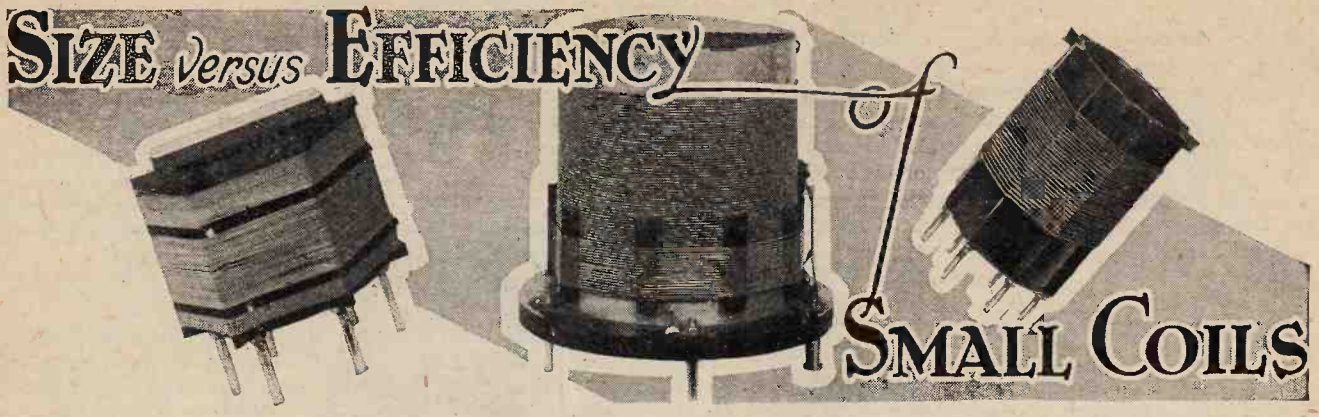
A perusal of the wording of this regulation makes it quite clear that, in his action with regard to Mr. Baron, the Postmaster-General has publicly approved of a breach of the Post Office regulations. Mr. Baron would have been unable to act as he did unless he had been listening to transmissions other than those permitted.

The Mullard Wireless Service Company was, we believe, the first to communicate the story of Mr. Baron's experience to the Press, and a statement in their report is, we think, significant of the general attitude towards what we regard as the unreasonable regulations of the Post Office. The paragraph to which we refer reads:—

> "In addition to the material broadcast officially from the studios, there is a wealth of unofficial messages continually 'on the air.' Many listeners have derived considerable pleasure in picking up messages sent out from Croydon Airport to air planes making the passage between England and the Continent. Moreover, those who are expert at reading the Morse code occasionally amuse themselves by listening to ships at sea."

The Post Office cannot hope to prevent or control what listeners overhear on wireless receivers, however desirable it may be that secrecy should be observed, so that it seems to us only foolish to make regulations which cannot be enforced.

SIZE versus EFFICIENCY of SMALL COILS



The Advantages of Low Stage Gain and Small Coils for Multi-stage Receivers.

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

THE continuous evolution of the valve, and especially of the valves used for high-frequency amplification, is likely to open up divergent lines of receiver design. On the one hand, these new valves offer the possibility of attaining a tremendous amplification in a single stage, and will therefore tempt many designers to replace two moderately efficient stages by a single "hotted up" stage giving superlatively high magnification. Besides the obvious advantage of the elimination of one valve, there must also be taken into consideration the fact that by adopting a design of this type, of which the "Record III" is an example, it becomes possible to use a band-pass filter while still not employing more than three tuned circuits. Further developments in this direction are not impossible, but it would appear probable that receivers of this general type will be limited to amateur construction, for which they are particularly suited.

TO what extent will the performance of a receiver be impaired by using compact tuning coils of the order of 2in. diameter? Based on laboratory measurements, this article clearly shows that while the use of such coils may reduce the amplification per stage, this can be outweighed by permitting easy ganging and producing stability.

The second possible line of development is similar in its aims, but different in its means of attaining them. Instead of pushing up the amplification until one stage, using a modern valve, will do the work that two valves did before, we may lower the efficiency of the tuned circuits to keep amplification still at or near its old level, taking our profits in the form of less "peaky" tuning and greater ease of ganging the tuned circuits if this should be thought desirable. The "Foreign Listener's Four" is an example of a receiver designed on these lines. Judging by the present trend of commercial set design, it is in this direction that the manufacturer is most likely to progress.

It will be realised, of course, that from the commercial standpoint a set of this kind is the more practical proposition, in that careful elimination of losses always adds very considerably to the cost of manufacture, and increases the likelihood of the finished receiver requiring a final adjustment by highly skilled experts before it can be passed as perfect. Moreover, a commercial receiver has to work with almost any valves that may happen to find their way into it, and so must not be dependent for its good behaviour on an expert's final touches.

For all these reasons, then, a multi-stage receiver of low stage gain suits the manufacturer. From an amateur's point of view, too, it has its points. Although it is an extremely difficult task to set up and operate two ultra-high-gain stages, it is comparatively easy to extract the same overall amplification from three low-gain stages. To attain a total magnification of 25,000 times in two stages, each stage must amplify about 160 times. It is not difficult to stabilise one such stage, but two in cascade offer very considerable difficulties even to the expert. But if three stages can be used, the 25,000 times can be made up at the much more modest rate of 29 times per stage. This implies coils of quite high resistance, or transformers of high step-up ratio, so that a little stray reaction will not set up oscillation quite so infallibly as with the high-gain stages; in addition, there should be no great difficulty in ganging the tuned circuits without incurring any loss of amplification.

It will therefore be seen that a receiver deliberately made inefficient by choosing tuned circuits of higher losses than the amateur set builder usually permits has something to offer in exchange for its higher cost of construction and greater demands on the batteries. Those who do not mind providing an extra valve and an extra tuning coil and condenser, together with an extra screening box and decoupling components, will find that the multi-stage receiver of low gain is pleasant to use and offers good selectivity for a reasonably small loss of side-bands.

With receivers of this type (though not necessarily of three stages) in mind, a series of small, compact and inexpensive coils have been designed. Some discussion arose as to the best inductance to choose for these coils,

Size *versus* Efficiency of Small Coils.—

and it was finally decided that 200 microhenrys should be fixed upon, partly because this inductance value goes well with a 0.0005 mfd. tuning condenser, which is the most generally used size, and partly because it ensures that even if, by compact construction and close shielding, the stray capacities in the finished receiver are brought up to high values, the wavelength range that they cover will still extend as far as is likely to be required in a downward direction. It should, however, be noted that where 0.00035 mfd. tuning condensers are available, and stray capacities can be kept reasonably small, 250 microhenrys is to be preferred. With the higher inductance the amplification does not fall off quite so much at the upper end of the wave-band, and at the same time the higher ratio of in-

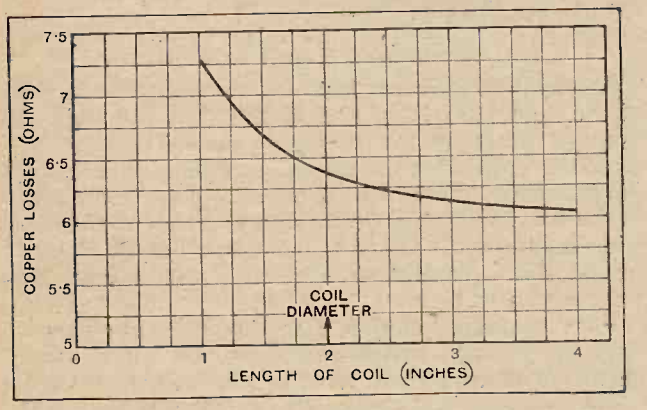


Fig. 1.—Relation between copper losses and length of coil. The inductance is 250 microhenrys and the diameter 2in.

ductance to capacity helps to flatten out the tuning curves and tends to check undue loss of side-bands.

In designing the coils, the method adopted was to take the diameter as a basis. Butterworth's formulæ show that, for a fixed diameter, the lowest coil resistance is attained by making the coil very long. By calculating the copper losses for a number of coils of the same diameter, but of different lengths, it was found that the resistance at first decreased fairly rapidly as the length was increased, but that after increasing the length to equal the diameter, any further improvement that could be attained was not worth the extra space that the coil would occupy. The relation between copper losses and coil length, for the particular case of a 250 microhenry coil of 2in. diameter, is shown in Fig. 1.

The Correct Gauge of Wire.

It should be noted that this result is not in contradiction with the well-established fact that the best coil shape is that which makes the diameter about double the winding length. This rule applies to a series of coils in which the overall surface is kept constant, both diameter and length changing when passing from one shape to another. If with a fixed diameter the length of the coil is increased, the departure from the best shape is more than counterbalanced by the increase in overall surface area.

Having settled the shape of the coil, it only remained to apply Butterworth's formulæ to find the best wire gauge. In doing this, the decrease of dynamic resistance shown by all tuned circuits at the upper end of their tuning range was borne in mind, and as a small contribution towards lessening this effect the gauge of wire was chosen to suit 600 metres instead of a wavelength more nearly at the middle of the range.

The specifications arrived at by calculation are as follows:—

COMPACT COILS; 200 MICROHENRYS.

No.	Diameter.	Wire Gauge.	Wire Covering.	Turns.
1	2¾ in.	22	Double Silk	57
2	2½ in.	22	Double Silk	64
3	2¼ in.	24	Double Cotton	71
4	2 in.	26	Double Cotton	80
5	1¾ in.	28	Double Silk	73
6	1½ in.	28	Double Silk	90

All coils are intended to be wound with consecutive turns of wire touching; it is with the idea of providing automatically correct spacing that various coverings are specified.

It was considered advisable, for the interest of those who may wish to employ coils of this type in a receiver, to make actual measurements of the high-frequency resistance of some at least of these coils, since dielectric losses in the tuned circuit are usually of such a magnitude that the copper losses alone cannot be taken as a guide in receiver design. Coils Nos. 2, 4, 5 and 6 were therefore wound, the former being paxolin tube bearing the trade-mark "MIC." First, the inductance of the various coils was measured, and was found in no case to be exactly 200 microhenrys. This turned out to be

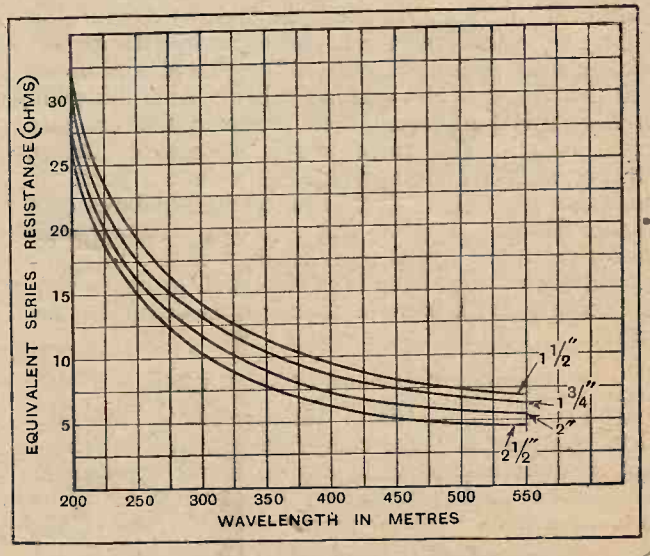


Fig. 2.—Equivalent series resistance of complete tuned circuit embodying 200-microhenry coils.

due to the fact that the particular wire employed did not conform exactly to the overall diameter (including insulation) attributed to it in the wire tables used. The specifications, however, have not been amended on that score, as it is probable that the diameters given in the

Size *versus* Efficiency of Small Coils.—

tables represent average diameters reasonably closely, while any corrections introduced would only be applicable to the particular sample of wire that happened to be used for the individual coils measured.

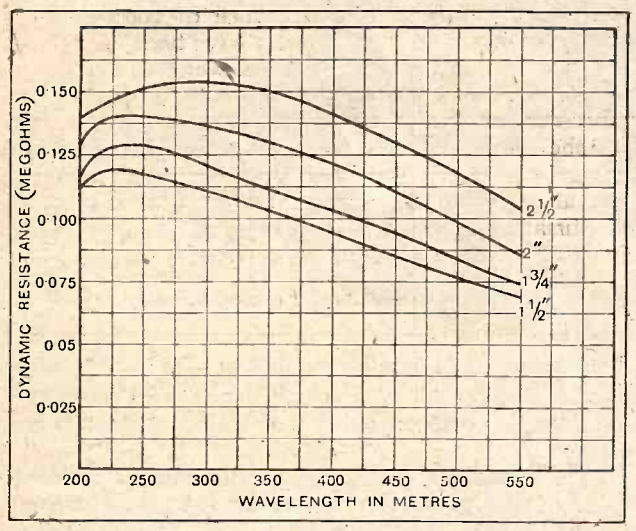


Fig. 3.—Dynamic resistance of typical tuned circuit incorporating 200-microhenry coils.

The equivalent series resistance of a complete tuned circuit, using each of the four coils in turn, was next measured. Besides the coil itself the tuned circuit contained a variable condenser in which the fixed plates were supported on ebonite. In order to reproduce the conditions existing in a practical receiver, a valve and valve-holder, together with a 3-megohm grid-leak, were connected in parallel with the tuned circuit. A "Burton" valve-holder was chosen as introducing unusually small dielectric losses; although it is not implied that there is no holder that is not better from this point of view, it is quite certain there are many that are very much worse. The valve was a Marconi or Osram HL610, while for the grid-leak was chosen a porcelain holder, owing to the fact that porcelain introduces only minute dielectric losses. This selection of components makes the tuned circuit representative of one in which the dielectric losses have been kept well in hand without going to such extreme measures as decapping the valve.

Dynamic Resistance of Small Coils.

In Fig. 2 the results of these resistance measurements are plotted. The curves do not, as a matter of fact, reproduce exactly the figures found experimentally, but have been to some extent adjusted to the values that the writer regards as representative of an average case. It was found necessary to "cook" the results in this way because the largest coil, which should naturally have had the lowest resistance, turned out to have a higher resistance, over part of the waveband, than any of the others. Analysis of the figures showed this to be due to an unusually large share of dielectric losses—presumably in the paxolin former, since every other factor was unchanged from coil to coil. It is thought, however, that the curves give, as they stand, a fair estimate of the resistance that may be expected in other coils made up to the same specification on good quality formers, and connected in a tuned circuit containing the same components.

In addition, the resistances found were all adjusted on the basis of constant magnification ($m = \frac{2\pi fL}{r}$) to the values they would have had if the inductances of all four coils had been exactly 200 microhenrys.

For receiver design, the series resistance of tuned circuits is of less interest than the dynamic resistance, since knowledge of the latter is required for the calculation of stage-gain, and in the choice of amplifying valves to precede the coils. The dynamic resistances of the same four tuned circuits at different wavelengths is therefore given in Fig. 3.

The Auto-coupled Tuned Grid Circuit.

As might be expected from the compact construction of the coils, their dynamic resistance is not high—it averages only some 100,000 ohms or so. The very considerable drop towards the upper end of the tuning range is partly due to the comparatively low inductance of the coils, and partly to the fact that they are wound with solid wire. The dynamic resistance of a Litz-wound coil is usually more nearly constant from low wavelengths to high.

For maximum amplification in a high-frequency stage employing a screen-grid valve, the tuned anode circuit, or its equivalent, must be used with these coils.

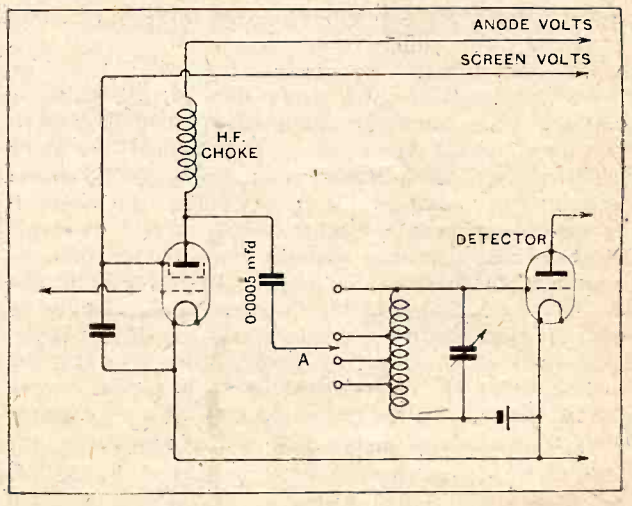


Fig. 4.—Tuned grid H.F. coupling, using tapped coil. By connecting the lead A to different tappings, selectivity, amplification and stability can be varied until the best compromise is found.

If higher selectivity is required, a step-up transformer of ratio about 2 to 1 will be found very suitable, and will help towards providing stability in a multi-stage amplifier. This extra stability may be indispensable if screen-grid valves having a high residual grid-plate capacity are employed.

A remarkably convenient method of intervalve coupling is suggested in Fig. 4, which shows a "tuned grid" circuit employing a choke and coupling con-

Size *versus* Efficiency of Small Coils.—

denser for parallel feed. No separate primary winding is required for this arrangement, a tapping on the coil serving to convert it very simply into an auto-transformer. Where there are doubts as to the selectivity

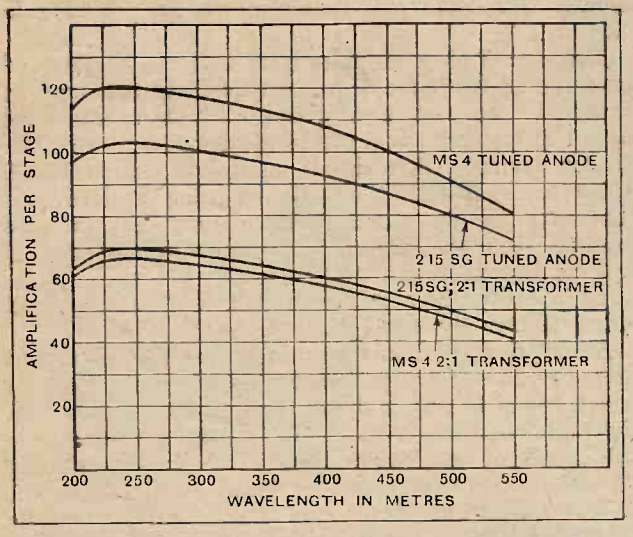


Fig. 5.—Amplification per stage with 2in. coil, as tuned anode coil and as secondary of 2 : 1 step-up transformer.

or stability of the amplifier, several different tappings may be provided, so that when the amplifier is being tested the most satisfactory compromise between selectivity, stability and amplification may readily be found by trying different tapping points.

The amplification per stage given by the 2in. coil, with the Mazda 215SG battery-heated valve and the Marconi MS4 mains valve, has been calculated, and is given in Fig. 5. The upper pair of curves refer to the use of the coil in the tuned-anode circuit or its equivalent (in the circuit of Fig. 4, with the lead from the coupling condenser connected directly to the upper end of the tuned circuit), while the lower pair give the amplification that may be expected if the coil is used as the secondary of a 2-to-1 step-up transformer (in Fig. 4, with the tapping at the mid-point of the coil).

Inductance Affected by Close Screening.

The high stage-gain that the best modern valves can provide, even with such modest coils as these, enables a receiver of high overall magnification to be built in a comparatively small space.

With coils of the type described here, which are of small dimensions and are comparatively long for their diameter, the extra resistance introduced by putting the coils inside screening boxes will be found quite small. Even with much larger coils of quite low resistance and more extended field it is possible to allow the screens to approach surprisingly close to the coils before any serious increase in resistance occurs. It must not be forgotten, however, that the close proximity of metal will lower considerably the inductance of a coil, and if too closely screened there may be a failure to tune over the wave-range expected.

