S.G. SHORT WAVE III

The Wireless World
AND RADIO REVIEW

4D

The Paper for Every Wireless Amateur

Wednesday, January 1st, 1930.

No. 540. Vol. XXVI. No. 1.

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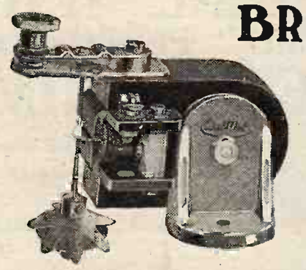

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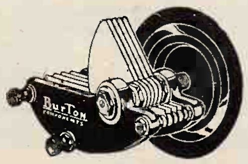

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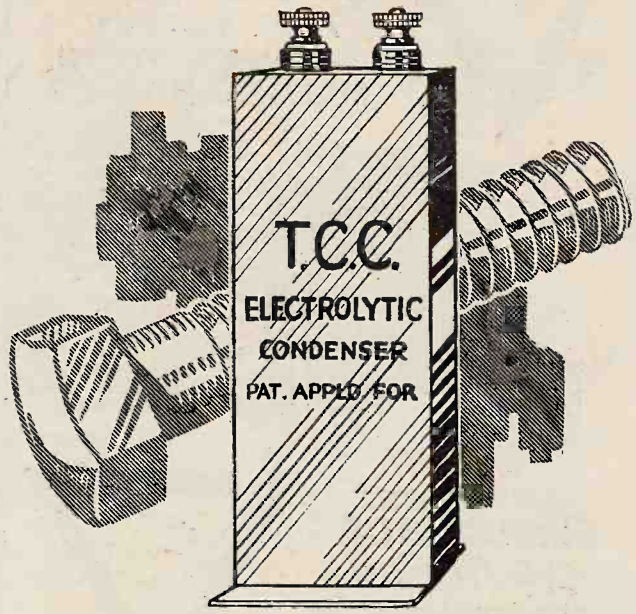

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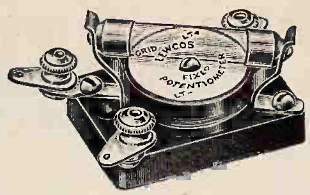
Lewcos Centre-tapped Coil No. 40 was specified for use in the two-valve set described in "The Wireless World," December 25.



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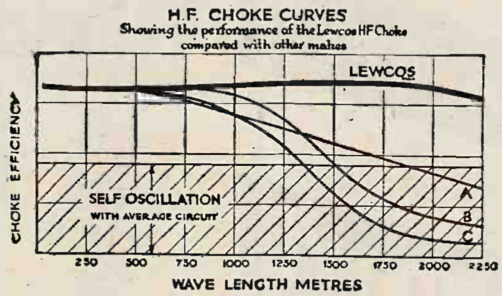

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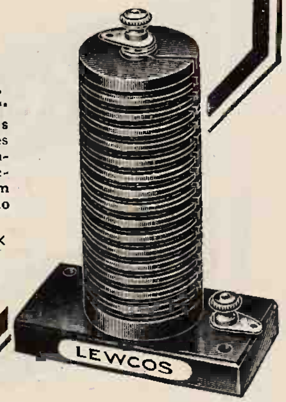

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As many of the circuits and apparatus described in these pages are covered by patents, readers are advised, before making use of them, to satisfy themselves that they would not be infringing patents.

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SHOULD THE DATE OF THE SHOW BE CHANGED?

THE New Year always suggests the opportunity for reviewing the events of the old year so as to endeavour to profit by the experience gained in the past and put it to good use during the year that is ahead. In wireless we are continually profiting by experience, for the science is a new one, and broadcasting, in particular, being relatively very new, there are few precedents to go upon to assist in guiding the policy of the broadcasting service and the industry which it has founded.

Delay in Fulfilling Orders.

A reader whose letter is published in this issue comments on the date which has been chosen for the annual Radio Show, and whilst this subject has been discussed previously, our correspondent now puts forward some very good arguments as to why the date of the annual Show should be changed. Our readers and, in fact, all sections of the wireless community are painfully aware that this year, as in previous years, manufacturers are in many instances far behind in executing orders which they have received for apparatus which was first exhibited at Olympia in September. Our correspondent points out that it is common knowledge that at the annual Motor Show at Olympia orders for new cars frequently cannot be fulfilled until the spring, but as, luckily, the spring is just the time when most people want to put new cars into commission, there is nothing very much the matter with this arrangement. With the wireless public, however, it is in the autumn that the public demand for wireless apparatus is at its height, and this demand continues throughout the winter months. If the Wireless Exhibition were to be held at a date which gave time for apparatus to be in full production by the autumn, then much would have been accomplished towards overcoming the present difficulties.

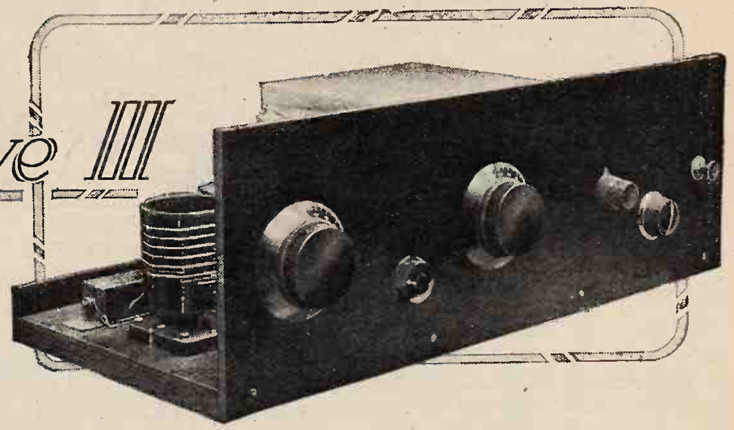
When is Interest at its Height?

It has been argued that the Radio Exhibition should be held in the autumn because that is the time when public interest in broadcasting and indoor entertainment has been aroused, but we believe that the public interest is even greater towards the close of the winter months, when the value of wireless is fresh in their minds, than it is at the end of the summer months before their interest has been fully rekindled. We are aware that manufacturers cannot well be expected to make arrangements for a very large production of apparatus until they have some indication of the demand for that apparatus, and this is given as the reason why in many instances deliveries of apparatus exhibited at the September show are still far behind several months later. But by holding the Exhibition at the end of the winter the demand would tend to develop more gradually than at present and would help to ease the manufacturing problem. In addition, it is believed that this change would be to the advantage of exhibitors because it would tend to make radio sales less seasonal in character.

A Matter for Urgent Consideration.

We are given to understand that arrangements for the annual Radio Show have to be made a year or two in advance, but if the reason for a change in date is sufficiently good, as we believe it is, then the question should be looked into now in order to see how quickly the change can be introduced. As matters stand at present, with each succeeding season the same complaints occur regarding delay in deliveries of apparatus, and there seems to be no obvious cure for the situation, except by shifting the date of the annual Show.

S.G. Short Wave III



An Empire Set Embodying a Tuned H.F. Stage.

By H. B. DENT.

TO-DAY the number of short-wave broadcast stations operating a regular schedule is more than sufficient to afford a welcome recreation to listeners in this country. As regards the exile abroad, possibly separated by many thousands of miles from the home country, the only link is through the medium of the special programmes radiated from 5SW, the short-wave experimental station at Chelmsford.

The ubiquitous detector-L.F. arrangement has done yeoman service and for long has been regarded as the accepted standard for a short-wave set. So far there has been a decided reluctance on the part of designers to apply the principles of high-frequency amplification to short-wave reception, and possibly some justification existed in the past, as the general unsuitability of the average receiving valve was a serious obstacle. The question was discussed, however, at some length in an article entitled "High-Frequency Amplification on Short Waves," which was published in *The Wireless World* as far back as October 12th, 1927. When it is realised that the frequencies dealt with are of the order of 15 million cycles per second, it will be appreciated that the problem is no mean one.

In view of the many improvements made recently in the design of valves—especially those developed particularly for high-frequency amplification—the present would appear opportune again to focus attention on this subject. The screen-grid valve, which has effected such a radical change in the design of H.F. amplifiers for broadcast reception, should prove equally efficacious on the ultra-short wavelengths.

In conformity with modern practice, neutralised circuits will be ruled out, since, on short wavelengths, the complications in the assembly of a suitable receiver would tend to place this beyond the reach of the average home constructor. Consideration will be given, therefore, only to the possible ways and means whereby a worth-while stage gain is possible of attainment by employing a relatively simple unneutralised H.F. amplifier.