If a series of these coils is to be used in cascade in a multi-stage amplifier it becomes desirable to have some idea of the overall resonance curve to be expected. On the assumption that the damping due to the anode impedance of the valve will be equivalent to shunting each tuned circuit with a resistance of 200,000 ohms the curves shown in Figs. 6 and 7 have been calculated. The two-way logarithmic scale on which these curves are plotted does not give, at first glance, a very correct impression of the shape of the resonance curve, but has the very considerable advantage that relative voltages can be read with the same percentage accuracy over all parts of the scale. This is of especial value in estimating selectivity, for which the height of the " skirt " of the curve has to be read.

Resonance Curves.

In examining the curves there are two points that claim special attention. For the proper reproduction of the high harmonics and overtones that serve to render one musical instrument distinguishable from another playing the same fundamental note it is necessary that the tuned circuits should pass frequencies up to some 5 kilocycles away from the fundamental at reasonable strength. The height at which the various response-curves cut the line marked " 5 kc." thus enables the high-note loss involved by the various numbers of these coils at wavelengths towards the two ends of their tuning range to be estimated very readily. As a guide

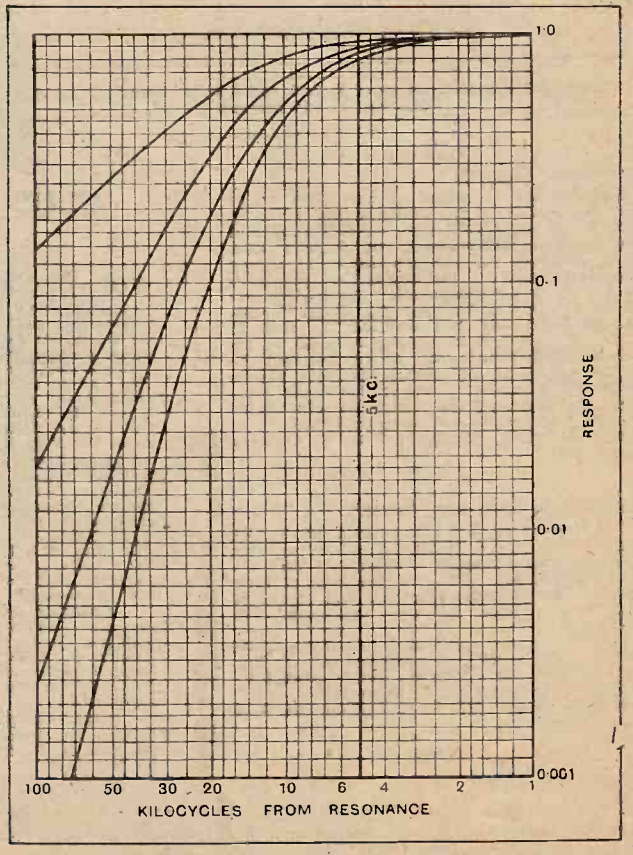


Fig. 6.—Resonance curves of 1, 2, 3 and 4 tuned circuits, using 2in. coil at 225 metres.

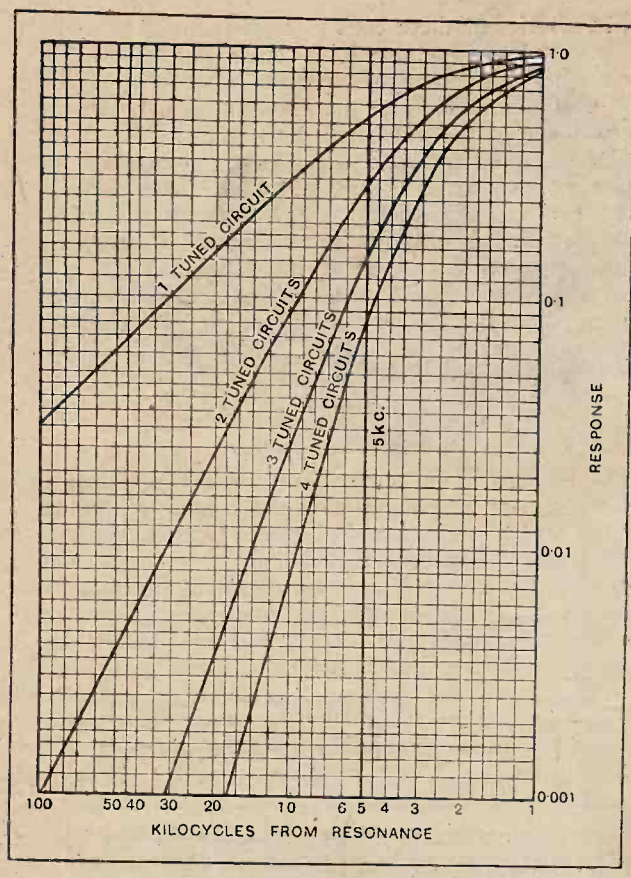


Fig. 7.—Resonance curve of 1, 2, 3 and 4 tuned circuits, using 2in. coil at 550 metres.

one might suggest that 10 per cent. at 5 kc. means acceptable quality, 25 per cent. means good quality, while 65 per cent. or over implies reproduction up to the best "local station" standard. But since different people have different opinions as to what constitutes "good quality" these figures need not be taken too rigidly, although they should assist in providing a clue.

The second piece of information that can be gathered from the curves is the degree of selectivity that may be expected. For determining this we must examine the height of the curve at a greater distance from the peak. If, for example, there is an interfering station B, 36 kilocycles away from the station A being received, and the curve for the tuned circuits in use cuts the line marked "36 kc." at 0.008, we know at once that B will be heard, as an interference to B's programme, at an intensity of 0.008 times that at which it is received when deliberately tuned in.

Attention is particularly drawn to the enormous difference in selectivity between the two figures, one of which refers to 225 and the other to 550 metres. At the latter wavelength selectivity is very high, and the side-bands of received telephony are very drastically cut down where three or four tuned circuits are used. At 225 metres even five or six tuned circuits would be perfectly harmless from this point of view, but selectivity is, of course, poor. For all-round reception, where any station that comes in well can be detuned a little, a three-circuit receiver would be found quite satisfactory even when high quality is required, for when the circuits are not accurately tuned to the station being received the resonance curve is broadened very considerably.

Short-wave Reception.

Loud-speaker reception on the short waves was the feature of the demonstration given by Mr. K. Alford, G2DX, before the Muswell Hill and District Radio Society on January 15th, when members had the opportunity of testing for themselves the distance-getting properties of the Igranic "Neutrosonic" 5-valve receiver which Mr. Alford had brought along. Transatlantic telephony was received, as well as hosts of short-wave telegraphy stations. In his accompanying lecture, Mr. Alford described the good work done by British amateur experimenters in the development of short-wave working, and described the difficulties experienced on the new 5-metre and 10-metre bands.

Hon. Secretary, Mr. C. J. Witt, 39, Coniston Road, N.10.

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"A.C. Mains Units and Circuits."

The Smethwick Wireless Society, at Empire House, High Street, Smethwick, whose call-sign is G2GX, recently made arrangements with the Marconiphone Co., Ltd., for the loan of their three lantern lectures, the first and second of which have been delivered to appreciative audiences.

The last lecture, entitled "A.C. Mains Units and Circuits," will be delivered on Friday, February 7th, at 8.30 p.m., and a cordial invitation is extended to all interested.

Hon. Secretary, Mr. S. S. Chatwin, 50, Pool Road, Smethwick.

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Rectification Filmed.

Mr. S. A. Stevens, B.Sc.(Eng.), A.C.G.I., D.I.C., of the Westinghouse Brake and Saxby Signal Co., Ltd., dealt with metal rectifiers in a recent lecture before Slade Radio (Birmingham). The difference between D.C. converters and A.C. rectifiers was fully explained, and the lecturer gave an interesting record of the progress made in rectification problems. The lecture was followed by a display of the company's film, which provided living diagrams illustrating the performance of alternating and direct current. The Society, membership of which is open to anyone interested in wireless, holds its meetings every Thursday at 8 o'clock. Details may be obtained from the Hon. Secretary, 110, Hillaries Road, Gravelly Hill, Birmingham.

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CLUB NEWS.

FORTHCOMING EVENTS.

WEDNESDAY, JANUARY 29th.

Muswell Hill and District Radio Society. At 8 p.m. At Tollington School, Tetherdown, N.10. Lecture and demonstration: "The Testing of the Modern Gramophone Pick-up," by Mr. F. N. G. Leevers.

Edinburgh and District Radio Society.—At 8 p.m. At 16, Royal Terrace. Lecture: "Frame Aerial Reception," by Mr. H. F. Ferguson, M.B., Ch.B.

THURSDAY, JANUARY 30th.

Ilford and District Radio Society. At the Wesleyan Institute, High Road. Loud speaker demonstration.

Golders Green and Hendon Radio Society. At 8.15 p.m. At the Club House, Willifield Way, N.W.11. The Fourth Dance.

Slade Radio (Birmingham). At the Parochial Hall, Broomfield Road, Erdington. Junk Sale.

MONDAY, FEBRUARY 3rd.

Newcastle-upon-Tyne Radio Society. At 7.30 p.m. In the English Lecture Room, Armstrong College. Lecture: "The Anode Feed System," by Mr. W. W. Pope, followed by a demonstration of electrical reproduction.

TUESDAY, FEBRUARY 4th.

Thornton Heath Radio Society. At 8.15 p.m. At St. Paul's Hall. Demonstration by Mr. R. M. H. Lucy, of Messrs. S. G. Brown, Ltd.

WEDNESDAY, FEBRUARY 5th.

Institution of Electrical Engineers (Wireless Section). Visit to the Laboratory of the City and Guilds Engineering College, South Kensington, S.W.

A New Club.

A meeting to discuss the formation of a Radio Society in Market Harborough was held in the Old Grammar School on Thursday, January 16th, and nearly forty local enthusiasts enrolled as members. Dr. Crisp was elected president and Mr. F. Sketchley chairman. All interested are requested to get in touch with the Hon. Secretary, Mr. A. H. Richardson, "Fernleigh," Wartnaby Street, Market Harborough.

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A Successful Year.

At the Hackney Radio and Physical Society's eighth annual meeting held recently, the secretary's report showed that the past year has been a very successful one for the society.

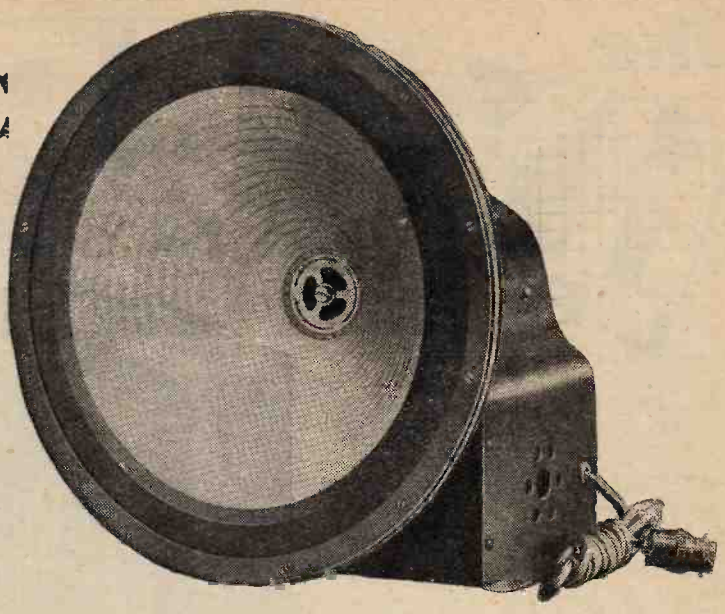
The following officers were elected for 1930:—

Chairman: Mr. E. Cunningham.
Vice-chairman: Mr. W. J. Samson.
Hon. Secretary: Mr. G. E. Sandy.
Publicity Secretary: Mr. G. W. Heath.

An interesting programme has been arranged for the coming year, and the Society will be pleased to welcome new members. Anyone interested should apply for particulars to the Hon. Secretary, Mr. G. E. Sandy, 4, Meadway, Raynes Park, S.W.20.

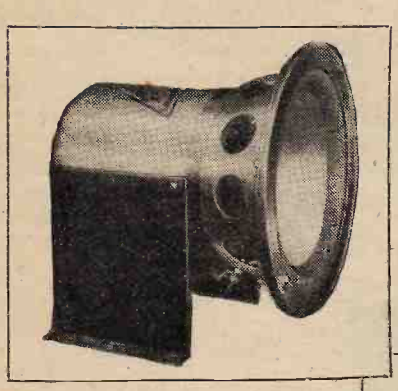
HEAR MUSIC

. . . as it *really is!*

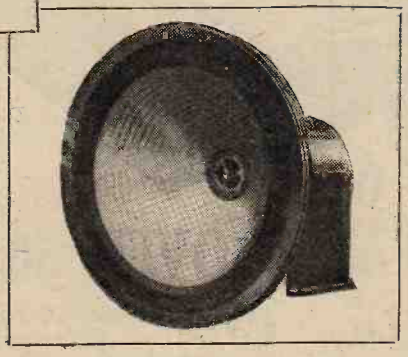


Senior "R.K." Unit with A.C. Field Excitation.

This "R.K." Unit has a 10 in. corrugated cone with moving coil having an impedance of 10-15 ohms at 50/4,000 cycles. The pot magnet is mounted in a pressed metal base which also contains a mains transformer, Mazda U.U. 60/250 rectifier valve, and smoothing condenser for the supply of field current. *Price £11 10 0*



The Junior "R.K." Unit has a 6 in. straight-sided cone with moving coil having an impedance of 10-15 ohms at 50/4,000 cycles. Copper damping rings are fitted to reduce the impedance at the higher frequencies. *Price £6 6 0*



The Senior "R.K." Unit incorporates a 10 in. corrugated cone with moving coil having an impedance of 10/15 ohms at 50/4,000 cycles. Copper damping rings are fitted to reduce the impedance at higher frequencies. *Price £7 7 0*

When the "R.K." first appeared on the market it was hailed as the perfect reproducer and achieved instant leadership.

That leadership—so readily attained four years ago—is maintained to-day, and wherever fine reproduction is desired the "R.K." is the speaker to use.

B T-H

RK

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EDISWAN

W 45.

Accurate Wavemeter Design

Points in the Construction of Precision Instruments.

By W. H. F. GRIFFITHS, F.Inst.P., A.M.I.E.E.

AT a meeting of the Institution of Electrical Engineers lasf year Capt. P. P. Eckersley, then Chief Engineer of the British Broadcasting Corporation, during his contribution to the discussion on wavelength standards, said: "Some years ago (wavelength) accuracies of 1 or 2 per cent. were sufficient for ordinary stations. To-day, particularly in the field of broadcasting, 1 part in 10,000 is desirable if mutual interference is to be avoided." Capt. Eckersley then explained the methods which are employed by M. Divoire (of the University of Brussels) to check the wavelength of all broadcasting stations of Europe from one central broadcasting control laboratory in Brussels. The wavelengths of ordinary 1 kW. broadcasting stations 1,000 miles distant from Brussels are measured to within 200 cycles in a million, an accuracy of 0.02 per cent.

It is natural, of course, that with the crowding of the available ætherial waveband the necessity for accurate determinations and standardisation of wavelength should be every-increasingly felt.

In the early days of "wireless" there was very little difference in accuracy between the carefully constructed standard wavemeter and one of an ordinary commercial type, whereas now we have wavemeters differing in accuracy by over a thousand to one. This must necessarily be the case when the measurement of any physical quantity becomes more precise, since the quality of workmanship then plays a far larger part in the overall accuracy of the instruments for its determination. Thus the accuracy of wavemeters (of any given type) to-day depends almost entirely upon the quality of their component inductances and condensers—particularly the latter.[1] It is obviously ridiculous to impart a highly accurate calibration to a wavemeter whose variable condenser is, through mechanical imperfection, neither constant enough to "hold" this calibration nor sufficiently uniform in capacity variation to permit interpolation (between adjacent calibrated points) of the same high order of accuracy.

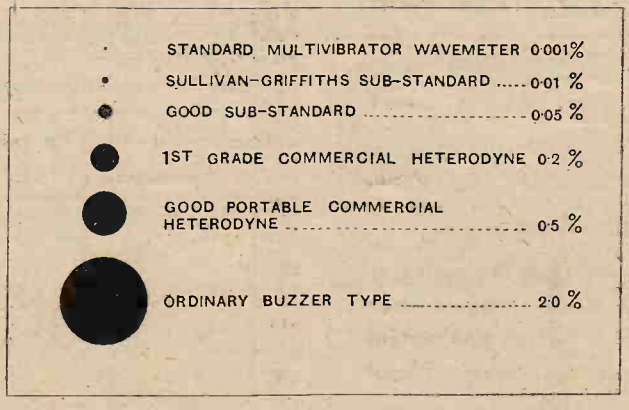

Fig. 1.—The relative inaccuracies of various types of wavemeter are shown proportional to the areas of the circles.

The Relative Accuracy of the Various Types of Wavemeter.

The better the quality of variable condenser employed in any particular type of wavemeter and the smaller the wavelength range covered by a single sweep of its condenser, the more accurate will be its calibration.

The *extent* to which the accuracy of a wavemeter is determined by the quality and range of its variable air condenser varies with different types. In the case of the simple buzzer wavemeter, for instance, flatness of tuning will sometimes limit accuracy of reading and so render condenser quality of less importance. And in a wavemeter of the heterodyne type the quality and range of the variable condenser will only be the governing factor of accuracy if the initial calibration conditions of valve emission, etc., are exactly reproduced on all subsequent occasions.

The sub-standard wavemeter of the simple resonant circuit type is, on the other hand, almost entirely governed, as regards accuracy, by the quality and range of its variable air condenser, although the constancy of the inductance associated with the latter is also of importance.

The relative inaccuracy of the various generalised types of wavemeters is depicted diagrammatically in Fig. 1 by the relative *areas* of circles—the variation of accuracy being far too great for representation on a linear basis. To those inexperienced in the field of standardisation and measurement, the outstanding feature of this diagram is, perhaps, the relatively high inaccuracy of a *good* portable commercial heterodyne wavemeter. One must remember, however, that this inaccuracy, even if one ignores all other contributing factors, may be introduced by an uncertainty of capacity of 1 or 2 micro-microfarads, and that such a variation of capacity may be due to a great variety of causes in a portable instru-

[1] W. H. F. Griffiths, "Notes on the Accuracy of Variable Air Condensers for Wavemeters."—*Experimental Wireless*, vol. IV., No. 51, December, 1927.

Also W. H. F. Griffiths, "The Accuracy and Calibration Permanence of Variable Air Condensers for Precision Wavemeters."—*Experimental Wireless*, vol. V., Nos. 52 and 53, January and February, 1928.

ment such as non-permanence of wiring, change of self-capacity of range coil, and the earth capacity introduced by the proximity of the hand during operation, as well as to the chief cause—that of post-calibration capacity change in the variable condenser itself.

The Design of the Resonant Circuit of a Wavemeter for Accuracy.