This proviso unfortunately limits us in our choice of valve for the H.F. stage, because only those which show a very low internal anode-to-grid capacity will be at all suitable for this purpose. At the outset it might be stated that even with the best valve—regarded from this viewpoint—the amplification afforded on 20 metres could not possibly attain that at 200 metres. For example, the Mazda 215 S.G. valve shows a theoretical stage

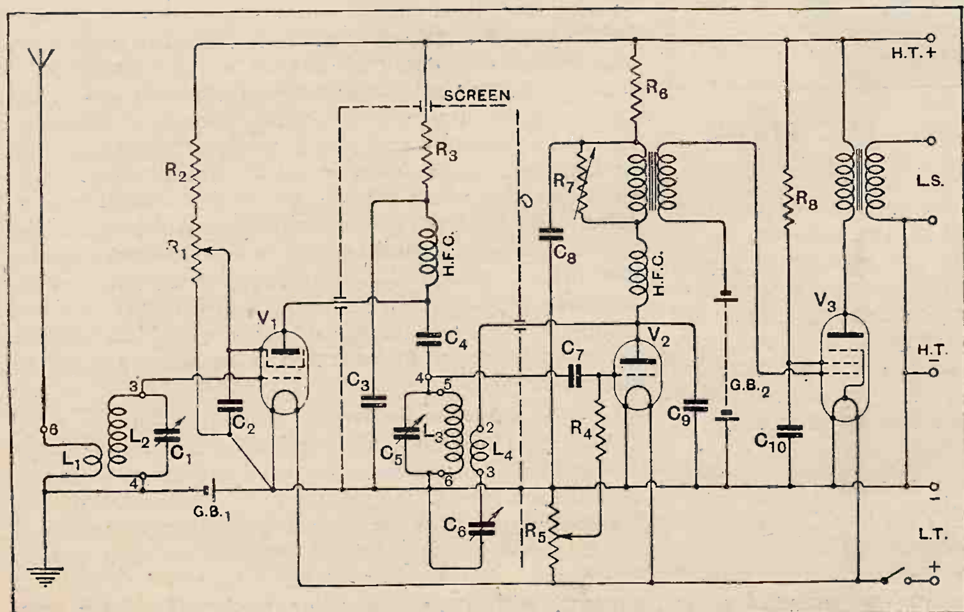


Fig. 1.—The theoretical circuit values are as follows: C_1 and C_5 = 0.00015 mfd., C_2 and C_3 = 0.01 mfd., C_4 and C_9 = 0.0002 mfd., C_7 = 0.0001 mfd., C_6 = 0.000075 mfd., C_8 = 2 mfds., C_{10} = 1 mfd., R_1 = 30,000 ohms, R_2, R_3 and R_6 = 20,000 ohms, R_4 = 5 megohms, R_5 = Polar semi-fixed potentiometer, R_7 = 200,000 ohms, R_8 = 5,000 ohms.

S.G. Short Wave III.—

gain of about 150, unneutralised, at 200 metres, whereas at 20 metres the calculated stage gain, also unneutralised, is of the order of 60 only. We know that in practice the theoretical amplification is difficult of attainment. On 20 metres the incidental losses pile up in an alarming manner; how they accumulate is far too involved to be dealt with here. But in spite of this some preliminary tests showed that a useful gain is possible, and accordingly the design of the set described in this article was prepared.

As an indication of the importance of choosing a valve with the lowest possible anode-grid capacity, it may be mentioned that with one having an internal capacity of 0.05 $\mu\mu$f—or ten times that of the particular example given above—the calculated stage amplification, unneutralised, would fall to 18. So that it is very doubtful if, under these conditions, any justification would exist for employing an H.F. stage.

Single H.T. Feed.

Ease of construction has been the guiding factor in designing the set and, so far as technical considerations will allow, only those parts readily obtainable have been used. With the exception of winding the coils, it resolves into a straightforward assembly job for which the tools found in the average amateur's workshop should suffice.

The theoretical circuit is shown in Fig. 1, and from this it will be seen that the receiver consists of a screen-grid H.F. stage followed by a leaky grid detector which is transformer-coupled to a pentode output valve. This choice assures the maximum overall amplification with the minimum number of valves. A single H.T. positive feed is favoured, as this discharges all sections of the H.T. battery at the same rate. Each stage is adequately decoupled to counteract any tendency towards instability, the decoupling resistances acting also as voltage limiting devices where a lower potential than the maximum bat-

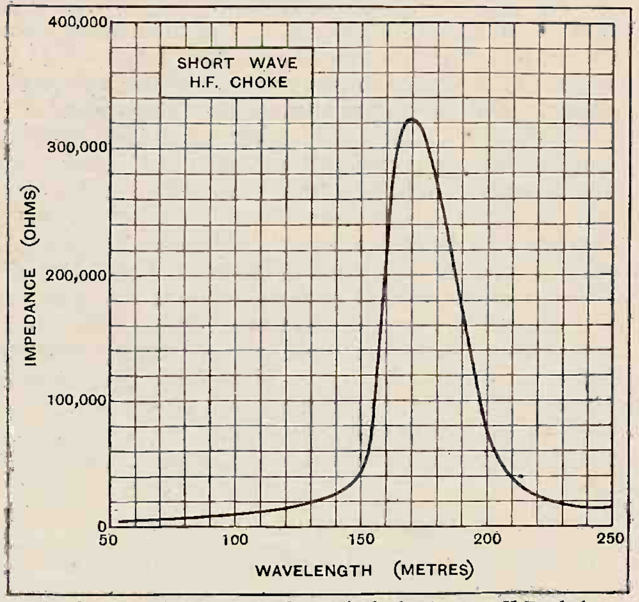
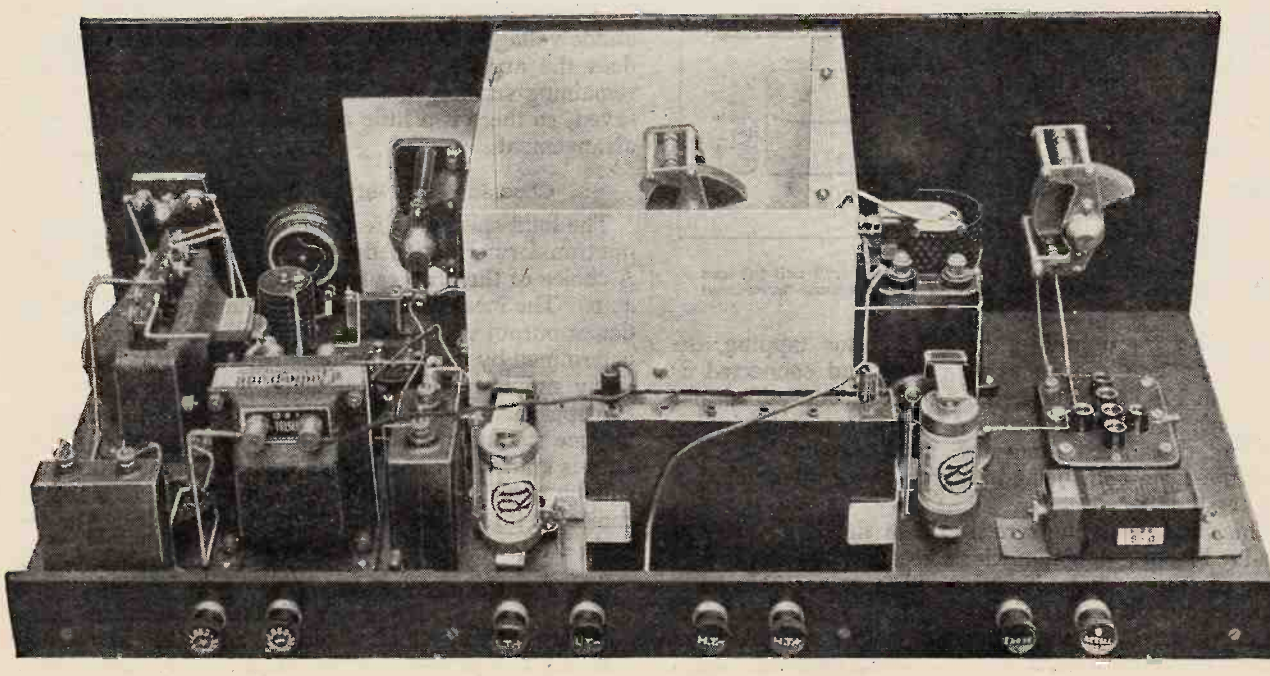


Fig. 2.—Impedence curve of a typical short-wave H.F. choke with a shunt capacity of 8 $\mu\mu$F.

tery voltage is considered desirable. It should be pointed out that this policy slightly increases the initial cost, but not to any appreciable extent, because decoupling resistances would be required in any case, but their value has been raised in some instances to conform with the requirements of a single H.T. feed.

In designing the tuning coils it was decided to give preference to the parallel feed and tuned grid circuit, as the construction of H.F. transformers suitable for use on



Rear view of set with coils and valves removed.

S.G. Short Wave III.—

the wavelengths dealt with in this case would be rather involved. Incidentally, it may be mentioned that preliminary tests showed there was little to choose between these two tuning arrangements. From the illustrations it will be seen that the ordinary broadcast type of H.F. choke is incorporated in favour of one of the short-wave variety. This course was adopted after very careful consideration of the merits of both types. Readers will be familiar with the impedance curves of H.F. chokes, as these have been published from time to time in this journal. In Fig. 2 is reproduced a representative curve of a short-wave choke resonating at 170 metres when shunted with the capacity mentioned in the inscription. The difference in impedance at 50 metres and at 170 metres is most marked, and on still shorter wavelengths the broadcast variety shows an impedance very nearly equal to that of the short-wave type. Since there is so little to choose between the two preference was given to the larger choke, as this enables the usefulness of the receiver to be extended to cover the normal broadcast wavelengths with ease.

Extension to Medium Waveband.