It is of primary importance, therefore, that the minimum value of capacity of the variable air condenser of a heterodyne wavemeter shall be augmented by a fixed condenser to such an extent that these unavoidable capacity uncertainties are rendered less important by

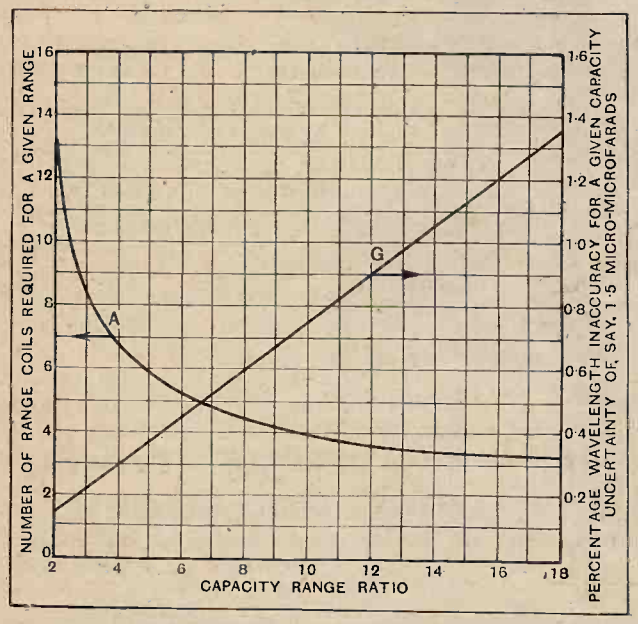

Fig. 2.—Curves showing the number of range coils and capacity ratio of condenser of a wavemeter.

being made a smaller percentage of the total circuit capacity. The range of wavelength covered by a single sweep of the condenser will, of course, be very considerably reduced even by a small increase of minimum capacity, and this will, in turn, increase the number of "range coils" required to cover a given total wavelength range, thus adding appreciably to the cost of the instrument and making it less convenient to use. For a wavemeter either of the heterodyne or sub-standard (absorption) type the number of range coils required to cover a certain band of wavelength can be found from a curve such as (A) of Fig. 2, which is plotted for a wavelength range ratio of 100 to 1 (irrespective of the actual wavelength values), corresponding with any desired capacity range ratio of variable condenser.

In order to use this curve, however, one must first determine the capacity range ratio of the variable condenser to be employed. Since this depends upon the accuracy required of the wavemeter it is possible to plot another curve, Fig. 2 (G), connecting these two quantities. The right-hand scale in this case represents the inaccuracy to be expected due to capacity uncertainty in an ordinary commercial heterodyne wavemeter. Lower inaccuracy values would, naturally, be associated with laboratory sub-standard wavemeters.

Commencing therefore with only the total wavelength range and percentage inaccuracy permissible as data, the resonant circuit is designed by finding from curve G the capacity range ratio corresponding with the inaccuracy permissible and then from curve A finding the number of range coils corresponding with this capacity ratio. The ratio of the inductances of successive range coils will, of course, be the same as that of the condenser and their values are thus easily calculated.

For a variable condenser and wavemeter of any given quality the inaccuracy due to a small uncertainty of capacity will depend upon the total value of circuit capacity and any curve of inaccuracy such as G must be associated with one definite value of maximum capacity —in this case 1,000 micro-microfarads.

Tuning Range and Percentage Inaccuracy.

In Fig. 3 curves similar to those of Fig. 2 are given for the outline design of wavemeter circuits having various values of inaccuracy, for any value of total wavelength range, and for any value of maximum capacity. The curves A, B, C and D are plotted for wavelength ratios of 100 to 1, 40 to 1, 20 to 1 and 10 to 1 respectively. For other wavelength ratios interpolation between the curves may be applied and the next higher whole number of range coils employed. The straight line curves E, F, G, H and J give inaccuracy—capacity ratio relationship for circuits having maximum capacities of 500, 750, 1,000, 1,500 and 2,000 micro-microfarads respectively.

The curves have been made more complete by the addition of an alternative scale of percentage inaccuracy

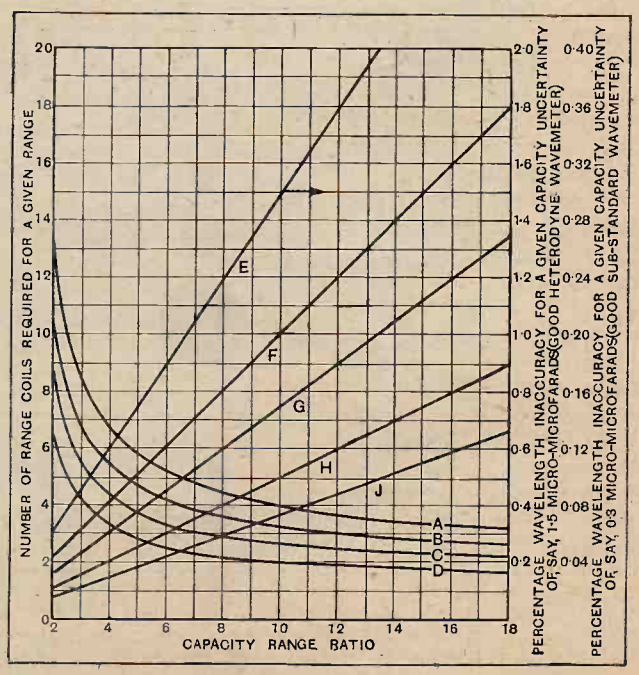

Fig. 3.—Showing the number of range coils and capacity ratio of condenser of wavemeters of various accuracies.

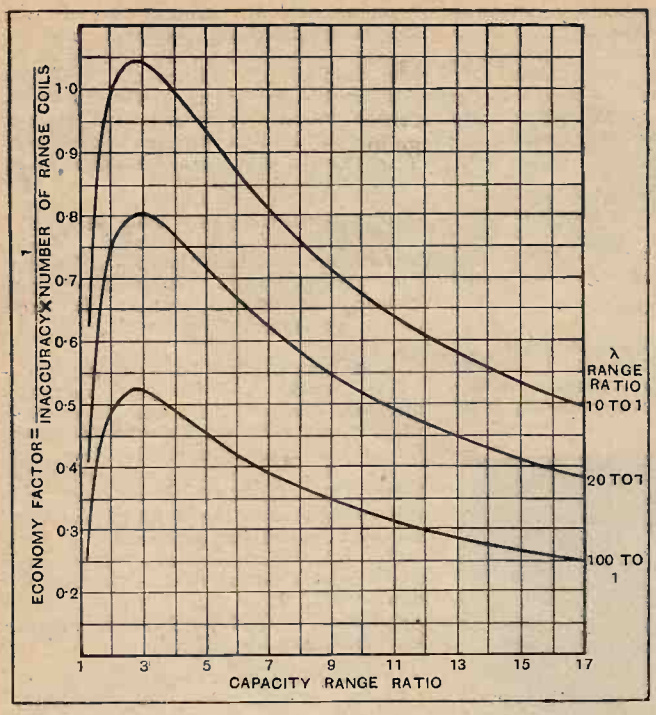

Fig. 4.—The optimum economic capacity range for wavemeters having regard to accuracy, cost and convenience.

to be used when the wavemeter under consideration is of the better-class substandard absorption type employing a precision variable condenser and well-designed range coils.

It will, of course, be understood that in the use of these curves only that component of inaccuracy which is due to capacity uncertainty is accounted for, and although this should always form the basis of design the possibility of other sources of inaccuracy should not be overlooked.

Optimum Capacity Range.

As will be seen from Fig. 3, the number of range coils rendered necessary becomes prohibitive if the capacity range ratio is reduced too much and, moreover, the attendant reduction of capacity uncertainty is not sufficiently great to justify this above a certain point. The value at which a still further reduction of capacity range ratio does not justify the added cost and inconvenience of extra range coils is found by plotting curves (as in Fig. 4) of economy factor against capacity range ratio. The economy factor is assumed to be the ratio of accuracy to number of range coils, the accuracy, of course, being taken as the reciprocal of inaccuracy. The curves of Fig. 4, which are plotted for wavelength ratios 10 to 1, 20 to 1 and 100 to 1, indicate an optimum economy value of capacity ratio of about 2.7, which is, incidentally, that employed in the best wavemeters.

(To be concluded.)

Events of the Week

FRANCE'S DX PRESIDENT.

President Doumergue is reported to be a wireless "fan" of the DX type, leaving his bed in the early hours to listen to America.

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RADIO WEEK FOR IRELAND?

The organisation of Irish Radio Week is being considered by the Irish Radio Traders' Association.

It seems to us that before the Free State can stage an effective Radio Week it will be necessary to provide a broadcasting service covering a bigger area of the country.

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WIRELESS IN PUBLIC LIBRARIES.

The Sheffield libraries are setting an example to the country by allowing the public free facilities for listening to the B.B.C. language talks. Sets are in regular operation at the Walkley and Hillsborough branches, and visitors are invited to join the discussion groups which have been formed in connection with the B.B.C.'s Adult Education campaign.

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AS OTHERS HEAR US.

Brookmans Park is receiving "a good press" in France, according to our Paris correspondent. Several journals draw the attention of the public to the excellent transmission from the new station, while "Petit Radio" praises the station for the prudent care taken to "minimise inconvenience as a result of the application of new conditions of reception." This cryptic remark probably indicates satisfaction at the constancy of the Brookmans Park wavelengths.

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MARITIME TRIBUTE TO WIRELESS.

A long-standing association between seafarers and the wireless service has been acknowledged by the Worshipful Company of Shipwrights by the admission of Mr. F. S. Hayburn, deputy managing director of the Marconi International Marine Communication Co., Ltd., as a Freeman and Liveryman.

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PROPOSED NEW RADIO COLLEGE.

A new form of wireless college, specially intended for youths who wish to enter the wireless trade, has been proposed by the Association of British Radio Societies, whose headquarters are in Manchester. It is believed that a need exists for a training centre in which the student would have an opportunity of handling modern commercial apparatus, such as moving-coil loud speakers, etc., of a kind which is usually absent in the ordinary technical colleges. While the theoretical side would not be neglected, the aim of the course would be to give the learner an acquaintance with the practical problems associated with the trade.

It is stated that the scheme has met with the approval of several important wireless firms.

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TONIC TOUCHES IN AUSTRALIA.

In Australia the month of January is witnessing the acquisition of more stations by the Australian Broadcasting Company, the latest to come under its control being Adelaide, 5CL, and Brisbane, 4QG. The recent broadcast legislation makes the "A.B.C." responsible for the direction of seven stations, two in Sydney, two in Melbourne, and one each in Brisbane, Adelaide, and Perth.

The company announces its intention of putting fresh life into the programmes.

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GREECE TO "COME ON THE AIR."

The "Isles of Greece" will shortly resound to the strains of national broadcasting as a result of the decision of the Hellenic Government to invite offers from organisations who would be prepared to operate a State-subsidised broadcasting service, the income to be derived from listeners' licence fees. At present there are no applicants for the monopoly, but the Ministry of Posts and Telegraphs is

CURRENT TOPICS

In Brief Review

determined to waste no time on the question and has already ordered a certain amount of transmitting equipment from the Marconi Company and the French Compagnie Radio Electrique. The sites chosen for the studios are at Zanli, Vari, and Sitta (Crete), with high-power transmitters at Athens, Chios, and Heraclion (Crete).

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EVERLASTING GRAMOPHONE RECORDS?

Startling claims are made in a Washington message regarding the properties of a new type of gramophone record composed of a substance called Durium. The inventor is Dr. Hal T. Beans, professor of chemistry at Colombia University. The records consist of thin sheets of cardboard on which a coating of Durium is laid by a dipping process. On these the impressions can be stamped at the rate of 200 records per minute. The inventor affirms that the records are practically everlasting.

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PUBLIC LISTENING HALLS.

"I have often wondered why somebody has not opened a public Radio Hall for listening to wireless programmes," says a writer in *The Manchester Guardian* Commercial Edition. "Home audiences must of necessity be scanty from 11 a.m. to 6 p.m., and there are lots of people whose opportunities for evening listening are very limited who would appreciate daytime facilities in an airy hall with comfortable seats and rubber flooring. Wireless manufacturers might help to finance such a scheme in return for exhibiting their sets and gadgets."

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THAT CANARY CALL.

Doubt is expressed by an Irish contemporary as to whether the canary interval call from the Turin station is produced by a real bird. Considering that so many birds, including canaries, nightingales, and cuckoos, are specially trained for broadcasting work, we feel sure that the station authorities would not deceive listeners with a gramophone record.

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LEAMINGTON'S LOUD SPEAKERS.

The Leamington Town Council has submitted a draft bylaw to the Home Secretary for the suppression of noisy loud speakers and gramophones in public places.

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A BORROWED WAVELENGTH.

Congestion on the long-wave broadcasting band has led to an interesting situation in regard to the wavelength of 1,071 metres. According to the Prague Plan, this wavelength is allotted to the Norwegian relay station at Trondjhem, but, as the station will not be completed for service until April or May, the wavelength is being "borrowed" by the Dutch stations Hilversum and Huizen.

What will happen when Trondjhem leaps into life is a little problem best left to the Union Internationale de Radiofusion.

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WIRED WIRELESS IN CANADA.

A new land line, 300 miles long, is being installed between Oshawa and Sudbury (Northern Ontario) by the Bell Telephone Company of Canada, to be operated on the "wired wireless" principle. This will make it possible for eight persons to converse at one time over the same pair of wires, or for two people to talk and forty people to be in communication on teletype or telegraph simultaneously.

Construction will be completed in a year from the beginning of operations, and the line will handle not only the increasing telephone business between Toronto and the northern Ontario mining districts, but will be a link in the Atlantic-Pacific system. On the completion of this transcontinental project persons in Halifax will be able to talk to Vancouver over an all-Canadian route with perfect audibility.

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MORE "SUPERHETS" FOR FRANCE.

The Etablissements Radio-L.L., which manufacture and sell "superhets" under the patents of M. Lucien Lévy, has trebled its capital, which is now 35 million francs.

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OPPORTUNITIES IN THE R.A.F.

The trade of wireless operator-mechanic is among those open to successful applicants for six hundred vacancies for aircraft apprentices in the Royal Air Force The apprentices, who must be between the ages of fifteen and seventeen, will be enlisted as the result of an Open and of a limited Competition.

Full information regarding conditions and prospects can be obtained on application to the Royal Air Force (Aircraft Apprentices' Dept.), Gwydyr House, Whitehall, London. S.W.1.

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GRAMOPHONE NEEDLE WEAR.

We regret that, owing to a printer's error, three illustrations were misplaced in the article appearing under the above title in our last issue. The photographs represented as Figs. 2, 4 and 6 should have appeared as Figs. 4, 6 and 2 respectively. The descriptive captions appeared in their correct places.

PREMIER'S SHORT-WAVE TALK. On Wednesday last the Prime Minister broadcast a special address to American and Dominion listeners on the subject of the Disarmament Conference. Mr. Ramsay MacDonald is here seen before the microphone in the Cabinet Room at Downing Street. The address was transmitted only from 5SW, the Empire broadcasting station, and listeners in this country were unable to hear it.

Catalogues Received.

Runbaken Motor & Electrical Accessories, Ltd., Magnet Works, Ardwick, Manchester.—80-page illustrated catalogue of electrical equipment. A section is devoted to battery chargers.

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Messrs. W. and G. Foyle, Ltd., the well-known booksellers of 119-125, Charing Cross Road, London, W.C.2, have issued a useful catalogue of new and second-hand books on all technical subjects and applied science, from aeronautics to water analysis and supply, including electricity and electrical engineering. We can recommend this list to readers, especially to those on the look out for special, out-of-print, or other rare books

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Messrs. Lissen, Ltd., Lissenium Works, Worple Road, Isleworth, Middlesex.—Illustrated and descriptive literature of Lissen radio components, valves, loud speakers, and gramophones. Also constructors' broadsheet for building the Lissen "Screened Grid Three" receiver.

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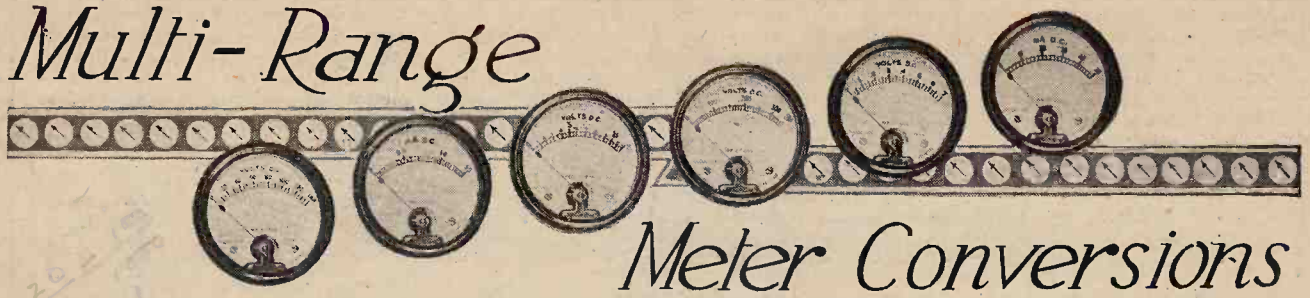
The Record Electrical Co., Ltd., Broadheath, Manchester.—Descriptive folder dealing with the Record Bridge Ohmmeter, a combined ohmmeter and Wheatstone bridge for insulation testing and measuring resistances of from 0.01 ohm to 999,900 ohms.

Multi-Range Meter Conversions



Extending the Scale of D.C. Instruments.

By W. A. BARCLAY, M.A.

Our contributor, whose research work in connection with various problems of reception is so well known to readers of our sister journal "Experimental Wireless," deals here with the surprising utility range of the D.C. moving-coil milliammeter, and supplies a valuable abac.

THERE is no instrument which is so universally serviceable to the wireless worker as a sensitive and accurately calibrated milliammeter. The uses of the D.C. moving-coil meter are legion and need not be enumerated here. Not the least among its advantages is the fact that it is possible to use it as voltmeter or ammeter at will over widely differing ranges of voltage and current.

The question is often put by beginners as to how the same instrument may be used for two such different purposes as to measure voltage and current. Happily, the answer may be found without much mathematics by the aid of that "Pons Asinorum" of electricity, Ohm's law. A current-measuring device such as a milliammeter necessarily has a small internal resistance, the smaller this resistance the more sensitive being the instrument. This resistance, R ohms, let us say, remains the same no matter what the deflection of the needle, i.e., no matter what the current passing may be. If, then, our milliammeter needle is fully deflected when a current of 5 milliamps. is flowing, we can see by Ohm's law that there must exist a potential difference of $5R$ millivolts between the terminals of the instrument. If, to take an actual case, the internal resistance R of the meter is 20 ohms, then if 5 milliamps. causes full-scale deflection the potential across the terminals will be 0.1 volt. Smaller voltages will, of course, give lesser readings in proportion, i.e., our milliammeter is also a voltmeter, and may be used directly to measure voltages up to this amount.

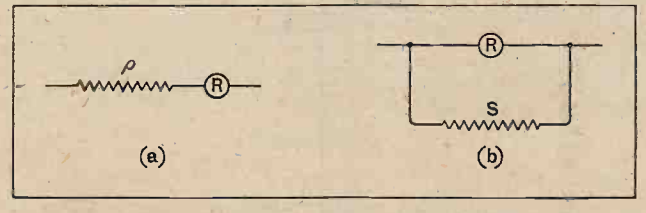


Fig. 1a.—Voltmeter connections with series resistance. Fig. 1b.—The shunt resistance connection for extending the ampere scale.