To maintain a reasonable degree of selectivity the leaky grid detector should be connected across a portion only of the H.F. coil when using the set on the normal broadcast band, but there is nothing gained by adopting this course on short waves. The connections to the coil base are planned accordingly, the required interconnection between the sockets being made on the coil former. Selectivity can be further improved on the 250-500-metre band by arranging the H.F. coil as an auto-transformer. Ultimately a compromise was made between the best

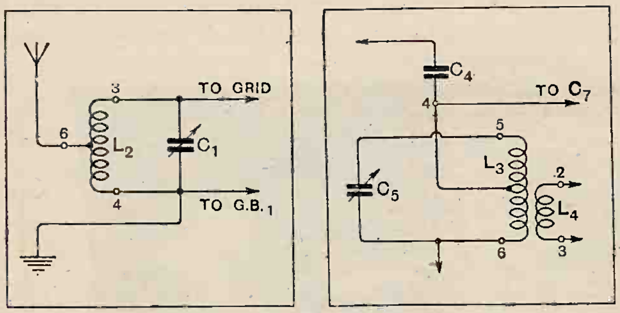
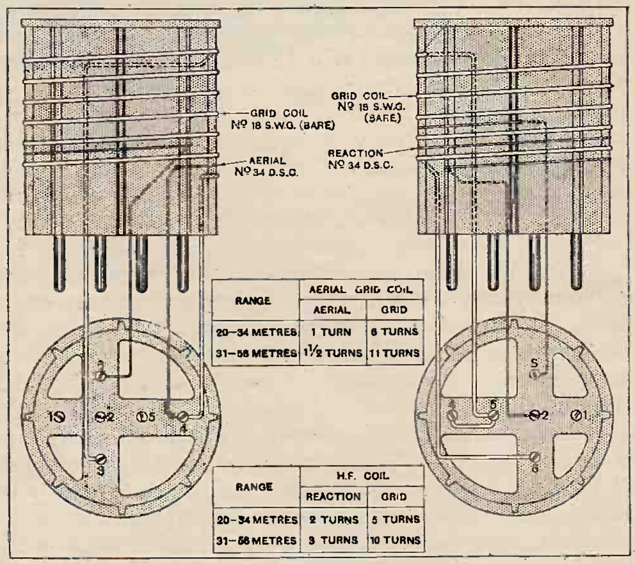


Fig. 3.—Theoretical connections of the aerial grid coil (a) and tuned grid H.F. coil (b) for use on the medium broadcast waveband.

transformer ratio and optimum detector tapping, the H.F. coil being tapped at its centre and connected as shown in Fig. 3. The aerial-grid coil connections also are given in this diagram. A separate aerial winding was not considered necessary, a tapping, a few turns from the earth end, being brought out for attachment of the aerial lead.

The voltage for the screen-grid in the H.F. valve is obtained from a potentiometer consisting of a fixed resistance of 20,000 ohms, in series with a 30,000-ohm wire-wound potentiometer. Assuming that a 150-volt H.T. battery is used, the screen voltage will be variable from 0 to 90 volts approximately. The fixed resistance sets a limit to the maximum potential available, and assures that the valve will not be overrun. The remainder of the circuit calls for little further comment, as it is perfectly straightforward. Mention might be made, however, of the 5,000 ohms resistance in the auxiliary grid lead of the pentode valve. It has a dual function. It serves to decouple this circuit, counteracting any tendency towards L.F. instability due to battery resistance, and secondly, it limits the voltage on the grid. Without the resistance the potential on the auxiliary grid would be higher than that on the anode, due to the voltage dropped across the primary of the output transformer.



RANGE	AERIAL GRID COIL	
	AERIAL	GRID
20–34 METRES	1 TURN	6 TURNS
31–56 METRES	1½ TURNS	11 TURNS

RANGE	H.F. COIL	
	REACTION	GRID
20–34 METRES	2 TURNS	5 TURNS
31–56 METRES	3 TURNS	10 TURNS

Fig. 4.—Detailed drawing of the coils giving winding data for the 20–34 metre and 32–56 metre wavebands. On the left is the aerial-grid coil, the other being the H.F. coil.

The writer has found that pentode valves function just as well with an auxiliary grid potential slightly less than the anode voltage. The A.C. resistance rises slightly, but so does the amplification factor, the mutual conductance remaining sensibly the same. A few milliamps can be saved, so there is a little compensation for adopting this arrangement.

Choosing the Output Transformer Ratio.

The loud speaker is fed through a Pye step-down output transformer designed especially for use with pentodes. A choice of three ratios is available, viz., 2 : 1, 3 : 1 and 4 : 1. The most suitable ratio, having regard to the particular output valve and loud speaker used, might well be determined by trial and error. Alternatively, it is a relatively simple matter to calculate, if the valve resistance and speaker impedance are known. This will be correct for one frequency only, but if the loud speaker impedance is known at mean speech frequency, the ratio found will be sufficiently accurate for our purpose, since the choice of three alternatives only is available. The formula is:—

$$\text{Transformer ratio} = \sqrt{\frac{\text{Valve A.C. resistance}}{\text{Speaker impedance}}}$$

Before passing on it would be advisable to mention that one side of the secondary coil on the output trans-

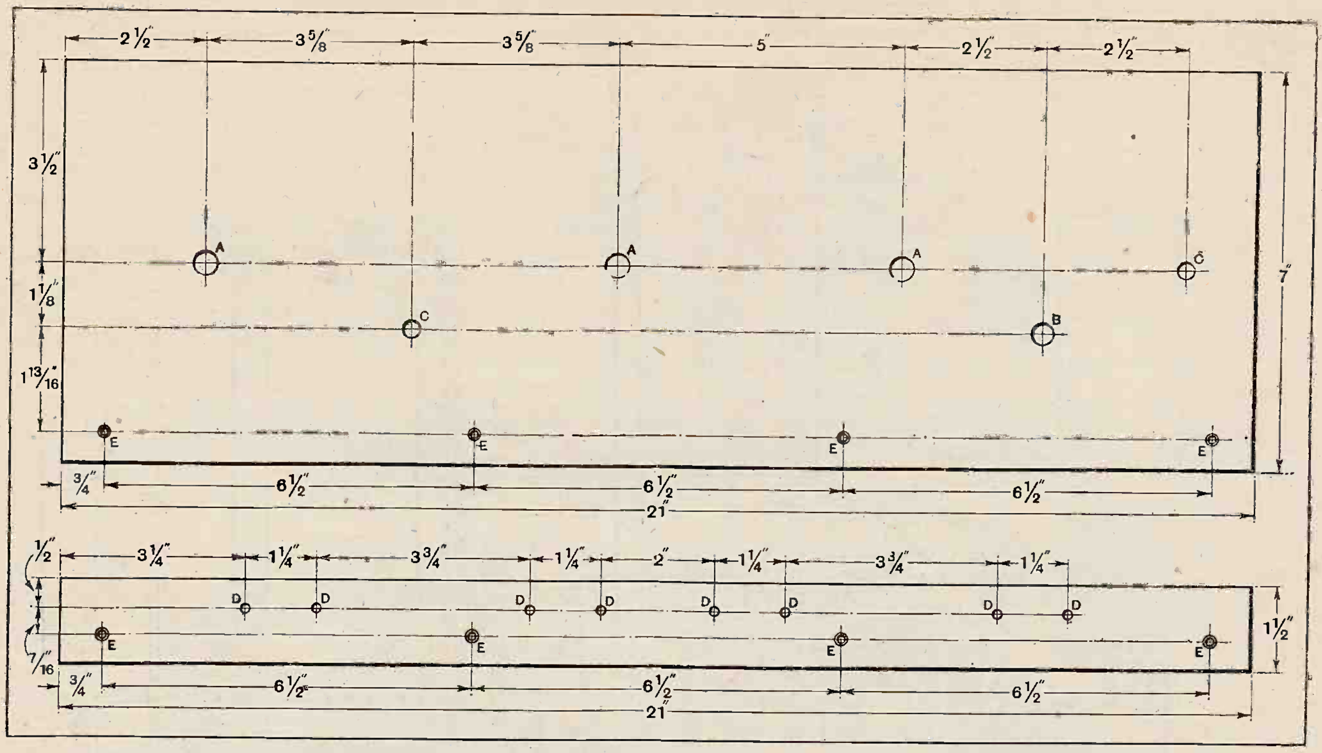


Fig. 5.—Dimensional data of panel and terminal strip. Sizes of holes are as follows: A = 7/16in. dia., B = 3/8in. dia., C = 5/16in. dia., D = 5/32in. dia., E = 1/8in. dia., countersunk for No. 4 wood screws.

former should be tied down to the filament circuit. Unless this connection is made, trouble might be experienced from an occasional L.F. howl. There are other means of curing it, but that suggested is quite satisfactory. Experiment will determine the "live" terminal, and this should be "earthed."

The process of assembly will be found a relatively simple matter, as all parts are readily accessible. The screening box, which is supplied unassembled, can be put together in a few minutes. When putting this box together it will be necessary to use countersunk screws, in place of the round head variety supplied, for fixing the

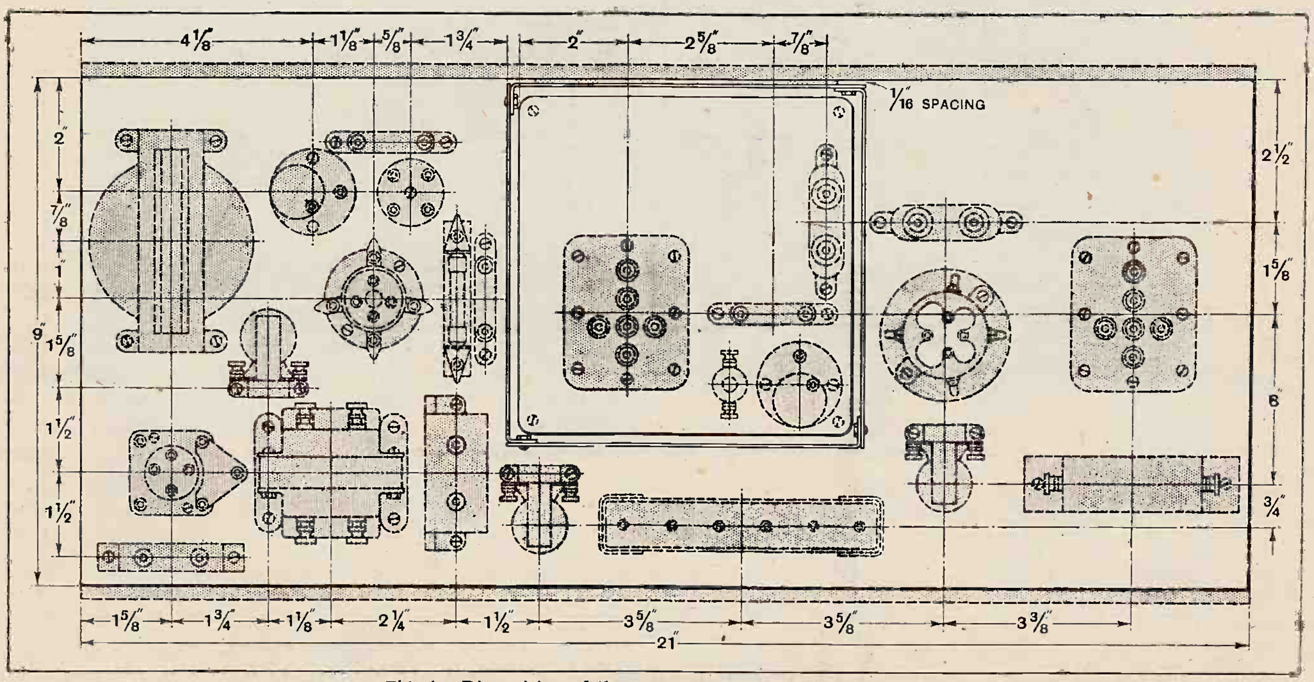


Fig. 6.—Disposition of the components on the baseboard.

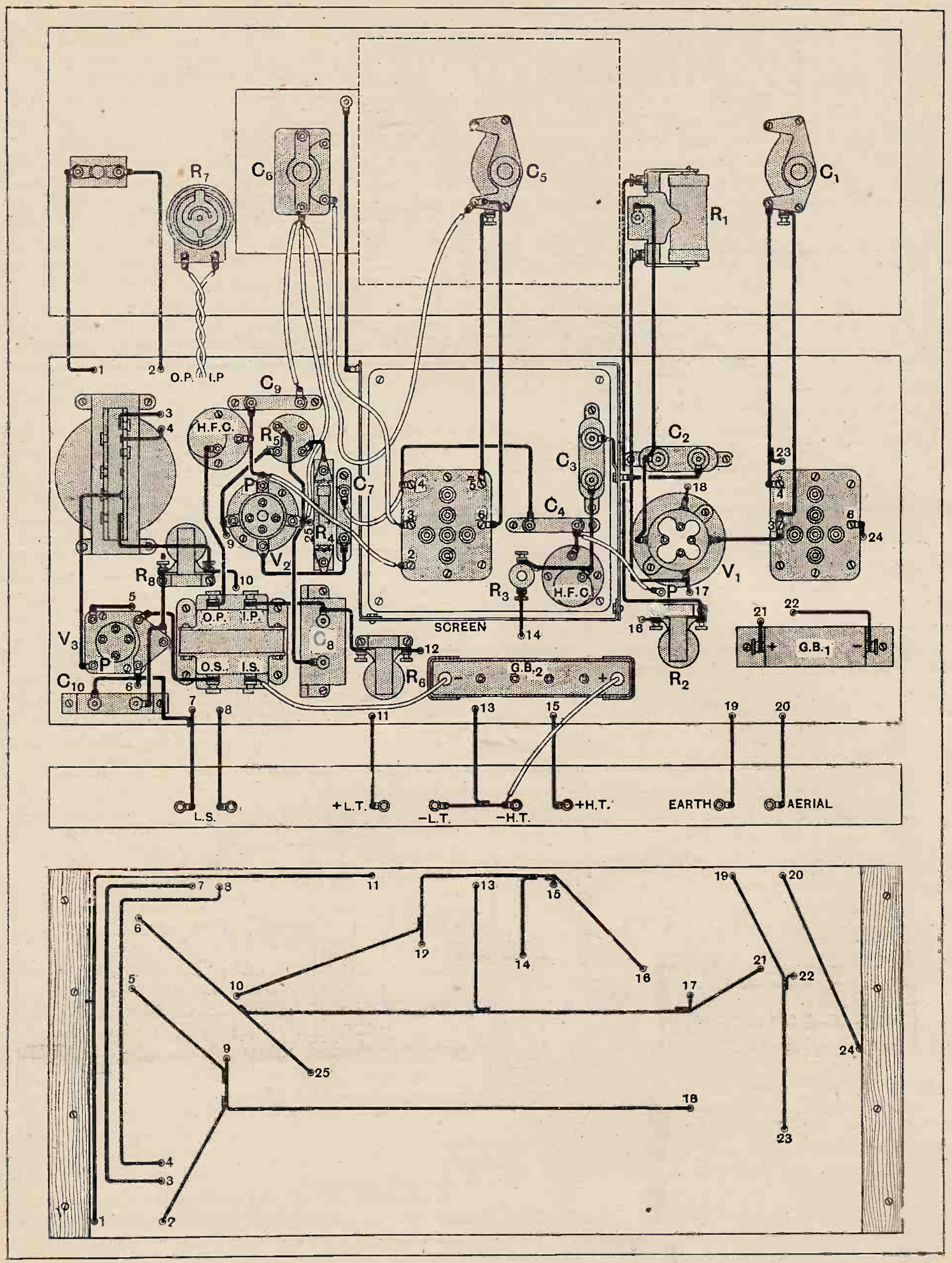


Fig. 7.—Practical wiring plan. Wires passing through the baseboard are lettered to facilitate tracing their path as shown on the under-deck plan.

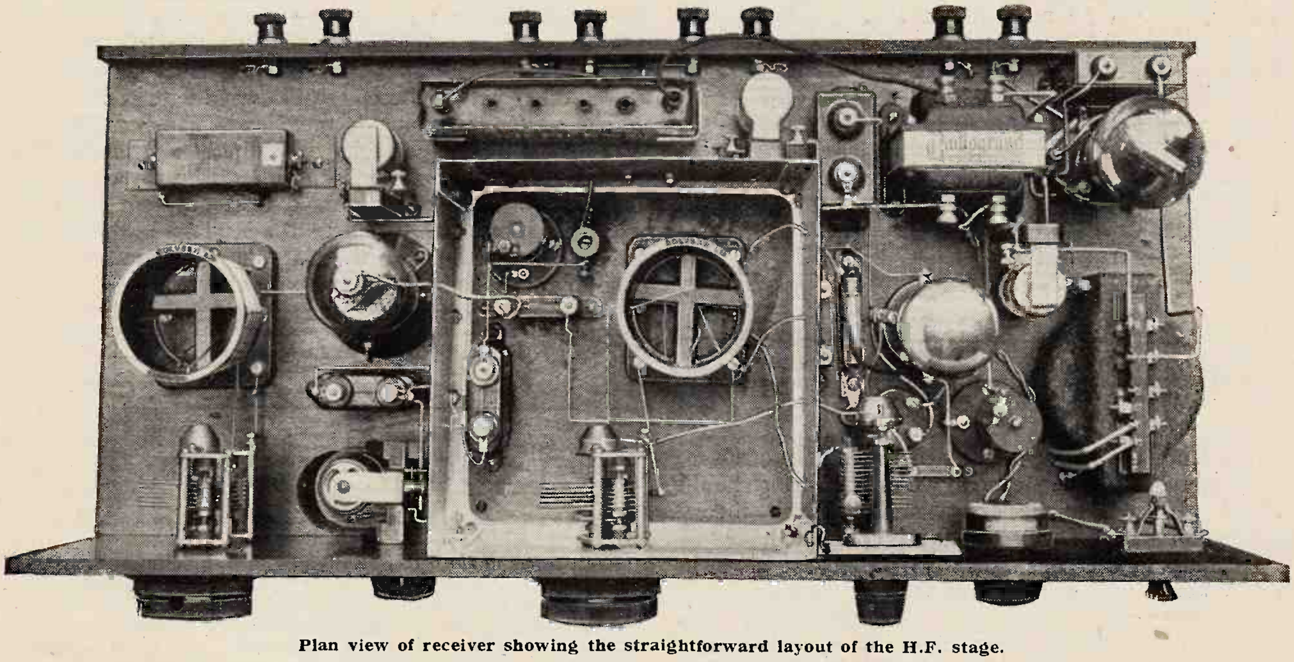
LIST OF PARTS.