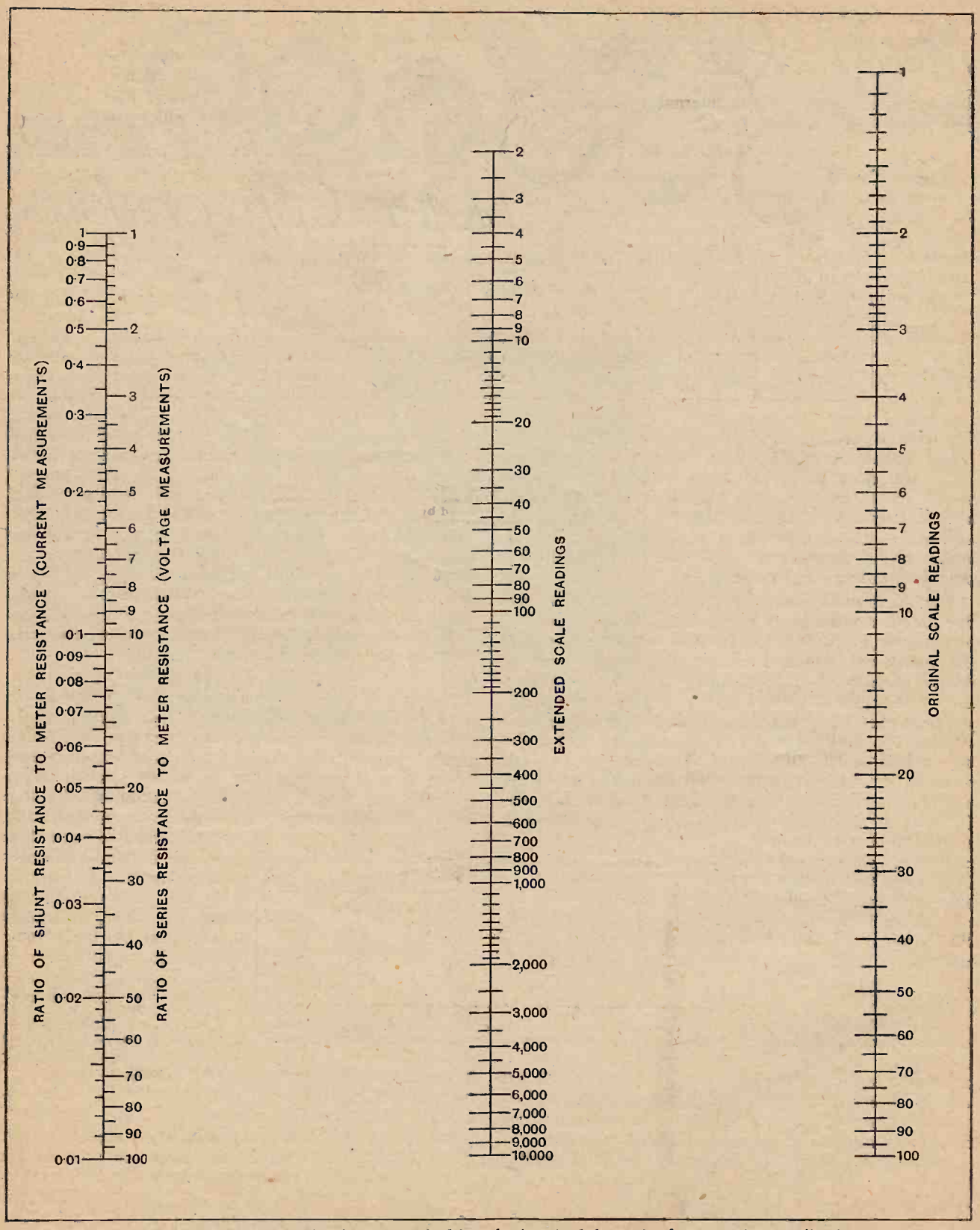
Although 0.1 volt is the highest E.M.F. it is possible to apply to the terminals of this instrument with safety we can utilise it to measure E.M.F.s of much greater amount in an indirect way. If, for example, it is desired to measure voltages up to 1 volt, we should employ the circuit of Fig. 1a, in which an external resistance of ρ ohms is placed in series with the meter. Since 0.1 volt is all that we can apply across the meter to ensure full-scale deflection it is obvious that the value of ρ must be so chosen that the remaining 0.9 volt is dropped across it. It will be seen that in the case considered this external resistance must have nine times the value of the meter resistance, i.e., 180 ohms. Generally, if the meter by itself reads up to V_1 volts, and it is desired to extend the range to measure up to V_2 volts, the value of the external series resistance ρ required may be found from the formula

$$\rho = R\left(\frac{V_2}{V_1} - 1\right),$$

R being the internal resistance of the meter.

Again, if the instrument is considered in its simplest aspect, that of a low-reading milliammeter, it is easy to see that it may be used to measure much larger currents than would be possible directly by shunting the meter with a resistance whose value is generally small compared with that of the internal resistance of the meter. In the case of the instrument considered above, full-scale deflection of the needle occurs for a current of 5 mA. Suppose now it were desired to measure currents up to a maximum of 50 mA.; for a full-scale reading on the instrument it would be necessary to shunt the balance of 45 mA. through the parallel resistance.

Since this parallel current has nine times the value of the meter current it will be seen that the value of the shunt would require to be one ninth of the internal resistance of the meter, or 2.22 ohms. Generally, if the meter by itself reads up to A_1 milliamps., and it is desired to extend the range to measure up to A_2 milliamps., the shunt resistance S to be included



This chart gives the value of resistance required in order to extend the range of an ammeter or voltmeter.

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Multi-range Meter Conversion.—

is found from

$$S = \frac{A_1 R}{A_2 - A_1}$$

where R, as before, is the internal resistance of the instrument.

A Graphical Illustration.

A graphical illustration of the manner in which the range of voltage- and current-measuring instruments may be related to the auxiliary series and shunt resistances employed with them will now be given. In the case of the voltmeter (Fig 2a), let the distance OA represent the internal resistance R of the instrument, and OB the extra resistance ρ to be used in series with it. Let OC, drawn perpendicularly to AB, represent the original full-scale meter reading V_1 in volts. Join A to C, and produce it to meet the vertical through B in D. The length BD will now represent (to the same unit as OC) the new full scale of the voltmeter readings V_2 for the external resistance ρ.

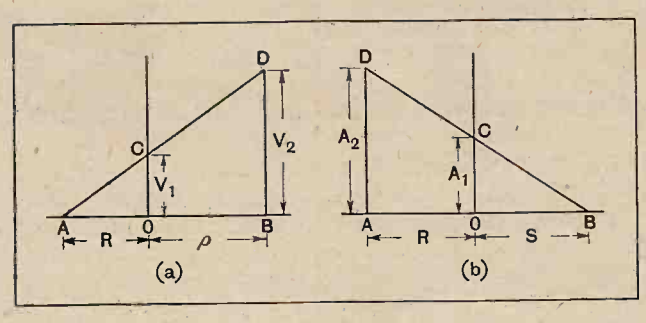

Fig. 2a.—Extended range V_2 of voltmeter may be increased by the use of the larger series resistance ρ. Fig. 2b.—Extended range A_2 of voltmeter may be increased by diminishing the value of the shunt resistance S.

Similarly, in the case of the ammeter (Fig. 2b), let OA represent, as before, the internal resistance R of the instrument, while OB is now the shunt resistance S to be included. Let OC be now drawn perpendicularly to represent the original full-scale reading A_1 in milliamps. In this case B is joined to C, and produced to meet the vertical through A in D. The length AD now represents the new full scale of ammeter readings A_2 for the particular shunt resistance S.

An Alignment Chart.

For those experimenters who desire to have a rapid means of correlating meter readings with auxiliary resistances, the alignment chart has been prepared. In this chart it is found convenient to dispense with the actual values of the auxiliary resistances and internal meter resistances, substituting instead the ratios of the former to the latter. By his means a greater degree of generality is obtained over a wider range of auxiliary resistances than can be conveniently exhibited on the diagrams of Figs. 2a and 2b. The method of use will be familiar to readers of *The Wireless World* from the series of Useful Data Charts which have already appeared in the pages of this journal.

The centre and right-hand support lines carry values which may represent either current or voltage readings; the left-hand support gives the ratios of the auxiliary resistances to the internal resistance of the meter. It will be observed that this left-hand support carries two scales; that to the outside gives the radio S/R when current extension readings are in question, the inside one giving values of ρ/R when dealing with voltage extension readings.

Let us take, as an example of the use of the chart, the case of the milliammeter cited above which registers full-scale deflection for a current of 5 mA., and which it is desired to extend to read to 50 mA. Joining these two values on the right-hand and centre scales of the chart, it is found that the index line cuts the left-hand scale at the value $S/R = 0.111$, so that the shunt must be 0.111 times the value of the internal resistance.

The chart, of course, gives approximate values only. The practical work of rigging up and calibrating an accurate multi-range volt-ammeter calls for skill on the part of the constructor. Much care is needed, for example, to ensure that the small shunt resistances for the different ammeter ranges are of the correct values. For this reason anything in the nature of a multi-stud switch for the purpose of placing such resistances in circuit is to be deprecated, as such devices are apt to introduce unwanted resistance which might seriously affect the readings of the instrument.

Readers who wish to pursue the subject in greater detail should consult the admirable article by E. H. W. Banner, M.Sc., which appeared in *Experimental Wireless* of February, 1925.

TRANSMITTERS' NOTES.

Short-wave Tests—

The Radio Society of Great Britain asks its transmitting members to take part in the series of tests on the 28,000 kc. waveband on March 2nd, 9th, 16th and 23rd, when it is intended to run continuous tests for the full 24 hours on each day.

The main objects are to determine if simultaneous reception of distant stations is obtained at different places in Great Britain; the comparative effectiveness of low power and high power; the suitability of various transmitting circuits; the practical value of H.F. amplification and the possible relation between solar and magnetic conditions and propagation. Full particulars can be obtained from the R.S.G.B., and reports should be sent to Mr. R. W. Leader (G 5VL), at Porth, St. Columb Minor, Cornwall, who is offering a challenge trophy for yearly competition.

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—And 2,000 kc. Tests.

It is also proposed to conduct a series of tests on the 2 megacycle waveband during April, but we understand that the details and conditions are still under discussion. We pointed out last week that transmissions on the 7 mc. band are suffering considerably from interference by badly rectified A.C., and it is hoped that these tests may convert the sufferers to the lower frequency bands.

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The Prime Minister's Speech.

We understand that many listeners were disappointed in being unable to pick up Mr. Ramsay MacDonald's speech to America on January 22nd as 5SW was using a special wavelength which was kept secret.

WEIRD WIRELESS

By D'ORSAY BELL, M.A.

Blazing New Trails in Radio Research.

NO, it is *not* a misprint for "Wired," as you thought it was. Weird Wireless, as opposed to the ordinary forms of radio (wireless telegraphy, wired wireless, television and so on) about which the readers of this journal know most that is worth knowing, is that large branch of radio about which they know nothing. Do I realise what I am saying? I do. Am I not giving utterance to an unwarrantable and gratuitous piece of impertinence? I am not.

I have never, for instance, come across any animated correspondence in these pages on the subject of Paint and Varnish Radio. And yet paint and varnish radio is a very important—an increasingly important—subject. The research laboratories of big P. and V. manufacturing concerns are studying, by radio technique, the effects which heat and cold, oxidation and so on, produce on their latest products. Particularly useful here is what might be called an "ultra" edition of the Ultra-micrometer. If two circuits, each kept oscillating by a valve, are almost but not quite in tune and are carefully coupled together, the very least change in tune in the one will produce a great change in current in the other. In the Thoma variation of the ultra-micrometer, a slight increase in the thickness of a paint film alters the capacity of a condenser, brings about an infinitesimal change of tune in one circuit, and gives such a magnified result in the other circuit that the change in the thickness of the film can be recorded and studied very easily.

Upsetting the grid circuit.

Robots: Efficiency 500 per cent.

It is said that this new "tool" is enabling the research people to investigate the why and wherefore of important actions going on in their paints, the very existence of which was unknown till now. But this is only one way in which wireless technique is being used in the paint industry. There is a most attractive, superhuman gadget which analyses the colours of paints (and writes down the results) quite automatically and five times as accurately as can be done by the human eye. The machine flashes a beam of light (red, for instance) backwards and forwards between the sample under test and a standard colour. If the red beam is reflected more by the standard than by the sample, the result—thanks to the help of a photoelectric cell such as is used in photo-telegraphy and television—is a pulsating current. This, after passing through valve amplifiers, sets a little motor buzzing round and altering things so that the red beam now divides its attention between the sample and a second standard colour: if this does not correspond exactly to the sample, the motor keeps on buzzing round and tries a third standard, and so it goes on till a standard is encountered which gives an exactly equal reflection. When this happens, there is no pulsating current to drive the motor, which comes to rest with a feeling of duty well done. The machine makes a note of that particular standard, switches on a test beam of another colour, and the whole process goes on all over again. The complete colour analysis takes only a few minutes, which is far quicker than can be done by human beings.

And Meanwhile, in the Vast Open Spaces . . . .

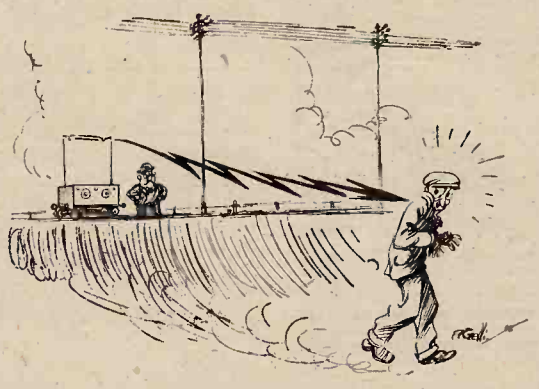
Let us leave the stuffy laboratory and get into the vast open spaces of America, Canada and Australia. Here, screen-heroes in khaki shirts and shorts are busily using short-wave valve generators to explore for oil and minerals. Various methods are used, but one favourite plan is to compare the velocity of sound waves through the ground with that of short radio waves. The latter

Weird Wireless.—

keep their velocity constant, while the sound waves vary theirs according to the nature of the soil: the presence of oil, in particular, has a marked effect. For minerals, the method usually employed involves the use of direction-finding loop aerials—plus the usual valve amplifiers.

Mutual Interference.

In fact, practically the whole resources of modern wireless are being concentrated on the unwarrantable spying-out of these harmless and carefully concealed minerals, oils, and so on. It is pleasant to be able to relate that occasionally the victims get a bit of their own back: it is reported from Wiesbaden that listeners-in have been worried by a strange kind of interference, rather like atmospherics but more regular, and this has now been found to come from the radio-active mineral springs under the town. Perhaps that will teach people to let well—and spring—alone. Which reminds me: I ended my last article with a suggestion, more or less flippant and for the sake of a neat ending, that perhaps hazel-twig water-divining was only another branch of wireless. As a result of this remark a correspondent has kindly referred me to an article in the sedate pages of *Nature*, in which a researcher describes a series of tests leading to the following conclusions:—that the faculty of water-divining is possessed by some individuals; that these individuals respond to some at present unknown stimuli; and that these stimuli can be cut off by the interposition of certain substances: for instance, if one leg of the twig has a bit of rubber tubing slipped over it, thus insulating one hand from the twig, the phenomena cease (=a break in the loop aerial? Weird Wireless!)



Sacking the foreman.

A Ceaseless Stream of Development.

But since the Editor will only give me a miserable page or two, I must be much briefer than this if I am to keep anything like up to date. For every day seems to bring fresh developments which clamour for notice. Piezo-electric quartz, that high-brow laboratory phenomenon which was so promptly seized on to keep radio transmitters to their proper wavelength, is now being used to register variations of pressure in water-mains: so is the effect of capacity change on a heterodyne note, one plate of a condenser being forced in towards its second plate by any increasing pressure. The photo-electric cell—direct descendant of Elster and Geitel's "academic" experiment where light falling on to a spark-gap stopped the spark—is now used for about as many purposes as an Austin Seven. Apart from its jobs in picture telegraphy and television, it counts the traffic passing through the big tunnel joining New York to New Jersey; it judges the winning horse in a race; it sorts and counts mass-produced goods; it is used in chemical works to decide when enough alkali—for instance—has been added to complete a reaction (some of you may remember the titration tests at school, when the critical last drop suddenly wiped away every trace of colour from a whole big flask-full of coloured liquid; the photo-electric cell watches for this, and when it happens, turns off the tap). It, as well as its brother the selenium cell, is used as a burglar alarm; another burglar alarm, by the way, is one in which the action—or the mere presence—of the burglar upsets the tuning of the grid circuit of an oscillating valve and causes an anode-current change which works a relay. The condenser-microphone, which some engineers swear by for broadcasting, is now being used by doctors to give them a record of their patients' heart-beats. Thanks to the valve amplifier, the tiny resistance-changes in the human body, due to emotion of various kinds, can now be recorded—and this procedure, it is said, is going to be very valuable in studying the effects of drugs and in investigating nervous fatigue. Noises in gear boxes, ball bearings and other machinery, and noises indicating insulation trouble and the consequent danger of breakdown in big transformers, are being tracked down by microphone and valve amplifier: the ordinary, normal running noises being filtered out by electrical filters such as are used in wireless, so that the trouble-noises can be distinguished.

Flaws in Metals.

Flaws in steel axles are now being looked for by rotating the axle rapidly and exploring with an instrument rather like the magnet arrangement of a telephone receiver—the disturbances induced in the telephone windings by the presence of a flaw rapidly passing by are detected after amplification in the usual valve amplifier. A similar process is applied to steel wire ropes—but here the rope remains still and the magnetic flux rotates. Think of the accidents which may arise from flaws in axles and wire ropes, and you see how beneficial to man are these new applications of radio technique.

At least one company exists in America for testing railway lines for flaws and other defects in the rails: it provides a specially equipped railway truck which runs over the track at about five miles an hour. Two brushes, a little distance apart, continually conduct direct current to and from the bit of rail between them. Half-way between these main brushes is a trio of searching brushes connected in a kind of push-pull way to a transformer. The secondary of this transformer goes to a four-valve amplifier which works various relays, and when any kind of flaw upsets the symmetry of the current flowing in the rail, these relays do their work—they sound a warning buzzer, record the exact position on a travelling tape, and even go so far as to spray a blob of paint on to the offending bit of rail. Having done all this they send off a wireless message to H.Q., sacking the foreman responsible for laying that bit of rail . . . and that is the only bit of exaggeration this article contains.

WIRELESS THEORY SIMPLIFIED

Part XVIII.—Dynamic Resistance of Tuned Circuits.

By S. O. PEARSON, B.Sc., A.M.I.E.E.

(*Continued from page 74 of issue dated January 15th.*)

IN dealing with the parallel type of tuned circuit in the last issue we arrived at the important conclusion that, when tuned to resonance, the circuit behaves like a pure resistance of L/CR ohms, where L is the inductance of the coil, C is the capacity of the condenser and R the "equivalent series resistance" within the closed loop itself. The value L/CR ohms was referred to as the "dynamic resistance" of the tuned circuit, and can be defined as the resistance measured between the ends of the circuit when accurately tuned to resonance, because under these conditions the current is exactly in phase with the applied voltage.

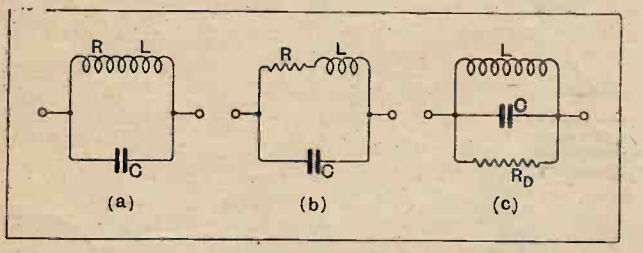


Fig. 1.—(a) Tuned parallel circuit with effective resistance R in the coil. (b) Equivalent circuit with internal resistance. (c) Equivalent circuit with whole of the resistance imagined in parallel. The equivalent parallel resistance is the dynamic resistance of the circuit.

In Part XVI it was shown that a circuit consisting of a perfect condenser in parallel with a resistanceless coil would allow no current to pass to and from the circuit at the resonant frequency; that is to say, for such a circuit the dynamic resistance would be infinitely great. Now, a practical circuit having an effective series resistance of R ohms, as shown in Fig. 1 (a), is equivalent to circuit (b) at any frequency; but at the resonant frequency it is also equivalent to a perfectly resistanceless tuned circuit shunted by a pure resistance of such a value that the current is the same as that taken by the actual circuit. This equivalent circuit is shown at (c) in Fig. 1, and the equivalent parallel resistance represents the dynamic resistance of the tuned circuit, its value being $R = \frac{L}{CR}$ ohms.

Numerical Values.

As a numerical example, suppose that a tuned circuit consists of a coil whose inductance is 2,532 microhenrys and whose high-frequency resistance is 50 ohms, connected in parallel with a condenser of 0.00025 microfarad capacity. The dynamic resistance will be $R_D = \frac{L}{CR} = \frac{2,532}{0.00025 \times 50} = 202,000$ ohms. (Note that it is not necessary to convert microhenrys to henrys and microfarads to farads in any formula where L and C form a ratio.)