2 Variable condensers, 0.00015 mfd., with vernier and dial (Polar Q.J.).
1 Reaction condenser, 0.000075 mfd., with vernier (Polar Capcon).
2 Fixed condensers, 0.0002 mfd. (T.C.C.).
1 Fixed condensers, 0.0001 mfd. (T.C.C.).
1 Fixed condensers, 1 mfd., 400 volt D.C. Test (T.C.C.).
1 Fixed condensers, 2 mfd., 400 volt D.C. Test (T.C.C.).
2 Fixed condensers, 0.01 mfd. mica (Dubilier B. 775).
2 H.F. chokes (Wearite H.F.O.).
1 Decoupling resistance, 600 ohms. (Wearite).
2 Anode resistances, 20,000 ohms. and holders (R.I.).
1 Anode resistances, 5,000 ohms, and holders (R.I.).
1 Fixed potentiometer (Polar).
1 Power potentiometer, 30,000 ohms (Varley).
1 Valve holder (Aermonic "D.")
1 Valve holder (Aermonic "H.")
1 Valve holder (Whiteline Pentode).
1 L.F. transformer, 3-1 (Telsen Radiogrand).
1 Output transformer (Pye 657/P.).
1 Variable resistance, 0-200,000 ohms (Electrad Royalty "J." Rothermel).
1 Grid leak, 5 megohms (Ediswan).
1 Holder for above (Wearite).
1 On-off switch (Pioneer).
1 Aluminium screening box (Bowyer Lowe).
4 Coil formers (Colvern Standard 6-Pin).
2 6-Pin bases with terminals for above (Colvern).
1 9-Volt Grid bias battery (Siemens).
1 Pair Grid bias clips for above (Bulgin).
1 Grid cell, 0.9 volts (Siemens).
8 Terminals (Burton).
1 Ebonite panel, 21 × 7 × 3/16in.
1 Ebonite terminal strip, 21 × 1½ × 3/16 in.
1 Baseboard, 21 × 9 × ⅜ in.
2 Wander plugs (Clix).
2 Dial indicators (Bulgin).
Quantity No. 18 S.W.G. tinned copper wire, Systoflex, screws, etc.

Approximate cost of parts, £9 2s. 6d.

In the "List of Parts" included in the descriptions of *THE WIRELESS WORLD* receivers are detailed the components actually used by the designer, and illustrated in the photographs of the instrument. Where the designer considers it necessary that particular components should be used in preference to others, these components are mentioned in the article itself. In all other cases the constructor can use his discretion as to the choice of components, provided they are of equal quality to those listed and that he takes into consideration in the dimensions and layout of the set any variations in the size of alternative components he may use.

front section to the side pieces, and the base piece. Four screws ¼in. long will be required. The size is No. 4B.A., with nuts to match. This is deemed necessary in view of the small clearance allowed on the condenser fixing bushes. They have been designed to accommodate panel thicknesses up to ¼in., and it will be very difficult to fit them unless the box is brought as close as possible to the back of the panel. If the screw heads



Plan view of receiver showing the straightforward layout of the H.F. stage.

are not countersunk into the metal they will separate the box just sufficiently from the panel to leave space for fitting the lid. In addition, a small washer—cardboard of suitable thickness will answer—should be slipped over the fixing bush between the box and the panel. A loose interior baseboard is included with the box, thus relieving the constructor of the onus of preparing this. A baseboard, 21in. long, 9in. wide, and ⅜in. in thickness, will be required. This may be cut from a piece of hard wood, such as mahogany, or even pitch pine would answer if it can be obtained more readily. In the model illustrated five-ply wood was used. Two battens, each 9in. × 1in. × ⅜in., are now required, one to be screwed on to each end of the baseboard, on the under side. A shallow well is thus formed, in which much of the wiring can be accommodated. A terminal strip, the full length of the base, and a panel 21in. × 7in. × $\frac{3}{16}$in., completes the framework on which the set is assembled.

Having marked out and drilled the panel in accordance with the details given, it can be fixed to the base and the position of the hole in the screening box, through which the H.F. condenser bush is passed, may be marked. Before assembling the components, unship the panel and screening box. The parts on the panel can

S.G. Short Wave III.—

then be assembled with the exception of the H.F. tuning condenser and the reaction condenser. It is advisable to leave the box off until most of the wiring has been done. This applies particularly to the connections on the panel potentiometer and other components in close juxtaposition to the metal container.

The H.F. tuning condenser cannot be fitted until the small sub-base is ready to be dropped into its box. As regards the reaction condenser, and its small screening plate, fitting this too early will interfere with wiring the various small components on the baseboard immediately below it.

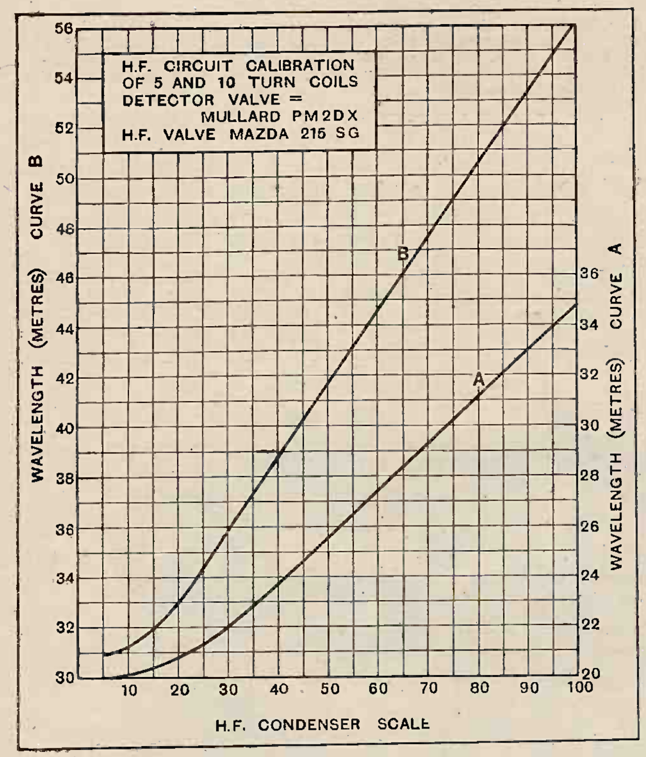


Fig. 8.—Calibration curves of the H.F. coil with reaction adjusted to cause the stage to oscilitate weakly.

Apart from the above-mentioned order of procedure, there is no particular sequence in which the wiring should be done. It is well to check occasionally with the theory diagram and mark off each lead as it is completed.

Particulars of the coils, so far prepared, are given in the diagrams. Two are required for each waveband. It has been found that for the 20- to 34.9-metre range, five turns of No. 18 S.W.G. tinned copper wire, spaced ¼in., are required for the H.F. coil, but to cover the same waveband six turns must be used on the aerial-grid coil. Incidentally, the aerial winding is separate, and consists of one turn of fine gauge wire, wound in the space between the first and second turns from the earth end of the grid coil. In all cases the direction of the windings is the same.

The two other coils shown cover a waveband of from 30.9 metres to 56.3 metres, and 10 turns of No. 18 S.W.G. tinned copper wire are used for the H.F. coil. The aerial-grid coil for this range has 11 turns of the same gauge wire. Each turn is spaced $\frac{3}{16}$in. from its neighbour. The aerial winding consists of 1½ turns in this case. It is hoped that shortly details of the coils required to extend the usefulness of the set to about 150 metres will be available for publication, also the winding data for a set of medium-wave broadcast coils.

Valves.

A calibration curve for each of the H.F. coils described here has been prepared. These may require a slight modification in some cases, as the calibration was made with the receiver just oscillating. Any change in the capacity of the reaction condenser will shift the tuning slightly. The curves will be a useful guide in the beginning, as, provided the same type of valve as mentioned on the chart is used in the H.F. and detector stages, tuning will be sufficiently accurate to identify most of the principal transmissions coming within the range of these coils.

With the exception of the H.F. stage, where unfortunately not much latitude can be given, any well-known make of valve may be used. In the case of the detector, best results will follow the employment of a valve not exceeding about 12,000 ohms A.C. resistance. The Cossor 210 L.F., Mullard P.M.2 D.X., the Mazda L.210 and the Marconi and Osram L.210 are good examples of the type most suited for use in this position. In the output stage a pentode is required, and since an output transformer with a choice of ratios is fitted, any pentode, provided it has the same filament voltage rating as the other valves chosen, can be used with confidence.

The writer recommends the Mazda 215 S.G. for the H.F. stage by virtue of its exceedingly low anode-grid capacity. But as there is a little delay in obtaining deliveries of this particular make at the present moment, excellent substitutes would be the Mullard P.M.12, Six-Sixty S.S.215 S.G., and the Marconi or Osram S.215, to mention a few only in the two-volt class.

This receiver is available for inspection by readers at the Editorial Offices, 116-117, Fleet Street, London, E.C.4.

BOOKS RECEIVED.

Photograms of the Year. Edited by F. J. Mortimer, F.R.P.S., the Editor of *The Amateur Photographer and Cinematographer.* About 100 reproductions of fine pictures made with the camera by the leading photographers in all countries where the camera is used. For the amateur photographer and those who are interested in picture-making, it provides guidance and inspiration that gives it an undoubted educational value. Published by Iliffe and Sons Ltd., London. Price 5s. net in stiff paper covers, or 7s. 6d. net in cloth boards.

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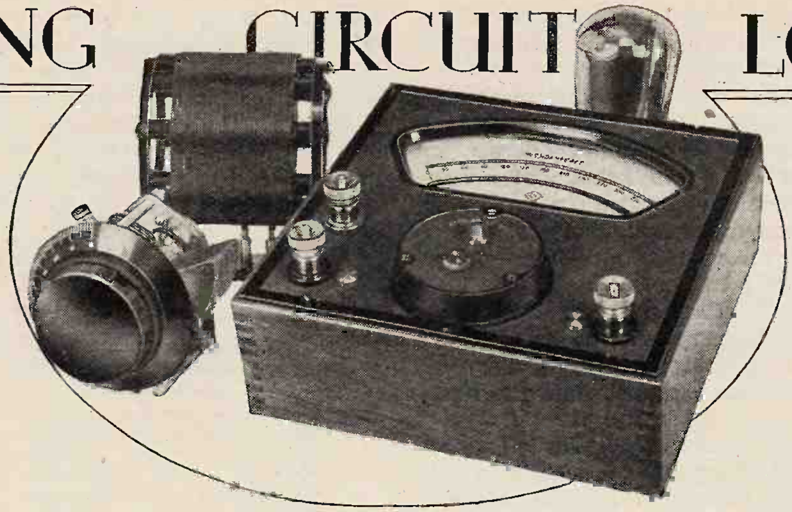
Electricity: What It Is and How It Acts (Vol. I), by A. W. Kramer, A.M.A.I.E.E.—A simple treatise on the part played by the electron in ordinary electrical phenomena, including its action in diode and triode valves. Pp. 274+xiii with 130 diagrams and illustrations. Published by Technical Publishing Company, Chicago, U.S.A. Price $2 net.

TUNING CIRCUIT LOSSES



Sources of Incidental Dielectric Loss.

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

THERE is no component in the whole of a high-frequency amplifier that has received so much attention as the tuning coil, for it was early recognised that the signal strength given by a receiver could be considerably enhanced by using coils of low high-frequency resistance. The classical researches on the subject by S. Butterworth[1] brought to light the fact that, for the frequencies used in the broadcast waveband, any coil of reasonable dimensions must be wound with stranded wire, or Litzendraht, if the lowest possible resistance, and hence the greatest amplification, was required. This information was promptly acted upon by *The Wireless World,* and complete receivers in which the tuning coils were wound with "Litz" were described and proved, as might be expected, appreciably in advance of receivers employing coils of less scientific design. The use of coils wound with Litz has now become usual in all sets in which the maximum amplification at high-frequency is desired.

Butterworth's researches into the resistance of coils were carried out on a purely mathematical basis, and had for their object the determination of the resistance due to the copper wire of which the coil is wound, without attempting to make any allowance for the extraneous losses due to the former and the plug or other mount used. Nor were they at any time intended to cover losses originating outside the coil itself in the tuning condenser and the various components which, in a finished set, are connected in parallel with the tuned circuit. It is known, however, that losses arising from such sources as these, and which consist mainly of dielectric losses, form a very considerable proportion indeed of the total losses in a tuned circuit, so that the formulæ developed by Butterworth, while they are an absolutely indispensable aid in designing a coil, yet give us no reliable estimate of the total resistance of the tuned circuit as it exists in a practical receiver.

The problem that lies before the designer of a receiver, then, is to find some approximation to the resistance of the tuned circuit as a whole, for it is this that he has to take as the basis of his design. The contribution to the total resistance made by the copper wire of the coil can fairly readily be calculated from Butterworth's formulæ, while at the cost of a little further calculation one can arrive at a coil so designed that it is physically impossible to improve upon it without increasing its dimensions. Unfortunately, that part of the total resistance which arises from the imperfections of the various insulating materials which have inevitably to be connected to the tuned circuit cannot be calculated at all. For any one case, of course, the value of the losses arising in the various dielectrics can be measured, but a systematic treatment does not appear to be possible.

Copper and Dielectric Losses Compared.

The sources of dielectric loss in a finished receiver are many and various. First, there is the insulation on the wire itself, and the former on which the coil is wound. If the coil is made interchangeable with others so that different wave-bands can be covered, there are losses also, and usually very considerable losses, in the plug-fitting of the coil and in the holder into which it fits. Then the tuning condenser contributes its share, for the fixed plates must be carried on a support of some insulating material, so that losses enter here also. Before any use can be made of the tuned circuit it must be connected across grid and filament of a valve, so that the insulating material both of the holder and of the base of the valve itself have an opportunity of absorbing energy.

Each of these sources of loss, if sufficient care is taken, can be made quite small; the sum-total of them all is always far larger than one would like, even when every possible precaution has been taken. As a result, the high-frequency resistance of the tuned circuit must inevitably be very much higher than the figure derived from applying Butterworth's formulæ to the coil itself.

[1] *Experimental Wireless,* April, May, July, and August, 1926.

Tuning Circuit Losses.—

The additional losses have still further depressed the dynamic resistance of the coil, and it will be particularly noticed that with this set of components in parallel with the tuned circuit the dynamic resistance is, for the first time, lower at 200 metres than at 550. The one comforting thought, in face of the heavy loss in amplification that the augmented dielectric losses have brought about, is that the dynamic resistance of the tuned circuit is now practically constant, especially with the Litz coil, over the range 250 to 500 metres, which makes for easier receiver design and uniform amplification.

A Bad Case.

The curve of Fig. 4 represents, as has been pointed out, a case in which the dielectric losses have been reduced, by careful choice of components, to a value very considerably below that which obtains in the average receiver, though it is reasonably representative of the receivers described in the pages of this journal. In many sets, and in commercial sets in particular, dielectric losses appear to be relied upon to ensure stability in the high-frequency stages in face of considerable laxity in screening and decoupling. To check the magnitude of the dielectric losses in a case where no attempt has been made to minimise them, a series of measurements was made on a 2-inch diameter coil of the type which is made up, complete with primary, neutralising, and reaction windings, as a single unit.

The coil was a standard type with pin connectors, intended to be plugged into a coil base, and was made by a well-known firm. It bore the inscription "Split-primary H.F. Transformer," and was intended to cover the wave-band from 250 to 550 metres. The winding was 90 turns of 30 D.S.C., giving an inductance of 252 microhenrys.

The copper losses were first calculated; the corresponding dynamic resistances are given in the second column of Table IV. It was noticed that the wrong gauge of wire had been chosen for the coil; for minimum resistance it should have been wound with No. 26 instead of No. 30 gauge.

Measurement of the dynamic resistance of a tuned circuit incorporating, besides the coil, the multi-pin base for which it was designed, and with an H.610 valve in a bakelite holder, and a 3-megohm leak in clips mounted on bakelite connected in parallel, gave the results of the last column of Table IV.

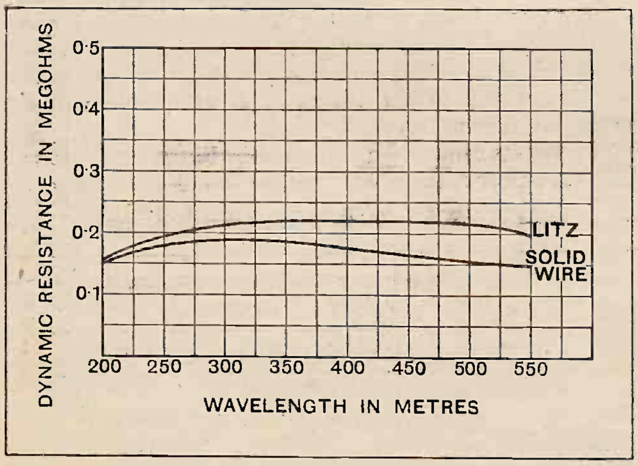


Fig. 4.—Dynamic resistance of tuned circuit with valve and valve-holder in parallel.

TABLE IV.

Wavelength. (Metres.)	Dynamic Resistance. (Megohms.)	
	Copper Losses Only.	Complete Tuned Circuit as Described.
225	0.543	—
250	0.461	0.0225
300	0.352	0.0368
350	0.279	0.0436
400	0.228	0.0485
500	0.162	0.0502
600	0.122	0.0486

The numerical results of this table are plotted as curves on the same scale as preceding figures in Fig. 5,

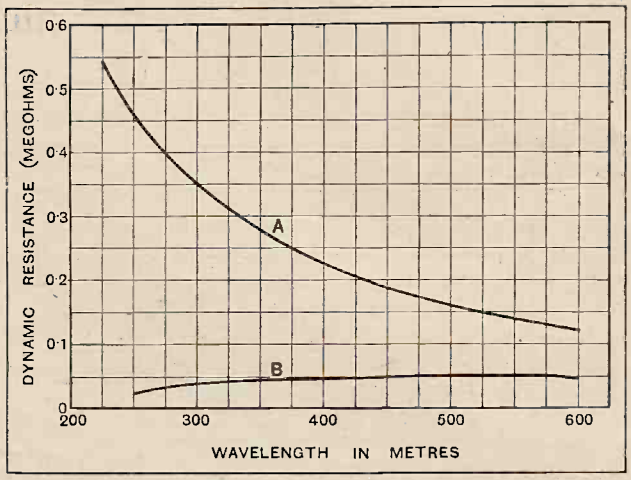


Fig. 5.—Losses in a commercial multi-pin plug-in coil of 2ins. diameter. Curve A shows the dynamic resistance calculated for copper losses only. Curve B gives the dynamic resistance as found in a practical circuit with dielectric losses. At 300 metres the dynamic resistance of this coil and circuit is about five times less than that of a 3in. *Wireless World* Litz coil.

from which can clearly be seen the appalling effect of unchecked dielectric losses on the efficiency of a tuned circuit. Nor must it be thought that the case chosen for measurement is in any way exceptional; on the contrary, it is typical of a very large class of sets. Dozens of receivers, embodying tuned circuits exactly like that examined, have been designed, and they are used in enormous numbers by those who are sufficiently unversed in technical matters to be unaware of the enormous loss in signal strength that the use of such tuned circuits necessarily involves.