This is the maximum impedance of the circuit, and in designing a tuned circuit the object in view is to obtain the highest possible dynamic resistance. The ratio of $\frac{L}{C}$ should be chosen as high as practical considerations will allow, and the coil resistance should be as low as possible. Now, in practice there are always losses, not only within the closed circuit itself, but associated with it due to connected apparatus, induced currents in neighbouring circuits and objects, and due to actual radiation. All of these go to reduce the dynamic resistance of the circuit or to increase the equivalent series resistance. For instance, suppose that the tuned circuit LRC of Fig. 1 (a) is, in effect, shunted by a resistance of r ohms due to some connected apparatus. The arrangement would then be as shown in Fig. 2 (a), being a circuit having both series resistance R and shunt or parallel resistance r. But we have already seen that the series resistance R has the same effect as a shunt resistance of L/CR ohms at the resonant frequency, and so the circuit of Fig. 2 (a) may be replaced by Fig. 2 (b).

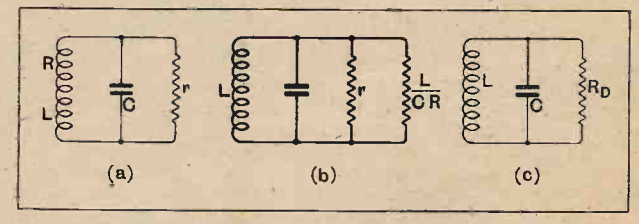


Fig. 2.—(a) Shunted tuned circuit. (b) and (c) Equivalent circuits. R_D is the resultant dynamic resistance and is given by $\frac{1}{R_D} = \frac{1}{r} + \frac{CR}{L}$.

Here we have a resistanceless tuned circuit shunted by the equivalent of two resistances r and L/CR ohms in parallel. The combination of these two resistances is the dynamic resistance of the tuned circuit of Fig. 2 (a). If R_D is the dynamic resistance, then $\frac{1}{R_D} = \frac{1}{r} + \frac{CR}{L}$.

Wireless Theory Simplified.—

Thus in its simplest form the equivalent circuit reduces to the arrangement of Fig. 2 (c) where R_D is the resulting dynamic resistance.

For the coil and condenser considered above the value of L/CR was found to be 202,000 ohms, or 0.202 megohm. Now, suppose that this circuit is shunted by a resistance of 500,000 ohms or 0.5 megohm. The dynamic resistance of the complete circuit will then be given by $\frac{1}{R_D}=\frac{1}{0.5}+\frac{1}{0.202}$, or $R_D=\frac{0.5\times 0.202}{0.702}=$ 0.144 megohm = 144,000 ohms. Thus the addition of the half-megohm resistance in parallel has reduced the dynamic resistance by about 30 per cent.

Comparison of Series and Parallel Circuits.

Comparing the series-tuned circuit with the parallel circuit we find that at the resonant frequency the former has its minimum impedance whereas the latter has its maximum impedance. Furthermore, the series circuit, where the energising voltage is injected into the closed circuit itself, has the property of giving a voltage magnification or step-up effect; but with the parallel circuit the voltage is impressed between its ends and no voltage magnification can possibly be obtained. As regards selectivity the two circuits obey similar laws, but are used under entirely different conditions. For instance, the series circuit, on account of its very low impedance at the resonant frequency (its value being equal to the effective resistance in the closed circuit itself), is usually found in places where the remainder of the circuit, of which it is a part, has low impedance or where it is independent of other circuits altogether. As a case in point the ordinary tuned grid circuit inductively coupled to the aerial or other source of alternating E.M.F. was referred to in a previous section dealing in detail with the properties of tuned circuits.

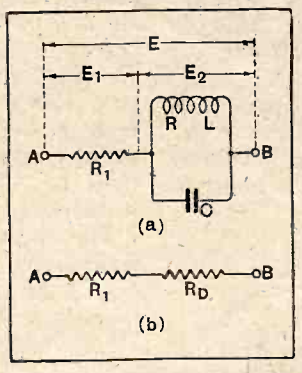


Fig. 3.—(a) Tuned circuit in series with a fixed resistance. (b) Equivalent circuit at the resonant frequency; $R_D=\frac{L}{CR}$ ohms.

The parallel circuit, on the other hand, has a very high impedance at the resonant frequency compared with its impedance at other frequencies, and is therefore always to be found in places where the rest of the circuit, in series with it, has a high resistance or impedance. The commonest example is the ordinary tuned-anode circuit where the A.C. resistance of the valve between the anode and cathode or filament constitutes the high resistance in series with the tuned circuit.

How a Parallel Tuned Circuit is Employed.

Since the tuned parallel circuit is incapable of giving any voltage step-up effect at the resonant frequency, it could not possibly have any selective properties unless used in conjunction with a series resistance in this manner, where the series resistance is more or less independent of frequency.

In order to see exactly how the presence of a series resistance of fixed value introduces selective properties, let us consider the circuit of Fig. 3 (a), where LRC is the tuned portion whose impedance depends on the frequency, and R_1 is a fixed non-inductive resistance independent of frequency. R is the effective resistance within the closed loop. Suppose that an alternating voltage whose R.M.S. value is E and whose frequency is f cycles per second is applied to the ends A and B of the circuit. Now, when the closed loop LRC is tuned to complete resonance with the applied frequency this part of the circuit is equivalent to a non-inductive resistance of L/CR ohms, this being the dynamic resistance R_D, and is in series with the fixed resistance R_1. Thus the circuit as a whole behaves like a simple arrangement of two resistances in series, the total resistance being R_1+R_D ohms, as shown by Fig. 3 (b). The R.M.S. value of the current is obtained simply by dividing the voltage E by this resistance.

Let E_1 be the voltage set up across the series resistance R_1, and E_2 the voltage across the tuned portion LRC. Then by Ohm's law $E_1=IR_1$ and $E_2=IR_D$ volts where I is the current. Each of these voltages is in phase with the current, and therefore they are in phase with each other. This means that the total voltage E applied to the ends of the circuit is equal to the numerical sum of E_1 and E_2, just as though it were a simple D.C. circuit; and, further, that the applied voltage is divided between the two portions of the circuit in the direct ratio of their equivalent resistances; that is to say, $E_1=E\frac{R_1}{R_1+R_D}$ and $E_2=E\frac{R_D}{R_1+R_D}$ volts at the resonant frequency.

A numerical example will make this clear. Suppose that L = 2,532 microhenrys, C = 0.00025 microfarad and R = 50 ohms as before. Then the dynamic resistance at the resonant frequency is 202,000 ohms. Suppose, further, that the series resistance R_1 has a value of 20,000 ohms and that the voltage applied to the ends of the circuit between A and B is 10 volts. The total resistance of the circuit when accurately tuned is 202,000 + 20,000 = 222,000 ohms and the current through it will be $\frac{10}{222,000}$ ampere. Thus the voltage across the tuned circuit will be $E_2=I\times R_D=\frac{10}{222,000}\times 202,000=9.1$ volts. That is to say, 91 per cent. of the available 10 volts applied is set up across the tuned portion LRC of the circuit, the remaining 9 per cent. existing across the series resistance R_1.

At any other frequency, different from the resonant value, the impedance of the loop LRC is a great deal less than L/CR ohms, and therefore a very much smaller proportion of the total voltage is set up across it. In tuning the circuit to resonance the chief aim is to get the highest possible fraction of the total available voltage to be set up across the tuned portion and as little as possible across the series resistance R_1, which would normally constitute the internal resistance of a

Wireless Theory Simplified.—

valve. Hence for good selectivity the value of the dynamic resistance L/CR ohms at the resonant frequency must be large compared with the series resistance R_1, whereas at other frequencies the impedance of the portion LRC should have a low value. This subject will be dealt with in greater detail when we come to the discussion of actual valve circuits.

The resonant frequency of the circuit considered above is $f=\frac{1}{2\pi\sqrt{LC}}=200$ kilocycles per second. Suppose now that the frequency of the applied voltage is increased to 210 kilocycles per second without changing the tuning of the circuit. The impedance of the tuned portion will now be $Z_2=32{,}200$ ohms,[1] and, incidentally, the voltage across it will no longer be in phase with the current passed by the circuit. Thus for a 5 per cent. increase in frequency the impedance of the tuned portion of the circuit is reduced from 202,000 ohms to 32,000 ohms, and therefore the ratio of the voltage across this part to the voltage across the series resistance R_1 is now only $\frac{32{,}000}{20{,}000}$ or 1.61. At the resonant frequency of 200 kilocycles per second the voltage across the loop circuit was seen to be just over 10 times as great as that across the series resistance, whereas at 210 kilocycles per second it is only 1.61 times as great.

These figures emphasise the fact that the parallel type of tuned circuit is highly selective when used in conjunction with a series resistance if the dynamic resistance of the tuned portion is high at the resonant frequency. In the ordinary tuned-anode circuit the object in view is to get as large a proportion of the wanted signal voltage as possible across the tuned circuit, losing as little as possible across the internal resistance of the valve. On the other hand, any unwanted signals of a different frequency or wavelength must be "lost" as far as possible in the internal resistance of the valve in the manner indicated above.

The opportunity is here taken of correcting an error which occurred in Part XV of this series. The second line of the second paragraph on page 24 should read—the external resistance r is $\frac{E_c^2}{r}$ watts.

(To be continued.)

[1] The impedance of a parallel circuit of this type is given at any frequency f by

$$Z_2=\frac{Z}{\sqrt{R^2+(\omega CZ_1^2-\omega L)^2}}\text{ ohms,}$$

where $\omega=2\pi f$ and Z_1 is the impedance of the coil itself at the frequency f.

NEW APPARATUS REVIEWED.

LOTUS DRUM VERNIER DIALS.

These drums are supplied as single units or in dual form for semi-ganging two-tuned circuits. The drum dial is standard in both models, the principal difference being in the shape of the condenser support and escutcheon plate. An epicyclic friction gear is employed, giving a reduction ratio of 10 : 1. The dial runs smoothly and without a trace of slip or "lumpiness." There is no backlash.

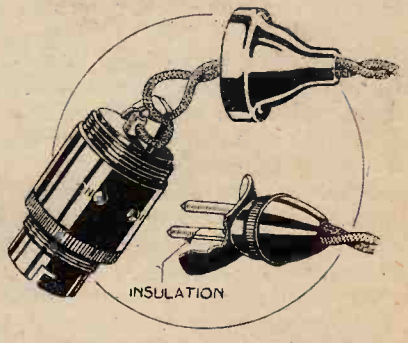
The driving disc is 4in. in diameter, $\frac{3}{16}$in. thick and provided with a milled edge. An ivorine scale 3½in. in diameter and $\frac{5}{8}$in. wide is fitted and engraved 0-180. Provision is made to accommodate a ¼in. condenser spindle, a small grub screw serving to position the dial.

Lotus single- and dual-drum Vernier dials.

The single and dual units can be obtained fitted with oxydised silver, bronze-finished metal escutcheon plates, or moulded-type can be had if required. These are in black or mahoganite bakelite. The price of the single unit is 9s., the dual assembly being offered at 18s. The makers are Garnett, Whiteley and Co., Ltd., Lotus Works, Mill Lane, Liverpool.

COMBINED LAMP HOLDER AND PLUG-POINT.

A cleverly designed lamp holder embodying a plug-point to which can be attached a battery eliminator, or domestic electric device, has been placed on the market recently by Wm. Beardsall and Co., Ltd., Victoria Bridge, Manchester, at the attractive price of 4s. 6d. There is no exposed metal, either "live" or otherwise. The body consists of a cleanly moulded bakelite shell carrying the usual bayonet-type lamp holder at one end and a cord-grip fitment at the other. The two-pin plug makes contact direct with the mains leads and not *via* the lamp plungers and springs. This is a point of some importance should the additional electric device demand a relatively heavy current. Massive contacts are provided, and these are rated to carry 5 amperes. It has not been thought necessary to fit a switch to control the extension point; removing the plug serves this purpose. A portion of the metal on one pin of the plug has been removed and the cavity filled in with some special insulating material. The contact points inside the holder are arranged so that on reversing the plug the lamp circuit is broken but without affecting the supply to the extension circuit. It is at once obvious that controlling the lamp by this means is possible only where A.C. is available—for battery eliminators or charging—or when the additional electric device operates irrespective of polarity. Reversing the plug changes the polarity of the supply on the extension leads. This useful accessory has been given the appropriate designation "Xtra-Point" lamp holder and plug.



"Xtra-Point" lamp holder. It is shrouded in bakelite and fitted with two-pin plug for extension lead. Can be used to supply a battery eliminator.

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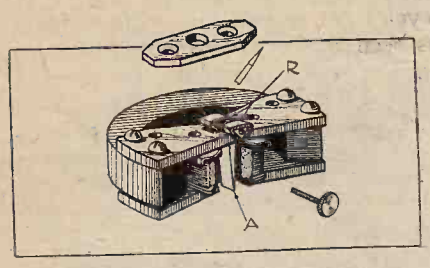
R.G.D. PICK-UP AND TONE ARM.

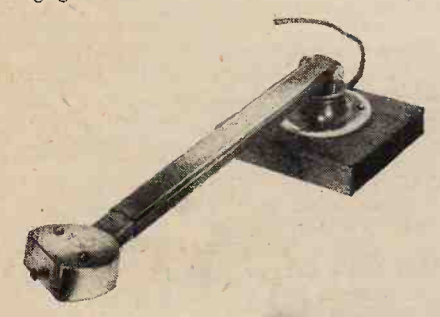
Made by the Radio Gramophone Development Co., St. Peter's Place, Broad Street, Birmingham, this unit forms an essential component of this firm's radio-gramophone equipment. The external appearance is particularly neat and businesslike, and the overall height is only 1½in., so that it can easily be accommodated under the shallowest cabinet lid. The tone arm is of hollow rectangular

section and is of negligible weight, and the pick-up unit is attached at such an angle that tracking errors are reduced to a minimum. The tone arm is extensible, giving a variation in length of about 1in.



Component parts of the R.G.D. pick-up. (A) armature. (R) rubber mounting.

The pick-up movement is sound in principle. The armature is kept down to the smallest possible dimensions and is mounted between the pole pieces in such a manner as to give differential variations of the flux surrounding the pick-up coil. Adequate control of the movement is obtained by clamping the knife-edge pivot between rubber packing. The needle set-screw passes through the axis of the pivot and its moment of inertia is therefore negligible.



The R.G.D. pick-up and tone arm.

The characteristic shows these principles of design to be justified, for the output is practically constant from 250 to 1,500 cycles. The principal reed resonance occurs at about 3,000 cycles, which is near the upper limit of fundamental frequencies in common use. No objectionable resonance could be detected by ear when playing ordinary records.

A few readings taken below 250 cycles showed that the characteristic rises slightly, but not sufficiently to correct deficiencies in the average record. An improvement could be effected here by decreasing the air gap to the smallest value consistent with manufacturing difficulties and freedom from chattering, as this would improve the output at low frequencies where the amplitude is large.

However, taking a general view, this pick-up is well above the average in performance and in use possesses a noticeable freedom from producing record wear.

The price finished in bronze is £3 and in oxydised silver £3 3s.

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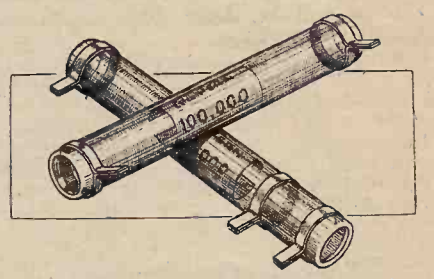
NEW COLVERN RESISTANCES.

With the rapid developments now taking place in the design of mains-operated sets the demand for resistances has enormously increased. In an all-mains A.C. receiver there may be more than half a dozen different resistances all capable of carrying a generous current and accurate to within narrow limits. To meet the need for an inexpensive component, Colvern Ltd., Mawney's Road, Romford, Essex, have developed a new series of wire-wound resistances carried on glass tubes measuring 3×½in. diameter. The wire, which is nickel chrome, is accurately space-wound as a single layer. The winding is terminated on metal bands, and a hard covering of bakelising material renders the resistance durable. To avoid the use of several series-connected resistances, tapping points are arranged by the use of additional clips. It is to be noted that with this form of winding the capacity from end to end of the resistance is exceedingly low, an important requirement when a resistance is used for the purpose of isolating H.F. circuits. Even with the highest value resistances the turns of wire are generously spaced.

The standard sizes advance in steps of 10,000 from a minimum of 10,000 to a maximum of 100,000 ohms, intermediate and higher values being supplied to order. The rating of the resistances is 10 watts, but on test it was found that 15 watts could be dissipated across a 50,000-ohm resistance without excessive temperature rise. A current of 10 mA. is safely passed by the 100,000-ohm resistance, and as 1,000 volts is required to produce this



New type Colvern resistances designed for use in mains-operated sets and eliminators.

current it is obvious that in ordinary use the resistance cannot be overrun. Small bent metal sockets are used for fixing, the connections being soldered direct to the clip on the resistances.

In sizes up to 50,000 ohms the price is 2s. 6d., and 50,000-100,000 ohms, 3s. 6d. Tapping points are provided to order at 1s. extra.

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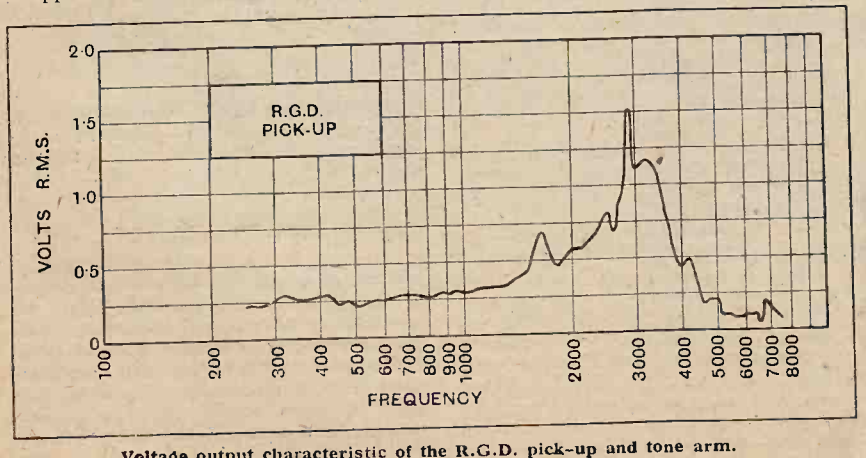
T.C.C. CONDENSERS.

A new process of manufacture has enabled the Telegraph Condenser Co., Ltd., Wales Farm Road, North Acton, London, W.3, to make a considerable reduction in the size of some of their well-known types of large-capacity condensers

Remodelled T.C.C. 4 mfds condensers. Note the generous size of the terminals.

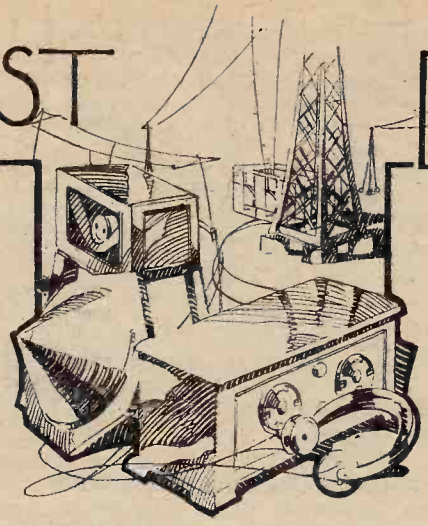
intended primarily for use in high-voltage battery eliminators. This applies particularly to the 4 mfds. 800-volt D.C. test models. It has been found possible to reduce the physical size by half without impairing the quality of the condenser. The working pressure is 400 volts D.C., and the price is 8s. 6d. Large-size terminals, well insulated from the metal container, are fitted.