The moral of all these measurements should by now be clear enough; it is that time and energy spent on determining the best winding for a coil are quite wasted unless a good deal of care is also devoted to keeping down the losses due to faulty dielectrics. If this point is overlooked, copper losses may be reduced to an almost negligible fraction of the total losses, being swamped out by the effects of dielectric absorption. In particular, it is interesting to enquire how far the use of Litz is justified in the average receiver.

Tuning Circuit Losses.—

There is, for example, no advantage whatever to be had from the use of stranded wire if the dielectric losses are to be on the scale found for the "multi-pin" coil and its appurtenances, for in such a case the copper losses form so small a proportion of the total losses that even if they are doubled or halved the efficiency of the tuned circuit as a whole would hardly be affected. At the other extreme, where dielectric losses are cut down to the minimum by decapping the valve, the substitution of solid wire for Litz would make a very large difference indeed to the behaviour of a receiver.

In the case where the valve is not decapped, but all components are picked carefully with an eye to reducing dielectric losses as far as convenience permits, we are not far from the borderline between the two extremes. Where there is but one tuned circuit in the receiver the replacement of a Litz coil by a competently designed coil of solid wire would probably not be very noticeable. Since, however, the slight, but appreciable, gain that can be had from using Litz is cumulative from coil to coil, a receiver with two tuned circuits, and, still more, one with three, would show quite a marked falling-off in performance if solid wire were used in its place. Since, in addition, doubling the input to the detector valve results in something like a fourfold increase in rectified signal voltage, even quite small changes in efficiency on the high-frequency side of the receiver are still further magnified by the detector.

But as these points apply equally to dielectric losses, they do but emphasise the need for paying the very closest attention to this insidious thief of signal strength.

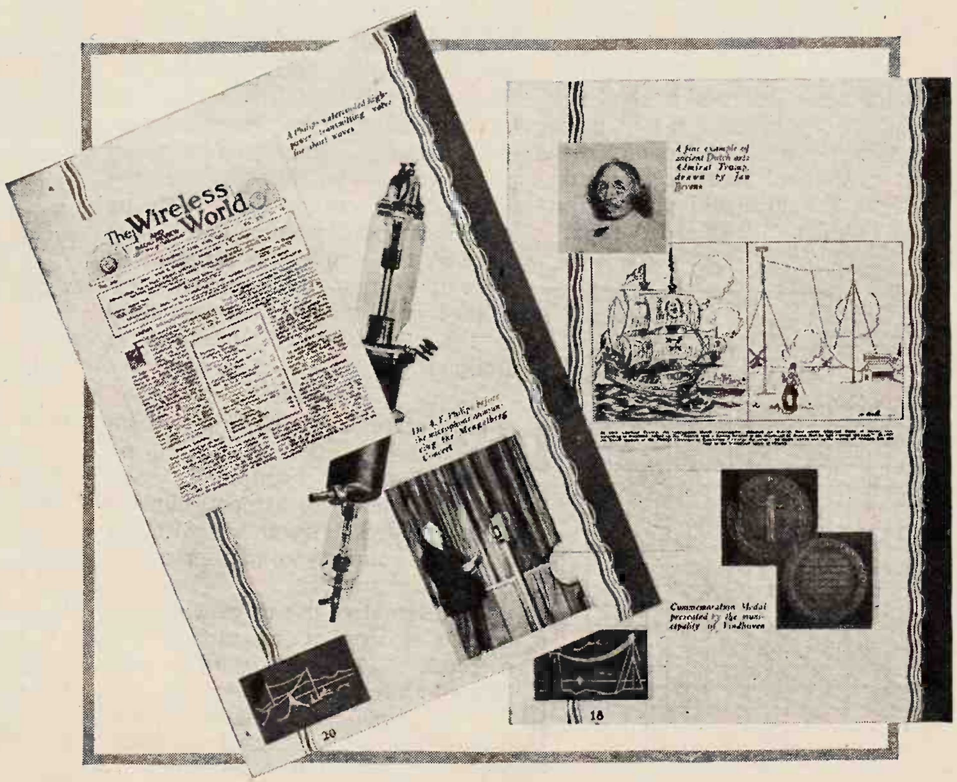
PCJ's BIOGRAPHY.

Short Waves and Long Distances.

THE history of wireless enterprise teems with achievements which really deserve that overworked epithet "remarkable." And no list of such achievements would be complete which did not include the exploits of PCJ, the Philips short-wave station at Eindhoven. The story of how, on a morning in March, 1927, PCJ woke (if it had ever slept) to find itself famous, is told in a handsomely prepared booklet now issued by Messrs. Philips Radio. In 28 pages, brightened by numerous illustrations, the author gives not only the story of PCJ's rise to fame, but many interesting observations on short-wave work in general.

Among the illustrations is a reproduction of a *Wireless World* cartoon, which appeared in June, 1927, and caused some heart-searching among British wireless authorities. The cartoonist drew a parallel between the victory of the Dutch Admiral Van Tromp over the British Fleet in 1652, and the triumph of the Dutch wireless station in the ether waves. Tied to the masthead of the Dutch ship was Van Tromp's legendary broom with which he "swept the seas," while a broom of more modern design was shown attached to the aerial at Eindhoven.

That PCJ's claim of a world-wide audience is not an idle boast is seen by reference to the world map included in the booklet, showing the places from which reports have been received. Only Greenland and Siberia appear to have missed the call. Up to the present time twenty different languages have been spoken before the PCJ microphone. This alone must constitute a record.



HOLLAND'S SHORT-WAVE ENTERPRISE. Messrs. Philips Radio have produced an attractive booklet giving the life story of PCJ the famous short-wave station at Eindhoven. The two pages illustrated, which are taken from the booklet, contain reproductions from "The Wireless World," one being an article of congratulation and the other our artist's cartoon on the subject.

CURRENT TOPICS

Events of the Week in Brief Review.

THE BIG QUESTION.

In the next census of the United States, to be taken this year, householders will be asked whether they possess wireless sets.

WIRELESS AT SCHOOLBOYS' EXHIBITION.

Electric and wireless displays are among the attractions of the Schoolboys' Exhibition now in full swing at the Horticultural Hall, Westminster. The Exhibition, which is organised by the *Daily Mail*, is open daily from 10 a.m. to 9 p.m. The closing date is January 8th.

MORE SHORT WAVES FROM HOLLAND.

The Dutch Government short-wave plant at Kootwijk will soon be augmented by the addition of three new transmitters equipped for C.W. and radio telephony, which are now under construction. These will use the call signs PCO, PCS, and PDM. Their wavelengths will be 15.686, 16.60, and 16-182 metres respectively.

BRITISH RADIO PUBLICITY IN FRANCE.

A number of British firms are now securing broadcast publicity *via* the French stations. *Radio Paris* devotes "hours" to Decca, Pathé, and Vocalion records, and also provides programmes sponsored by the Revelation Suitcase Company and other British concerns. *Radio Toulouse* is a mouthpiece for Kolster Brandes, Ltd.

MUSIC AT BREAKFAST.

A correspondent draws attention to the morning broadcasts from Huizen (1,875 metres). These take place on Mondays, Wednesdays, and Thursdays, beginning at 7.55, and consist of over an hour's recital of H.M.V. records.

SURREY'S LOUD SPEAKERS.

Surrey County Council are seeking the views of local authorities as to whether steps should be taken to reduce public annoyance caused by loud speakers.

VALVE MANUFACTURE DEMONSTRATION.

Working demonstrations of the process of valve manufacture will be a feature of the M.O. Valve Co.'s display at the Exhibition of the Physical and Optical Societies, to be held on January 7th, 8th and 9th at the Imperial College of Science, Imperial Institute Road, South Kensington. The valve demonstrations will include automatic grid making and technical displays designed to show the comparative power outputs of valves.

NEARLY ANOTHER MILLION.

Receiving licences issued up to November 30th last numbered 2,914,521.

WIRELESS AT THE B.I.F.