The 400-volt D.C. test models are now fitted in moulded bakelite cases provided with two sets of fixing lugs, thus allowing for either upright or sideways mounting. Large terminals are fitted to this model also. The type illustrated is a 4 mfd. size, working voltage 200 D.C., and the price is 6s. 3d.



Voltage output characteristic of the R.G.D. pick-up and tone arm.

BROADCAST BREVITIES



By our Special Correspondent.

Regional Perplexities.

"You are wrong," wrote a listener to Savoy Hill last week. The Technical Correspondence Department had told him that the 261-metre transmission would come in better if he tried changing his present dial setting from 36 to about 24. "You are wrong. I find the correct setting is 22."

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A Clean Start.

This is the sort of client (and there are many of them) who has driven the engineers to yet another literary effort, this time in a form resembling an "A.B.C. of Correct Listening."

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How to Tune.

The instructions are simple enough to be intelligible to a novice who might mistake the tuning dial for a barometer. For example, listeners who cannot hear the 261-metre transmission are advised to "try the effect of turning the tuning adjustment of the receiver, which is usually a numbered scale, DOWNWARDS." This means, it is explained, that the adjustment should be turned to a lower number.

But enough of technicalities. Even the pamphlet deserts the higher mathematics after a time with the admonition: "See your local dealer."

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A Popular Fallacy.

One disturbing feature of the correspondence regarding Brookmans Park is the prevalent idea that mutual interference between the twin transmitters can only be temporary and that all will be well "when the stations have finished testing."

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More Power from Brookmans Park.

On the whole, the letters are of a friendly nature, and the majority of listeners seem to be taking steps to meet the new situation. I think their difficulties are increased rather than diminished by the fact that the B.B.C. is gradually augmenting the power of the 261-metre transmitter.

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An Opening Ceremony.

By the way, I hear that schemes are now in the air for an impressive opening ceremony at Brookmans Park when the two transmitters finish their tests. The inaugural speech will probably be made by the Postmaster-General.

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Synthetic Echo.

Have you noticed an increase in the echo effect in the Savoy Hill studios during the past week or two? The engineers are introducing more "synthetic echo" with orchestral transmissions, and many letters of approval have already been received. Hilversum and Radio Toulouse both make good use of artificial echo.

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The Millionth Oscillator.

What a world of drama lies behind the disclosure that Savoy Hill has nearly exhausted its stack of anti-oscillation pamphlets. I hear that the original printing order was for one million copies.

Instead of ordering a reprint, the B.B.C. has decided to prepare an entirely new edition, in which the experience of a million howls will form the basis of an appeal more moving than soothing.

FUTURE FEATURES.

London and Daventry (5XX).

FEBRUARY 2ND.—Mozart and Haydn Concert.

FEBRUARY 3RD.—Concert relayed from Frankfurt.

FEBRUARY 5TH.—Symphony concert relayed from Queen's Hall.

FEBRUARY 7TH.—"Warren Hastings," a play by Feuchtwanger.

FEBRUARY 8TH.—Running commentary on Arsenal *v.* Everton football match, relayed from Highbury.

Daventry Experimental (5GB).

FEBRUARY 3RD.—Concert of contemporary music.

FEBRUARY 4TH.—Fireside songs.

FEBRUARY 6TH.—"Warren Hastings," a play by Feuchtwanger.

FEBRUARY 7TH.—"Sax-Appeal," a saga of syncopation.

FEBRUARY 8TH.—"Witch Wife," a drama by Michael Hogan and Mabel Constanduros; and "The Crossing," a play by Holt Marvell and Cyril Lister.

Cardiff.

FEBRUARY 6TH.—"Tywydd Mawr" (Heavy Weather), a programme with sea shanties, by Hilda M. Isaacs.

FEBRUARY 8TH.—Operatic concert relayed from City Hall, Cardiff.

Manchester.

FEBRUARY 2ND.—Mendelssohn concert.

FEBRUARY 8TH.—"A Matter of Policy," a play by Gordon Phillips.

Glasgow.

FEBRUARY 6TH.—A "Scott" programme.

Belfast.

FEBRUARY 7TH.—Orchestral concert relayed from Ulster Hall, Belfast.

FEBRUARY 8TH.—Running commentary on Rugby International football match, Ireland *v.* England, relayed from Dublin.

The World Broadcast.

If, in an ordinary day, we flitted from one station to another all over the globe and heard the same transmission all the time, we should either curse the set or take a strong restorative. Last week it was different. During the broadcast of the Naval Disarmament Conference it would have been possible to hear the speeches from nearly two hundred stations. Of these nearly a hundred and fifty were in the U.S.A. and Canada.

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A Short-wave Triumph.

The honours go to 5SW. Several stations on the Continent which had arranged to take the broadcast by land-line chose the less expensive but equally efficient method of tuning in Chelmsford. Among the stations which preferred this method were Turin, Naples, Stockholm, and Vienna, the last two starting with land-line, but resorting to 5SW because the transmission was better.

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The Australian Beam.

There was also the "hush-hush" relay to Australia by means of the new telephony beam, which has not yet been put into public service. This was moderately successful.

Last week should certainly go down in wireless history as the occasion of the first real "world-broadcast."

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Why Not a Carillon Recital?

It seems a pity that the B.B.C. cannot be persuaded to broadcast a recital on the New Zealand War Memorial Carillon now temporarily erected in Hyde Park. A Savoy Hill official tells me that the proposal has been rejected because the carillon was broadcast from the North-East Coast Exhibition, but the excuse seems inadequate. Apart from the fact that carillon music broadcasts extraordinarily well, the B.B.C. might remember that the repertoire of available selections is fairly extensive, and there would be no necessity to repeat the pieces already heard.

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New Series of National Programmes.

The first of the 1930 National programmes, to be broadcast on February 6, will consist of a tribute to France. Other countries to figure in the series later will be Belgium, Czecho-Slovakia, Holland, Italy, Poland and Sweden.

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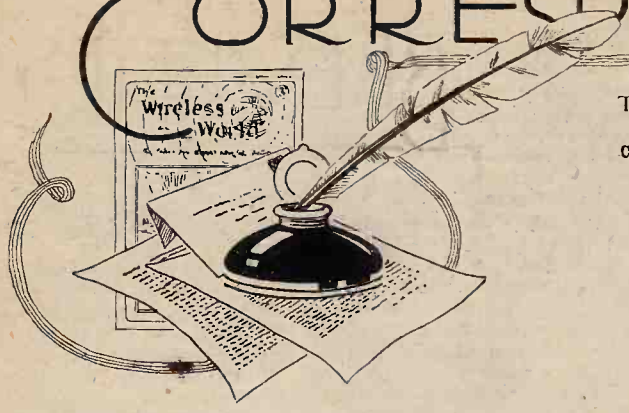
Women M.P.s at the Microphone.

"The Week in Westminster" will be described in a series of broadcasts from 2LO, starting on February 5. The three M.P.s who will be responsible for describing what Parliament is doing, turn and turn about, are Miss Ellen Wilkinson, Lady Astor and Miss Megan Lloyd George.

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.

WIRELESS LICENCE SCANDAL.

Sir,—I strongly disapprove of your article on the so-called "Wireless Licence Scandal," and fail to see why the tenants of the luxury flats should not have cheap wireless, if legally entitled to it, without your communistic sob-stuff being slung at them!

In any case the tenants of these flats are probably paying several thousands of pounds in taxation compared with the cottager—who is probably on the "dole"! BM/K.V.O.

London, W.C.1.

Sir,—Very pleased with "Editorial" in January 15th issue of *The Wireless World*. Gratifying to know that the Editor has such an eagle eye for an "injustice," and is broad-minded enough to give prominence to such a scandal in a technical journal. One of the roots of war is man's injustice to man. It is difficult to comprehend the mentality of people who will corner and violate the spirit of an Act. I suppose they would politely term it good business. Business is so often akin to charity; begins at home and covers a multitude, etc. The worst of it all is that so much good business savours of injustice, but is not brought to the light of day.

Wishing *The Wireless World* continued success.

Chatham. H. R. G. FORSTER.

THE P.M.G. EXPLAINS.

Sir,—The Postmaster-General's attention has been called to an article which appears on page 59 of the issue of *The Wireless World* dated January 15th, entitled a "Wireless Licence Scandal," and he desires me to inform you that the statement in the daily Press to which you refer in the third paragraph is inaccurate. No change has been made in the Post Office rules relating to wireless licences for apartment houses and flats.

G.P.O., London. W. E. WESTON,
For the Secretary.

REJECTOR CIRCUIT.

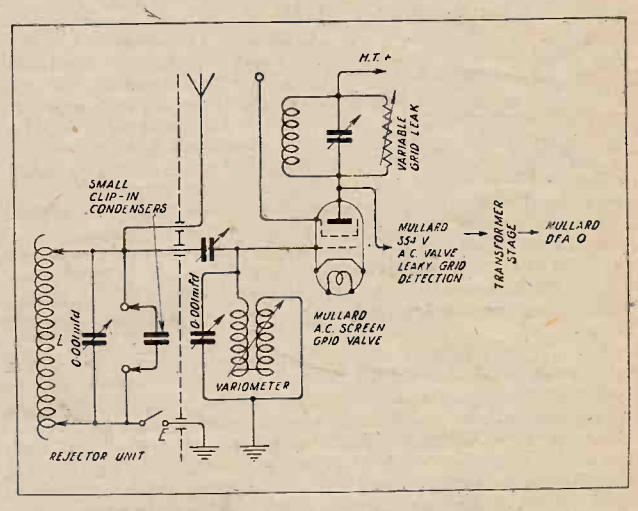
Sir,—Selectivity and quality of reproduction are seldom synonymous yet, and as one of the best known makers of sets can apparently do no better than provide three independent variables at the H.F. end, adjustment of any of which capsizes the lot, I send you this sketch of an arrangement which, though it contains much that is old, has the merit that it is easy to operate, needs no screening or decoupling gadgets, hairbreadth tuning, or even geared condensers, and, whilst amply sensitive, gives good reproduction with freedom from interference.

Neglecting the rejector unit for a moment, which we will suppose is disconnected by its switch above E on the left, the H.F. part consists of a straightforward arrangement of tuned anode with a tiny condenser between the aerial and the grid end of the variometer, which latter is used because, in conjunction with the variable condenser, it facilitates control of the waveform in the grid circuit, and can be adjusted so that the resonance curve will embrace the side bands. The tuned anode inductance can be damped by the variable gridleak across it, so that the H.F. valve will not oscillate, and this provides an easy control which introduces no distortion.

To tune in (rejector out of circuit), one sets the small aerial to grid condenser (Formodenser) at a small value near its minimum, and adjusts the previously calibrated tuned anode circuit, next bringing the grid circuit into resonance. The Formodenser should be set so that signals are about half as loud as could be obtained if it were not in circuit. Then the rejector switch is closed and the rejector brought into resonance, which can be done without upsetting the grid tuning at all, when the signals will greatly increase in strength.

We now have a loose coupled aerial system in which the coupling unit is the small condenser, with all the advantages of loose coupling, none of the drawbacks of inductive coupling, the beneficial double hump resonance curve to include the side bands, combined with unusual freedom from interference. But it is useless to expect such results unless the rejector is made up on proper rejector lines, with exceedingly low resistance, unless reaction is to be used, when we come to the Hinton rejector principle.

The theory of the rejector is well expounded in the Admiralty Handbook for Wireless Telegraphy (pp. 152-157), 1925 edition, and may be summarised by saying that the non-resonant frequencies are more readily drained away from the aerial as C becomes larger while L decreases, but that the voltage across the rejector falls somewhat as L decreases, all provided that the resistance is exceedingly low. The rejector inductance



should be made of something like copper strip, and the condenser should have definitely low resistance connections, particularly to the rotor, and the leads to the inductance should be of heavy flex.

As a guide to the ratio of L and C, for the region 2LO to Budapest, C can be increased to one-sixth of LC without undue clipping of the side bands, because of the double hump due to the coupling, but this takes us beyond any selectivity usually needed. It will be noted that the aerial capacity acts in parallel with the rejector condenser, and further, that, since the path to earth is so easy for non-resonant frequencies, neither they nor mush get into the grid coil. I can, however, give no guarantee that in this part of the country our enthusiastic friend FFB (Boulogne) will not force the set once in a way. Such a rejector can be readily applied to any set as a separate unit provided that no inductive coupling is made with the set components. WM. A. RICHARDSON.

Ashford, Kent.

IN SEARCH OF QUALITY.

Sir,—Let us congratulate Mr. Bertram Munn for his courageous article "In Search of Quality," even though we may not agree with his hearty condemnation of our particular pet—the moving coil. Nothing will convince me that the reproduction with his present unit is superior to a *really* good moving coil with an appropriate amplifier behind it, but undoubtedly his castigations of the average M.C. are well merited. There is, Mr. Munn, such a thing as a moving-coil speaker that does not thud.

But this letter is meant to be helpful and is prompted by Mr. Munn's penultimate paragraph, wherein he realises that his unit is not beyond reproach. Actually I am wondering if he has heard of the Western Electric 555W receiver. Moving-coil cone enthusiast that I am, I must admit that this unit on a large logarithmic horn beats the cone type easily. Added to which it is more efficient. But there are sundry snags: (1) I do not know if they are easily obtained, (2) they are probably expensive, judging by the workmanship, (3) the field eats up 1½ amps. at 7 volts, and (4) an output transformer would be required, the impedance being 15 ohms. And I hope that Mr. Munn will pardon me if I suggest that his horn would hardly do it full justice—the firm use a 14ft. horn cutting off at 57 cycles.

On reading this over I am afraid that it does not sound so helpful as it was intended to be, but I am sure that Mr. Munn would find that the results obtained would more than counterbalance the snags mentioned.

Incidentally, there was an article in *The Wireless World* about two months ago describing the fitting of such a unit on a horn some 25ft. long! R. C. PLAYER.

Worcestershire.

B.B.C. TRANSMISSIONS.

Sir,—The trouble with the "Look to your set" type of apologists for the shortcomings of the B.B.C. transmissions is that they seem to be as deaf to argument as they appear to be deaf to the imperfections of wireless. They ignore the fact which so many of us experience, namely, that, given a constant instrument at the receiving end, the quality of the sounds emitted by that instrument varies very considerably even when they are caused by the same transmitter on the same evening.

Speaking for myself, let me say that I am very conscious of the imperfections of my receiver, though it happens to include a liberal H.F. input to a diode rectifier, a resistance-coupled L.F. amplifier, L.S.5A output valve with 350 volts on its plate, a M.C. loud speaker and most, if not all, other modern improvements; and though some of my undiscriminating friends are kind enough to say that it gives results just like "the real thing."

The receiver, like all others, is undoubtedly imperfect. But that is really wide of the mark.

The point is that no receiver can, to take a striking example, accentuate the sibilants at one moment and almost entirely omit them the next, if that receiver remains unaltered. The fault must lie somewhere in the transmitting end; and, whilst the B.B.C. devote such a great deal of space in their publications to criticisms of their programmes, they give so very little space to criticisms of their transmissions from the technical point of view.

No doubt, as has been pointed out, faults at the transmitting end are often directly due to what one may call faulty wireless technique on the part of the various artists, or to errors of judgment in the control room. Artists who, so to speak, hurl their stuff at the microphone "come through" badly, whilst others who know how to humour the instrument come through far better. And the gentleman in the control room sometimes pushes something which, I take it, corresponds to a joy-stick forwards when he ought to push it back, and vice versa. But what does all this really show?

Surely no more than that the wireless transmitter, even at its best, is an imperfect instrument. And that is just the point which those of us who do not think that finality has been reached at the transmitting end are trying to make.

That all is not really perfect at the transmitting end is surely clear from the following quotation from the B.B.C. Year Book, p. 65 (the italics are mine):—"The *microphone* and the loud speaker continue to be the weakest links in all the long chain between artist and listener. The B.B.C., however, can record an advance in microphone design. A high quality capacity microphone has passed several severe tests and looks like being a standard for *most* studio work. The simpler and *more robust* carbon microphone must still carry the load of outside broadcasts, *cruder transmissions*, and so on, for some time to come."

From which it seems fair to conclude that even the most up-to-date microphone has its failings and that the "cruder" carbon microphone is responsible for at least some of the distortion which those of us who have ears to hear with so often notice.

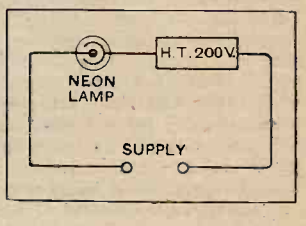
But why, one wonders, is information of this kind tucked away in a publication which appears but once a year, and why is it so very meagre as regards details? The B.B.C. transmissions are, in general, so good that surely the B.B.C. themselves can well afford to publish more information about them and more fair criticism of them? If this were the case, then we at our end would be in a far better position to "look to our sets" and correct as far as we can such failings as are there. E. C. RICHARDSON.

Sir,—I must reply to Mr. A. Gregson, of Bolton. I have heard fifty-nine stations on my set (not all at once), and, without any doubt whatever, Manchester has the other fifty-eight beaten to a standstill when it comes to quality.

Blackpool. "POLAR."

GRAMOPHONE SPEED TESTER.

Sir,—Your gramophone speed tester is a most useful accessory. The supply here is 200 v. 100 cycles, and, as there are many here who will no doubt like the advantages without having to draw up a fresh disc, perhaps you would publish the enclosed diagram, which enables it to be used without any further trouble.



No damage is done to the battery, which can be connected either way round.

Impulses are passed one way only, giving a 50-cycle effect.

Bournemouth. J. P. J. CHAPMAN.

RECEPTION OF CONTINENTAL STATIONS.

Sir,—With regard to the "Regional Scheme," "Reception of Continental Stations," and "The Thirst for Power," I should like to contribute some observations. Each country has its regional scheme. Warsaw, our capital, now has a station working with 12 kW. which in the near future will be 120 kW. In a week or so we are to have 1½ kW. local stations working on 218 metres. Everything is done for the crystal set user and to cater more and more for such listeners. But in your country, where crystal users are in a minority, there is no reason to erect so many powerful stations as 5XX, 5GB, and the new 2LO. I, personally, am very pleased that the power of 2LO is so strong that I can receive it at 11 p.m. on a one-valve Reinartz set in Warsaw, but it is a pity that it very often interferes with Graz, and then it is no pleasure to listen to Brookmans Park. I would like to appeal to all *Wireless World* readers to consider which foreign stations are worth listening to and make a record of them. After obtaining such material all European radio editors might collect it and send it to the next international radio conference with the listeners' requests that the selected stations might get more consideration in the ether. In this way it should be possible to increase the power of selected stations and minimise interference. According to the "Regional Scheme" I believe it is far better to erect many ½ kW. stations on the same wavelength than a few powerful stations. Listening sometimes on Berlin's common wavelength I can say from experience that distant reception is quite possible with very slight marring. In the selection of stations I would suggest as a standard the use of 1SG-V-2 sets.

M. S. MARCINKOWSKI.

READERS' PROBLEMS ANSWERED

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.

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

Lost Volts.

The screening grid of my 1-v-1 receiver is fed through a 1,000-ohm decoupling resistance. In determining the correct point on the H.T. battery to which the lead feeding this circuit should be connected, is it necessary to take into account the voltage absorbed in the resistance? A. C. P.

Practically speaking, no. Assuming a screening grid current of 0.5 milliamp., 0.5 volt only will be "dropped" in the resistance.

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Gramophone Speed Indicator.

Can you supply data for making an indicator on the lines described in your issue of January 8th, but modified to suit a 40-cycle supply? M. F. P.

The number of black lines required on the stroboscopic disc is arrived at by multiplying the A.C. frequency by 120 and dividing by the required r.p.m. of the gramophone turntable. This calculation will reveal that 60 bars will be needed on the disc when running at 80 r.p.m. and used with a 40-cycle supply. For 78 and 79 r.p.m. the relationship between frequency of supply and revolutions per minute is not an exact quantity.

The Output Filter as an Aid to Stability.

Is it correct to assume that an output filter will tend to prevent L.F. oscillation and motor-boating in a receiver fed from an eliminator or from a battery with a high internal resistance? E. M. N.

Yes. As compared with the more usual practice of connecting the loud speaker direct in the anode circuit of the output valve, the use of a filter confers an important advantage, because its inclusion tends to deflect the audio-frequency component from any resistance or impedance in the common anode circuit.

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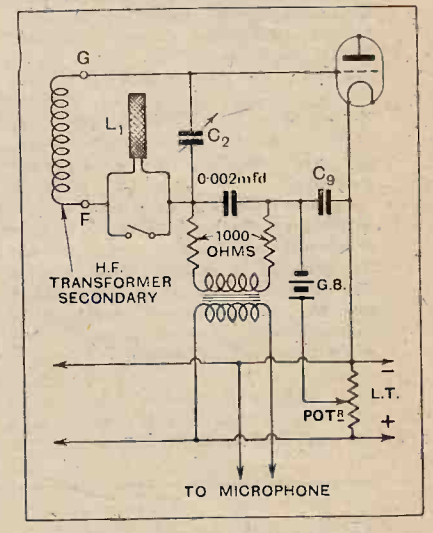
Another Harassed Parent.

Inspired by your reply to "T. S. W." in the "Readers' Problems" section of your issue for December 25th, I have been trying to connect a microphone in the detector grid circuit of my "Everyman Four" receiver (revised circuit, as described in the fourth edition of the booklet). Unfortunately, this addition results in instability over a good deal of the tuning scale unless the H.F. valve filament is dimmed considerably; for local station reception this is not a serious drawback, but it is rather inconvenient to have to disconnect the microphone transformer when distant stations are to be received.

Can you give me any hints as to how the trouble may be overcome, and at the same time suggest a method of using the L.T. battery of the set for supplying current to the microphone circuit—if this is possible, as I believe it is? W. B. B.

It is not unusual to find that the addition of any extra wiring in the detector grid circuit will bring about instability unless all the leads are kept very short, and in the first place we would suggest that you should try to improve matters in this respect.

Perhaps it would be as well to adopt the arrangement shown in Fig. 1; this includes an arrangement of non-inductive resistances and a by-pass condenser which will tend to prevent the development of H.F. potentials at points where they may be passed back by stray inductive or capacitative couplings to the grid circuit. If possible, we recommend you to earth the core and metal shroud (if any) of the microphone transformer. The by-pass condenser, given as 0.002 mfd., should be as large as it is possible to make it without bringing about too serious a reduction of microphone signal strength.



How to introduce a microphone into the detector circuit of the "Everyman Four."

The low-tension battery may be used in the manner indicated for supplying the microphone circuit; it should be pointed out that, if necessary, a series resistance may be inserted in order to reduce the flow of current.

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Station-to-Station Switching.

Will you please tell me if it would be possible to adapt the method of tuning (with fixed coils and semi-variable condensers) included in the "Twin-Station Two" for reception of the two Daventry stations? W. T. R.

This method is not applicable to the design of a set intended to receive two transmissions of widely divergent wavelength. To attain this object with a switch change-over it is, practically speaking, necessary to duplicate both the coils and condensers.

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.

Switched Neutralised H.F. Amplifiers.

From statements made from time to time in "The Wireless World," I gather that it is by no means easy to apply the principle of waveband switching to a neutralised H.F. amplifier. Will you please tell me if a practical design of a receiver including this arrangement has been published? C. D. N.

As you suggest, it is rather difficult to introduce a switching scheme into an amplifier of this sort, partly because it is necessary to make provision for changing over at least three circuits—primary, secondary and neutralising. Troubles are most likely to be encountered when one is aiming at high efficiency on both medium and long wavebands. The problem could be simplified a good deal if one were content with comparatively low amplification on, say, the long waveband.

A receiver with neutralised H.F. amplification (three-electrode valve) was described in our issues of July 4th and July 11th, 1928.

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"A Quality Receiver."

I live almost exactly midway between the London and Daventry stations; taking into account the comparatively high power of these transmissions, do you consider that the receiver shown in Circuit No. 3 of "The Wireless World Diary" for 1930 would be sufficiently sensitive for the reception of these transmissions?

If it is considered that more amplification is necessary, I take it that a neutralised triode would provide all that is necessary, and should like to have a circuit diagram showing the modifications necessary to this receiver, plus an added separately tuned aerial circuit. T. D. B.

In our opinion it would be unwise to expect this comparatively insensitive receiver as it stands to provide sufficiently strong signals from the stations whose programmes are required, and we feel sure it would be best and safest to add an H.F. stage—which, as you suggest, may be of the low-gain variety. It is assumed that the long-wave Daventry transmission will not be required, so the design may be simplified accordingly.

The circuit diagram for which you ask is given in Fig. 2; for the sake of completeness, we have added the L.F. amplifying portion of it, and have included capacity-controlled aerial coupling, as this arrangement is both simple and adequate.

FOREIGN BROADCAST GUIDE.

MOSCOW-POPOFF

(Russia).

Approximate Geographical Position: 55° 42′ N. 37° 39′ E.

Approximate air line from London: 1,552 miles.

Wavelength 1,103 m. Frequency 272 kc. Power 40 kW.

Time: Eastern European (two hours in advance of G.M.T.).

Standard Daily Transmissions.

14.30-16.00 G.M.T. musical concert (Wednesdays: 16.00-18.30). 18.00 or 18.30 relays of other Russian stations, or foreign programmes. Tuesdays: gives own studio programme, and dance music at 21.00

Man and woman announcers. Call (phonetic): *Sloo-schah-eetee* (twice), *sdie Govoreet Moskva Popov*. Between items: *Govoreet Moskva Radio Central.*

Closes down with words: *Das-vee-dan-yee spak-on-yee-notch* (au revoir, good night).

Absorbing Surplus Voltage.

Is there any limit to the voltage that can be safely absorbed by a resistance inserted in series with the anode of an amplifying valve? In my own particular case I wish to reduce a voltage of 450 to 150 volts—the maximum specified by the makers of the valve. E. T. H.

In this case it should be quite in order to insert a series resistance (of a value depending, of course, on the current consumed by the valve). It is safe enough to do this when dealing with an amplifying valve, but it would hardly be wise in the case of an anode bend detector, of which the mean anode current varies with impressed signal voltages.

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Accumulator Charging at Home.

I estimate that a 600-watt lamp would be required to pass the necessary current for charging my L.T. accumulator from the D.C. mains supply. It is understood that lamps of approximately this wattage can be obtained, but they are very expensive, and I am inclined to think that in this case some other form of resistance would be much better. Will you please give me your advice? E. R.

Although lamps will serve as voltage-reducing resistances, it is hardly recommended that they should be used when a heavy current is to be passed, but it may be pointed out that in your case there is no need to use a single expensive lamp of the full required wattage. It would be more economical to employ a number of cheap carbon filament lamps connected in parallel.

Perhaps your best plan is to use a "bowl heater" or similar appliance. These are not very costly, and in many cases the heat given off may be used to advantage, thus offsetting the usually heavy cost of charging low-tension accumulators from a D.C. supply

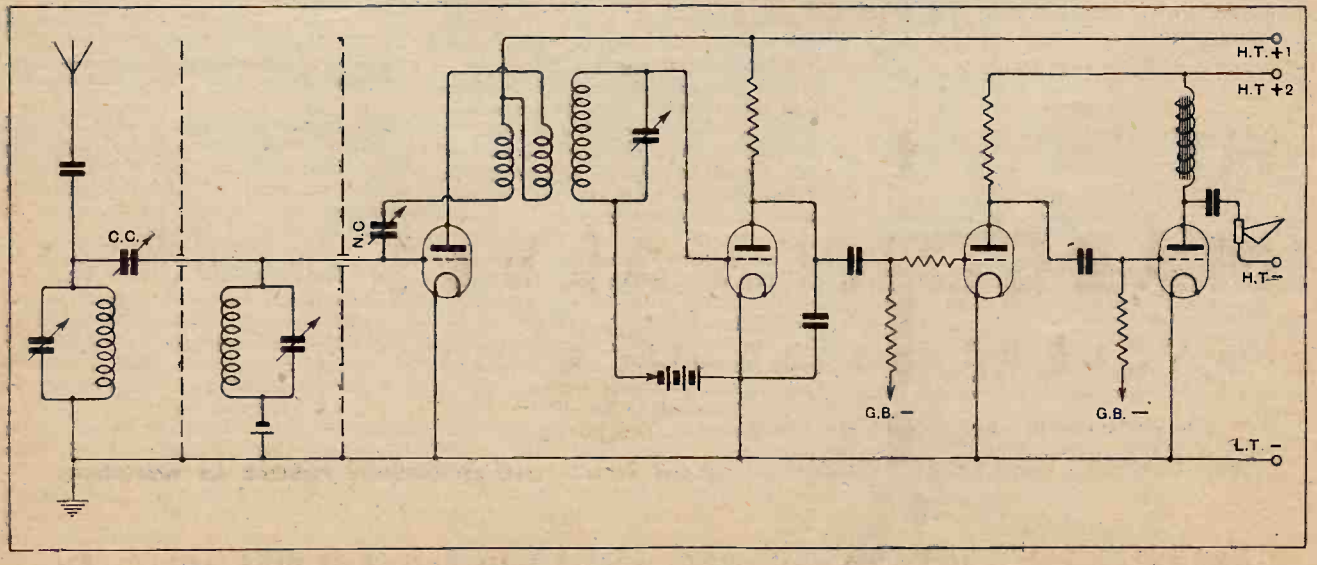
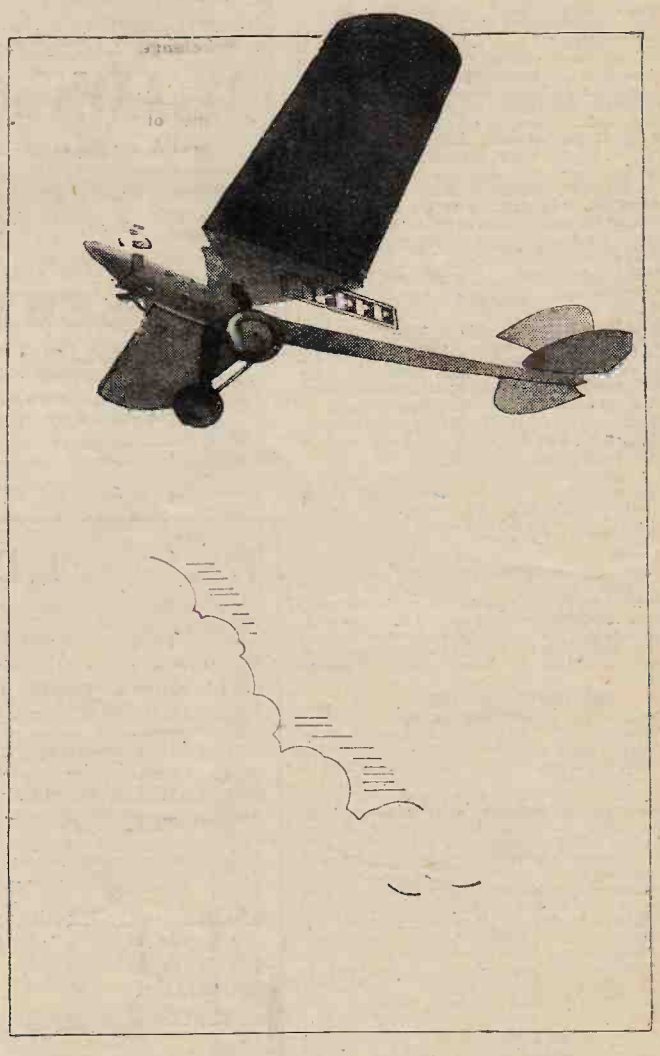


Fig. 2.—A "Wireless World Diary" circuit with two low-gain L.F. stages, modified by the addition of an H.F. amplifying valve.

3 HOURS — 300 MILES!

10,000 FEET UP! Giant Air Liner roars through clouds. Airport wirelesses warning—"Fog over French Coast." 'Plane in constant touch — receiving orders, reporting weather conditions—*through Marconi Valves.* All Imperial Airways machines are fitted with Marconi Valves. So is Croydon Control Tower. All British Broadcasting Stations . . . all Trinity House lightships . . . all Trinity House beacon stations . . . most British passenger ships . . . use Marconi Valves. For their reliability. For their long life. For their wide range.



● *In cases like these, when unfailing efficiency is essential, men insist on Marconi Valves*

FIT MARCONI VALVES

TO YOUR RADIO SET

Give you clearer tone, greater volume, longer range. Cost not a penny more. Fit any set.

The first and greatest name in wireless

MARCONIPHONE COMPANY LIMITED, 210-212 Tottenham Court Road, London, W.1

A39 *Advertisements for "The Wireless World" are only accepted from firms we believe to be thoroughly reliable.*

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NUMBERED ADDRESSES.

For the convenience of private advertisers, letters may be addressed to numbers at "The Wireless World" Office. When this is desired, the sum of 6d. to defray the cost of registration and to cover postage on replies must be added to the advertisement charge, which must include the words Box ooo, c/o "The Wireless World." Only the number will appear in the advertisement. All replies should be addressed No. ooo, c/o "The Wireless World," Dorset House, Tudor Street, London, E.C.4. *Readers who reply to Box No. advertisements are warned against sending remittance through the post except in registered envelopes ; in all such cases the use of the Deposit System is recommended, and the envelope should be clearly marked "Deposit Department."*

DEPOSIT SYSTEM.

Readers who hesitate to send money to unknown persons may deal in perfect safety by availing themselves of our Deposit System. If the money be deposited with "The Wireless World," both parties are advised of its receipt.

The time allowed for decision is three days, counting from receipt of goods, after which period, if buyer decides not to retain goods, they must be returned to sender. If a sale is effected, buyer instructs us to remit amount to seller, but if not, seller instructs us to return amount to depositor. Carriage is paid by the buyer, but in the event of no sale, and subject to there being no different arrangement between buyer and seller, each pays carriage one way. The seller takes the risk of loss or damage in transit, for which we take no responsibility. For all transactions up to £10, a deposit fee of 1/- is charged ; on transactions over £10 and under £50, the fee is 2/6 ; over £50, 5/-. All deposit matters are dealt with at Dorset House, Tudor Street, London, E.C.4, and cheques and money orders should be made payable to Iliffe & Sons Limited.

THE SALE OF HOME-CONSTRUCTED UNLICENSED APPARATUS.

A Service to our Readers.

We have made an arrangement with the Patentees whereby readers who wish to dispose of a home-constructed receiver not licensed under the patents made use of, can license the set by means of the Deposit System referred to above.

The person desiring to sell, in sending us particulars for his advertisement, will in every case make use of a Box No., and should add to the price which he requires the amount of royalty customarily paid by manufacturers.

If the purchaser is satisfied with his purchase, the sum realised will be forwarded to the seller, less the amount due in respect of royalties, which amount will be paid by "The Wireless World" to the owners of the patents concerned, and a certificate will be handed on to the purchaser of the set.

SPECIAL NOTE.—Readers who reply to advertisements and receive no answer to their enquiries are requested to regard the silence as an indication that the goods advertised have already been disposed of. Advertisers often receive so many enquiries that it is quite impossible to reply to each one by post.

RECEIVERS FOR SALE.

SCOTT SESSIONS and Co., Great Britain's Radio Doctors.—Read advertisement under Miscellaneous. [0264

FERRANTI 5-valve, push-pull amplifier, twin turntables, Magnavox speaker on 3ft. baffle, all new; cost £56, accept £30; delivered within 100 miles.—Bradford, Entertainer, Whitchurch, Bristol. [7943

B.T.H. Senior R.K. Amplifier, mahogany case, cost £45, accept £20; also Burndept Screened Four, as new, £12.—Box 4605, c/o *The Wireless World.* [8056

METRO Vick 5-valve Set, switch 4 valves, new 2 volt valves, 3 super power, also 5-6-volt valves included, 2 coil boxes, long and medium waves, good condition; cost £35, accept best offer over £8.—Smart, 30, Treen Av., Barnes, S.W.13. Tel.: Putney 4050. [8053

5-VALVE Solodyne, complete, 2 spare valves, 180v. H.T., 6v. L.T. accumulators, Western Electric moving coil speaker; sacrifice, £25.—Lloyd, 9, Primrose Mansions, S.W.11. [8052

METRO Vick 3-valve Set (V.2R.C.), complete, with accumulator, 2 60-volt H.T. batteries, Amplion horn unit, type A.R.39; £3, post extra.—Watts, 1, Elton Rd., (Entrance Elmdale), Tyndall's Park, Bristol. [8049

EXPENSIVE Ex Government Testing Set, in mahogany cabinet, with box of shunts, measures, voltage resistance, and current; cost £25, offered for £6/5; approval, deposit.—Owen, Wireless Works, Hodnet, Salop. [8046

BARGAIN.—Ready Radio portable screened grid 4-valve set, in beautiful mahogany cabinet, as new, £22/1, accept £10/10; also Blue Spot 66K, assembled with Squire cradle in mahogany cabinet, not used, £2/2/6.—E. A. Barker, 91, Hounsditch, E.C.3. [8044

3-VALVE Short Wave and Broadcast Receiver, complete, walnut cabinet, balanced armature speaker, 'phones, Jack switching, new valves, batteries, etc.; £10.—Below. [8037

BOWYER LOWE 7-vave Superhet, folding frome, 2 sets of valves; what offers?—Bloom, Fire Station, Letchworth. [8035

GECOPHONE 2-valve Cabinet, H.F. and D., D.E. valves, coils,, Gecophone amplifier, 2-stage L.F. D.E.R. valves, plug adaptors, 3 pairs 'phones, phone disc board; 5 guineas lot.—Pringle, 420, Main Rd., Darnall. [8032

ALL Mains Gambrell A.C., 4-valve; £15 (cost £42).—S.M.D., 2, Bucknall St., W.C.2. [8024

MULLARD 3-valve Screened Grid, set in fine mahogany cabinet, enclosing H.T. batteries and L.T. accumulators, almost new; 10 guineas, or near offer.—Box 4553, c/o *The Wireless World.* [8041

WIRELESS Portable Sets, with 5 Cossor new process valves, for 9 guineas; less than components cost, comparable with any set double this price, Royalty paid; seen between 1 and 2 p.m., or particulars sent on receipt of stamped addressed envelope.—G. Hodgson, 53, Windsor House, Victoria St., Westminster. [7971

GRAMOPHONE Amplifiers and McMichael Portable Sets Lent on Hire; sets modernised, installed and maintained.—Alexander Black, The Wireless Doctor, 55, Ebury St., S.W.1. Sloane 1655. [0328

NATIONAL Portable, just overhauled by makers, new batteries, perfect tone; £8.—BM/BRIER, London, W.C.1. [8041

WE Offer You the Following Inducements to Purchase Your New Receiver or Other Apparatus from us.

FIRSTLY.—Unbiassed advice. The Principal of the firm has twenty years' professional wireless experience, having been at Government Experimental Stations in 1910. He has been Manager for the Sterling Telephone Co., radio expert to the G.E.C., and Chairman of the Technical Committee of the National Association of Radio Manufacturers. His advice has saved our clients many thousands of pounds, for, as everybody knows, there is no hobby on which more money is wasted on useless apparatus by the uninitiated.

SECONDLY.—We take your old apparatus in part exchange for new. Send us a list of your old apparatus, or, better still, send us the apparatus, and state your new requirement. We will then make our offer for your goods, and if you do not approve, which is unlikely, we will return the parcel, carriage paid.

IF You are in Doubt as to the Make of Receiver or other Apparatus you should Purchase, write to us, and we will advise you; we have no leaning towards any particular maker, and will tell you the particular instrument you should buy for your purpose.

SCIENTIFIC DEVELOPMENT Co., 51, Fishergate, Preston. Tel.: 1364. [0226

SIMMONDS BROS.—Receivers constructed to your own or any published design; also repairs, reconstructions; and modernisations at moderate charges; best materials and workmanship guaranteed; numerous testimonials; quotations free.—Address, Shireland Rd., Smethwick. [5882

THREE 2-valve Sets, £3 each; four 3-valve sets, £4 each; three 5-valve portables. £8 each; new and ready to switch on; guaranteed; many other bargains while they last.—Adams, 48, Tyrwhitt Rd., S.E.4. [8075

Receivers for Sale.—Contd.

6-VALVE Fada Special; £5.—Goodmans, 27, Farringdon St., E.C.4. [8099

3-VALVE A.C. Mains, both wavelengths, suitably selective for close to Brookmans Park, mahogany case; selling account getting larger set.—Box 4615, c/o *The Wireless World*. [8112

FLAT-DWELLERS' Three, all mains, complete set parts as specified, including box, valves, etc.; cost £20, £12, no offers.—Box 4614, c/o *The Wireless World*. [8104

3-VALVE Set, with Osram P.240, Exide H.T. 120 volts, and Trickle charger (220v.), Ediswan speaker, set in mahogany dome top cabinet with doors, G.B. and Exide L.T.; £10; vendor building mains set.—Bryant, 2, South Ridgway Place, Wimbledon, S.W.19. [8092

ZENITH American 6-valve Neutrodyne, with valves, perfect, single control, 35 stations; £8.—2a, Salisbury Rd., Seven Kings, Essex. [8088

3-VALVE Portable, £4/15; suitcase 5-valve, £6; both complete, perfect, guaranteed.—Harris, 8, Rusham Rd., London, S.W.12. [8083

SUPERHETERODYNE.—Igranic Superhet., 6 valves, with additional H.F. unit, 7 valves in all, complete with all valves, frame aerial, etc., perfect condition, fully licensed; genuine bargain, £10, or near offer considered.—Burbridge, "Timescombe," Solihull. [8072

McMICHAEL S.V. suitcase Portable, as new, new batteries; 18 guineas, cost 28 guineas.—Box 4613, c/o *The Wireless World*. [8069

PHILIPS 3-valve Set, A.C. eliminator, 200-250 volts, Philips cone speaker, equal new, very cheap, what offers? Also Magnavox moving coil horn speaker, with A.C. rectifier.—C. R., 21, Highbury Quadrant, N.5. North 1508. [8063

PHILIPS All Electric 3-valve Set, also Celestion C12, just new; for quick sale £20, or nearest offer.—McEwen, 17, Craven Rd., W.2. [8062

HALCYON 5-valve Portable, 30 guineas, just overhauled by Halcyon; Celestion speaker, perfect, £14/10.—4, Brecon Rd., Handsworth, Birmingham. [8090

ACCUMULATOR HIRE.

DON'T Buy Accumulators or Dry Batteries, join our C.A.V. low- and high-tension accumulator hire service, the largest and best in London; better and cheaper reception with no trouble; regular deliveries within 12 miles of Charing Cross; no deposit, payment on each delivery or by quarterly subscription; over 10,000 satisfied users; explanatory folder post free; 'phone or write to-day.—Radio Service (London), Ltd., 105, Torriano Av., N.W.5. 'Phone: North 0623-4-5. [7596

C.D.E.S. Accumulator Hire and Maintenance Service (5 mile radius).—98, Cherry Orchard Rd., Croydon. [6374

BATTERIES.

WET H.T. Replacements.—Sacs (capped or uncapped), highest grade, No. 1, 10d. per doz.; No. 2, 1/9 per doz.—See below.

ZINCS.—Best quality (wired), No. 1, 8d. per doz.; No. 2, 9d. per doz.; orders valued 5/- carriage paid, otherwise 6d. for postage.—British Battery Co., Clarendon Rd., Watford, Herts. [0258

FULLER H.T. Accumulators for Sale, owner changing to mains; 120 volt 3 a.h., just overhauled by makers, each cell air spaced and mounted in rubber treated wood crates, 2v. tappings charged; inspection Bristol.—Offers to Box 4602, c/o *The Wireless World*. [8058

CHARGERS AND ELIMINATORS.

TANTALUM and Lionium for A.C. Rectifiers; make up your own inexpensive chargers; blue prints for H.T. and L.T., 1/- each; Lionium electrodes fitted with terminals, 2-3 amps. and 5-8 amps.—Blackwell's Metallurgical Works, Ltd., Speke Rd. Works, Garston, Liverpool. 'Phone: Garston 980 (2 lines). [6282

PHILIPSON'S Safety High Tension Battery Eliminators.

10/- Down and the Balance in Easy Monthly payments secures the finest high tension supply available.

PHILIPSON'S Safety Eliminators are Guaranteed for 12 Months.

PHILIPSON'S Safety Eliminators are the Cheapest to Install and the Cheapest to Run; prices: Model A.C.5 £4/17/6, A.C.7 £3/17/6, complete with full wave, rectifiers; D.C.4 37/6, D.C.5 45/-.

ALL Models Obtained for 10/- Deposit; take advantage of this and get constant high tension immediately.

WRITE for Our Booklet, "Radio Power" to Philipson and Co., Ltd., Radio Engineers, Astley Bridge, Bolton. 'Phone: 2038. 'Grams: Safety, Bolton. Est. over 50 years. [0318

CHEBROS.—Chebros for all types of transformers and chokes, high grade instruments at a very moderate price; enquiries invited.—Chester Bros., 244, Dalston Lane, London, E.8. [5290

Chargers and Eliminators.—Contd.

TRANSFORMERS and Chokes for Battery Eliminators and for all wireless purposes, receiving or transmitting; enquiries invited.—Chester Bros., 244, Dalston Lane, London, E.8. [7587

SECOND-HAND Philips's Rectifier for Sale, 190-200 volts, 40-100 cycles, complete, perfect condition; £2.—May be seen at 24, Connaught Av., East Sheen, S.W.14. [8039

VALLEY A.C. Charger, H.T. and L.T.; £2/10.—Scott, 10, East Parade, Ilkley [8051

SAVAGE'S Specialise in Wireless Power from the Mains, reliable apparatus at reasonable prices.

SAVAGE'S.—Transformer laminations and bakelite bobbins; intending home constructors should write for list.

SAVAGE'S.—Reliable smoothing condensers, 1,000 volt D.C. test, 1 mfd., 2/-; 2 mfd., 3/-; 4 mfd., 5/3; 500 volt D.C. test, 1 mfd., 1/6; 2 mfd., 2/3; 4 mfd., 3/9.

SAVAGE'S.—Super smoothing and output chokes, many types available; write for list.

SAVAGE'S.—Mains transformers for Westinghouse H.T.4 unit, 18/6; A3, 17/-; A4, 20/-.

SAVAGE'S.—Mains transformers for Westinghouse H.T.4, with additional winding, 4 volts 3 amps., 23s.

SAVAGE'S.—Mains transformers V.T.31, 200-0-200 volts 60 m/amps., 2+2 volts 2 amps., 2+2 volts 3 amps, 28/-.

SAVAGE'S.—Mains transformers V.T.35, 250-0-250 volts 60 m/amps., 2+2 volts 1 amp., 2+2 volts 3 amp., and, for automatically biased super power valve, 3+3 volts 5 amp., 33/-.

SAVAGE'S.—Mains transformer B.T.3, 500-0-500 volts 120 m/amps., 3.75+3.75 volts 3 amps., 3+3 volts 3 amps., 2+2 volts 3 amps., 51/-.

SAVAGE'S.—Mains transformers and power chokes are carefully and individually constructed from first class materials with an exceptionally generous margin of safety.

SAVAGE'S, 146, Bishopsgate, London, E.C.2. 'Phone: Bishopsgate 6998. [7976

RADIELLE A.C. 200-volt R.K. Model Eliminator, cost £13/13, perfect order, complete with rectifying valves; £6.—H. Lousada, 9, Aubert Park, Highbury, London. [8091

EKCO H.T. Eliminator, IV20, variable and power tappings, D.C. mains, unused prize; nearest offer £2.—104, Fairmead Av., Westcliff-on-Sea. [8087

MAJESTIC Eliminator, input 200-250/50 cycles, output 200 volts, 30-35 m.a., 2 variables, 0-140; cost £7/15, sacrifice, £3/17/6, plus carriage; wanting higher output.—Whittle, 22, Luck Lane, Huddersfield. [8080

IGRANIC H.T. Unit and Auto Charger Combined, practically new; cost £13/10, take £8.—Write Box 46, c/o 487, Finchley Rd., N.W.3. [8114

CABINETS.

ARTCRAFT Radio Cabinets are Britain's Best Value. [0315

DIGBY'S Cabinets.—Table models in solid oak and mahogany; from 11/6 to 71/-.

DIGBY'S Cabinets, fitted with Radion or Resiston ebonite if required.

DIGBY'S Cabinets.—Pedestal model, with separate battery components; from 56/- to £12.

DIGBY'S Cabinets Made to Customer's Own Designs.

DIGBY'S Cabinets.—Write for new 16-page art catalogue.—F. Digby, 9, The Oval, Hackney Rd., E.2. 'Phone: Bishopsgate 6453. [0128

ARTCRAFT Radio Cabinets; Britain's best value; lowest prices consistent with highest quality; illustrated list free from actual manufacturers.—Artcraft Co., 156, Cherry Orchard Rd., Croydon. 'Phone: Croydon 1981. [0040

KAY'S Cabinets, the greatest range of pedestal cabinets in the kingdom; original creative designs at prices 50% lower than elsewhere; quotations for specials by return; delivery at short notice guaranteed; moving coil, portable, baffle, vignette, radiogramo. electric pick-up, television, etc.; illustrated lists free. —H. Kay, Wireless Cabinet Manufacturer, Mount Pleasant Rd., London, N.17. 'Phone: Walthamstow 1626. [7745

ARTCRAFT Radio Cabinets are Britain's Best Value. [0314

SLIGHTLY Soiled Large M.C. Cabinets, approx. 18×18; from 17/6, usual price £2/2, upwards. —Goodmans, 27, Farringdon St., E.C.4. [8096

ARTCRAFT Radio Cabinets are Britain's Best Value. [0309

EVERYTHING in Cabinets.—Radio gramophone, £4/15; sideboard radio gramophone, £13/10; speaker cabinets, from 9/6.—Baker, 407, Hackney Rd., E.2 [8103

ARTCRAFT Radio Cabinets are Britain's Best Value. [0310

Advertisements for "The Wireless World" are only accepted from firms we believe to be thoroughly reliable.

COILS, TRANSFORMERS, ETC.

1,000-OHM Decoupling Resistances for "Wireless World" Circuits; 1/6 each, post free.—Groves Bros., St. Mary's Place, Shrewsbury. [7833

RADIOGRAPH.—W.W. coils, Record III, 35/-; new Kilo-Mag Four, 33/-; S.G. Regional, 37/6; foreign listeners' Four, 37/6 set; Europa Portable, 21/-; Europa III, 18/6; S.G. multi-valve portable, 22/6; new Everyman Four, 42/6.

RADIOGRAPH.—Litz wire, 9/40, 1/6; 27/42, 2/6 dozen yards; Redfern's deep ribbed or Becol tube, 5d. per inch, slotting 1/6 extra.—Station Rd., Handsworth, Birmingham. [7914

600-OHM Decoupling Resistances for New Kilomag Four, foreign listeners' four, and all "Wireless World" circuits, hand made and tested in our own workshops; improved model, 1/6 each, post free.—Groves Bros., St. Mary's Place, Shrewsbury. [7832

NEW Kilo-Mag Four Coils, 37/6 set; ebonite formers (slotted), for winding, 12/6 set of 3; all post free; trade supplied.—Groves Bros., St. Mary's Place, Shrewsbury. [7975

SIMMONDS BROS.—Berclif coils, Record Three, 50/- pair; new kilo-mag. four, 50/- set; foreign listeners four, low, 30/-; long wave, 37/-; screened grid Regional, 40/-; Mullard S.G.P. dual range coils, 30/- pair; Berclif standard coils, for new all-wave four, standard four, A.C. three, Everyman four, etc., 63/6 set of 4, with bases; the same coils for the Lodestone series ("Wireless Magazine"), 65/9 set of 4, with bases; Titan unit, 15/-; decoupling resistances, 600 ohm, 1/6; 1,000 ohm, 2/-; all "Wireless World" and similar coils in regular production by the leading specialists; list free; trade supplied.—Simmonds Bros., Shireland Rd., Smethwick. Tel.: Smethwick 751. [6314

DYNAMOS, ETC.

M-L Anode Converter, input 12v., output 300v. or 6v. to 150v.; £3/10.—59, Wellesley Rd., W.4. [8023

GRAMOPHONE PICK-UPS, ETC.

R.I. Varley, with Meltrope arm; 25/-; approval.—Redgewell, "Penrhyn," Chartfield Rd., Reigate, Surrey. [8050

B.T.H. Pick-up, 30/-; General Electric Universal gramophone motor, little used, £4/4.—Negus, Queen's, Oxford. [8067

RADIO-GRAMOPHONE, oak pedestal, screened grid three, self contained batteries, double spring motor; £18.—9, Palgrave Rd., Stamford Brook, W.12. [8082

LOUD-SPEAKERS.

GREAT Bargains.

GREAT Bargains.

GREAT Bargains.—Epoch model A moving coil speaker kit (or complete units), brand new; a large number of these famous instruments made for a special order for use in talkies, but not executed, for credit reasons only; regular prices, £3/10, £4/2, and £5/17/6, to clear at 50/- for accumulator operation, 55/- for D.C. mains operation, 85/- for A.C. mains; kit comprising copper plated super magnet-pot (weight 23 lb.), Chrystalene frame, fully adjustable, moving coil, any impedance, paper, leather and mounting rings, made up complete, if desired, 6/- extra.

GREAT Bargains

ENJOY Marvellous Epoch Reproduction at Ridiculous Cost; don't wait until they are all gone, but secure one immediately by writing, 'phoning, telegraphing, or hurrying to Epoch, 3, Farringdon Av., E.C.4. [7077

EPOCH

EPOCH Speakers by Deferred payments.

EPOCH.

EPOCH Speakers by Deferred payments.

EPOCH Famous Moving Coil Speakers, any type, may be obtained by any responsible householder, by easy payments; no interest, no references no red tape as simple, easy and quick as paying cash.

EPOCH.

EPOCH on the Easy.—Full particulars from Lasersson. Ltd., Gramol House, Farringdon Avenue, E.C.4. [7919

NIKOLA Cones; 3/-, 3/6, 4/-, 4/6; manufacturers' type, standardised, floating on leather.—Particulars from Knight and Co., 6, Chapel St., London, E.C.2. [8015

PERARDUA Moving Coil Reproducers.—Cabinet models, 230-volt D.C., £5/5; 6-volt, £5; chassis only, £3/3 and £3 respectively; state output valve.—R. Vevers, 4, York Rd., Maidenhead. [7968

BAKER'S SELHURST RADIO 36-page Booklet, "Sound Advice is Yours for the Asking"; write now for new edition; see displayed advertisement on page 21. [0231

BLUE Spot Cabinet Speaker, £3/5; Ecko mains unit, 20 m.a., 30/-, new.—2/31, Saltley Rd., Birmingham. [8047

Loud-speakers.—Contd.

"WIRELESS World"
"WIRELESS World"
"WIRELESS World"
"WIRELESS World"
NEW
NEW
PERMANENT-MAGNET
PERMANENT-MAGNET
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EPOCH.—Send for list of the parts, as well as Booklet W.S.2. describing 14 of the latest models of Epoch moving coil speakers. The correct speaker for each requirement.

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EPOCH.—The greatest moving coil specialists in England
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EPOCH RADIO MANUFACTURING Co., Ltd., are the manufacturers. City Office and Service Station, 3, Farringdon Avenue (Ludgate Circus end). E.C.4. 'Phone Central 1971 (2 lines). Private Branch Exchange [8016

Loud-speakers.—Contd.

AS New, Brown Vee chassis cone, 30/-; Amplion Lion chassis, £4; moving coil 6v. Baker suspension, 50/-; Watmel cone kit, 22/6.—BM/BRIEN, London, W.C.1. [8042

CELESTION Loud-speaker, oak, model C12; accept £3/3.—Hillside, Brigsley, near Grimsby. [8048

SELF-CENTRE, a device when fitted to your speaker unit will relieve driving rod of undue side stress, centering cone to driving rod thus improving results, ideal for linen speakers, easily fitted; price 2/6; c.o.d.; terms available.—Weedon, 80, Lonsdale Av., London, E.6. [8040

LOUD-SPEAKER Units, Hegra balanced armature, 10/6; Triotron, 6/6; Blue Spot 66A, 12/6; large assortment second-hand units of various makes and types; Hegra D.C. mains M.C. speaker, with transformer, 45/-; various odd sized moving coil pots, remains of special order, 12/6, unwound; state requirements.—Goodmans, 27, Farringdon St., E.C.4. [8095

AMATEUR'S Lion Amplion, solid mahogany Concert cabinet, space for pick-up; gift, £7/10.—After 7, Carter, 3, Grange Rd., Kenton, Harrow. [8111

TWINMAG.

TWINMAG.

TWINMAG.

WRITE for Particulars of Goodmans' New Super Double Magnet Balanced Armature Unit.—Goodmans, 27, Farringdon St., E.C.4. [8100

FINEST Suspension Leather, for fixing cones to moving coil or reed units, as supplied to principal makers; 2/- sq. ft., 1/6 10in. square; segments up to 12in. cone 9d. for 4; all post free, cash with order.—Dilley, 8, Ashby Rd., Essex Rd., N.1. Clissold 0736. [8093

BROWN H4, 8/6; also Igranic micro-condenser, 2/6, perfect.—21, Alexandra Rd., Chesterfield. [8081

GET Moving Coil Quality Liner Diaphragm Speaker, varnished ply, 17/-; polished mahogany, 25/-; handsome appearance, fit any unit.—Parke, 79g, Turnpike Lane, London, N.8. [8079

LISSEN Permanent Magnet Moving Coil Speaker, with Lissen output trans. (6-1 ratio) bolted on base, never been unpacked; sacrifice, £5.—Owen T. Llewellyn, Wereham Rd., Stoke Ferry, King's Lynn. [8073

EXPONENTIAL Horn, 2ft. square, on stand, extremely suitable for schools or demonstration; £10, or near offer.—Roed, South Lodge, Champion Hill, S.E.5. [8068

PICTURE RECEIVER APPARATUS.

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D.U.2 Mullard, full emission, makers' report produced; offer.—40, Harrington St., N.W.1. [8034

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TWO P.M.24A, perfect, used 6 hours; 33/-.—Box 4552, c/o *The Wireless World*. [8022

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Components, Etc., for Sale.—Contd.

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WANTED, 0.0005 Ormond or Lotus all brass variable S.L.F. condenser, also Ormond S.M. dial, black preferred.—58, Uplands, Stoke Heath, Coventry. [8027

SILVER Marshall, G.R.C., intermediate transformers, oscillators, bodine, aero frames.—BM/ENFA, London, W.C.1. [8033

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McEVOY Combination, 350 c.c., 1928, £40; or exchange Record Three, B.T.H. motor, B.T.H. R.K. 100 v. speaker, B.T.H. pick-up, A.F.5C, O.P.40, and cash adjustment; stamp reply.—97, Hanover St., Castleton, Rochdale. [8045

PHOTOGRAPHIC Outfit, cost £35, or old violin, Voirin bow, steel case, worth £20, for modern radio gramophone.—Morris, 8, Marmion Rd., Hove, Sussex. [8030

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