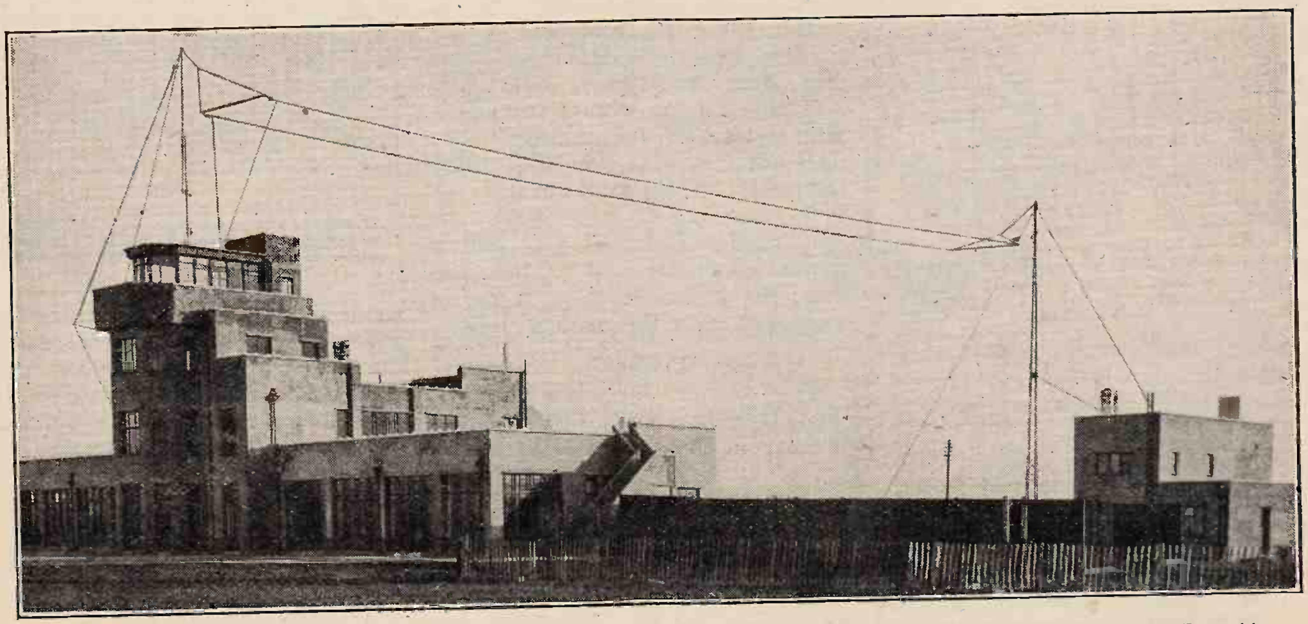
Over twenty firms have already booked space in the wireless section of the British Industries Fair, to be held in the new and reconstructed Olympia from February 17th to 28th next.

ISSUING A WIRELESS LICENCE.

In reply to a recent question in the House of Commons the Postmaster-General, Mr. Lees-Smith, stated that the average cost of issuing wireless licences during the last financial year was 1s. 1d. per licence. This cost was based upon the time occupied, and it included provision not only for the issuing, recording and renewing of annual licences, but also for headquarters work and for such duties as the detection of unlicensed stations and any subsequent legal proceedings.

THIS ETHERIAL MAGIC.

Alarming remarks are made by a writer in a Chatham newspaper. "Isn't this wireless craze going too far?" he asks. "With a great many people nowadays it would appear that there is but one thing they live for—wireless. It appeals to



FLYING LESSONS BY WIRELESS.—A general view of the recently erected aerial tuition tower at Heston aerodrome. From his vantage point above the transmitter room the instructor can observe the evolutions of his pupils and give advice when it is most needed.

them as a new toy does to a child; they cannot find out too much about it. But uninitiated in the most elementary things of this ethereal magic, they indiscreetly seek to investigate its intricacies, regardless of the results of their folly. The wireless set owner is legion, and it is not more popular than with the poorer people. . . . A working class man entered a wireless shop and purchased a valve costing half a guinea. He was accompanied by his barefooted child!"

Well, what are we going to do about it?

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A GEOGRAPHICAL ERROR.

By an unaccountable error we suggested that the Bucharest broadcasting station, illustrated in our issue of December 4th, exists for the delectation of *Hungarian* listeners. The Bucharest station is, of course, Roumanian, and is owned and operated by the Societatea de Difuziune Radiotelefonica din Romania. The power is 12 kW. and the wavelength 394 metres. We apologise for the mistake.

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LICENCEES CALL THE TUNE.

Renewal application forms for broadcast licences in Denmark are accompanied by a voting paper on which the Post Office requests listeners to express their views on the programmes. Apparently Danish programmes have points in common with those of other countries, a year's voting having shown that listeners are "dissatisfied."

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A NEW APPOINTMENT.

Mr. Bernard C. Holding, for the past three years editor of *The Electrician*, with which journal he has been associated since 1923, has resigned the editorship to take up an appointment with the International Standard Electric Corporation, London, on January 1st.

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WIRELESS OPERATORS DISSATISFIED.

General dissatisfaction with the wages and condition of marine wireless operators has led the Association of Wireless and Cable Telegraphists to apply for a conference with employers. The Association states that the 1926 award of the Industrial Court has been given loyal and patient trial, but that it is now considered that the award was and is a miscarriage of justice to Association members. Objection is taken to the method of fixing pay according to the tonnage of the ship, and the standard of wages is also condemned.

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G.W.R.'S RADIO BEACON.

The construction of a wireless beacon to assist the navigation of the Trans-atlantic liners and other shipping in Plymouth Sound during fog is being considered by the Great Western Railway Co. They contemplate erecting the station at Penlee Point, at the western end of Plymouth Sound, and, as owners of the docks at Plymouth, are prepared to bear the cost of building and equipping the station and necessary apparatus. The cost of maintenance, however, is the difficulty which is holding up the scheme. The company are understood to insist that after providing the station they should not be expected to undertake an annual expenditure of £600 to £1,000. Negotiations are in progress which it is hoped will settle the question of maintenance, but should they fail the station may not be erected.

A GERMAN "HAM" STATION.—D4CM, one of the most active amateur stations in Berlin. An input of 28 watts is used. The transmitter, seen on the left, employs the Hartley circuit.

TELEPHONES ON ATLANTIC LINERS.

Interesting technical details are now available regarding the new ship-to-shore telephony service inaugurated on the United States liner *Leviathan*.

The two parts of a conversation between the *Leviathan* and a land telephone are, as far as the radio link is concerned, carried by two separate radio waves of different wavelength. The radio wave from land to ship is about 34.8 metres, and that from ship to shore will be about 34.0 metres. The Deal Beach, N.J., experimental station of the Bell Telephone Laboratories transmits on the wave of 34.8 metres. The *Leviathan* transmitter operates on the wave of 34.0 metres. Telephone circuits from Deal Beach and Forked River, at which latter place the radio receiver is located, lead to a control room of the long-distance headquarters at 24, Walker Street, New York, of the American Telephone and Telegraph Company, from which are also operated the trans-Atlantic radio channels.

The 34.8 and the 34.0 metre waves are used in the daytime for distances from 250 to 500 miles. For distances in the daytime of less than 250 miles a wave of about 73.0 metres is used to carry the voice from land to sea, and a wave of about 68.3 metres to carry the voice from sea to land. At night the two waves are effective for all distances up to 500 miles or more.

The land transmitter is quite powerful, about 5,000 watts. The ship transmitter is of 500 watt capacity, but since receiving conditions on land are much more favourable than on shipboard, signals strengths from ship to shore and from shore to ship are about equal.

The British Post Office is not so advanced with its experiments as the American authorities, but it is probable that a similar ship-to-shore service will soon be in operation on this side of the Atlantic. Tests will shortly take place on the *Berengaria*.

FORTHCOMING EVENTS.

THURSDAY, JANUARY 2nd.
Ilford and District Radio Society.—At the Wesleyan Institute, High Road, Ilford. Lecture by a representative of the Igranic Electric Co., Ltd.
Golders Green and Hendon Radio Society.—At 8.15 p.m. At the Club House, Willifield Way. Lecture: "The Latest in Radio," by Mr. Percy W. Harris.

MONDAY, JANUARY 6th.
Newcastle-upon-Tyne Radio Society.—At 7.30 p.m. At Armstrong College. Lecture: "The Evolution of the Receiver," by Mr. J. G. Ogg.

TUESDAY, JANUARY 7th.
Physical and Optical Societies' Exhibition (and on January 8th and 9th). At the Imperial College of Science, Imperial Institute Road, South Kensington.
The Television Society.—At 8 p.m. At the Engineers' Club, Coventry Street, London, W. Lecture: "Photographic Problems of Picture Telegraphy," by Mr. W. S. Newton, B.Sc. (Hons.).

TRANSMITTERS' NOTES.

Radio Amateur Call-book.

The December issue of the Amateur Call-book is now published and can be obtained from Mr. F. T. Carter, Flat A, Gleneagle Mansions, Streatham, price 4s. 6d. post free.

The lists of amateur transmitters have been revised and brought up to date; that for Great Britain alone occupies over 24 columns of closely printed matter. The supplementary features include the "Q," "R," and "T" codes, and a list of the principal commercial short-wave stations, with regard to which the publishers specially ask for reliable information concerning new stations working regularly on frequencies above 3,000 kC.

We hope there will be a good response to this request, as up to the present time we have not seen anything like a really comprehensive list of short-wave stations, though we receive constant enquiries from readers who ask if a complete list is obtainable.

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Experiments on 170 Metres.

Mr. S. J. Styles (G 5BQ), 15, Pickwick Road, Dulwich Village, S.E.21, is carrying out experiments on the longer amateur wavelengths and wishes to arrange schedules on the 170-metre wave-band for Saturday or Sundays with stations outside London. He will also appreciate any reports on transmissions received on this wavelength.

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New Call-signs and Changes of Address.

G 6IO T. Woodhouse-Rayner, 25, The Gardens, East Dulwich, S.E.22. (Change of address and re-issue of licence); transmits on 1740–1970 and 7050–7250 kC. and will welcome reports.

G 6NM North Middlesex Radio Society (Portable). Hon. Sec., E. H. Laister, "Windflowers," Church Hill, Winchmore Hill, N.21 (Change of address.)

American Beam Stations

An Account of the Short=wave Achievements of the Bell Telephone Laboratories.

By M. RAY.

AT a meeting of the Wireless Section of the Institution of Electrical Engineers in March, 1926, a paper was read by Mr. Shaughnessy describing the remarkable achievement of the General Post Office—the thousand-kilowatt Rugby transmitter completely controlled from a small tuning-fork. Many speakers complimented the engineers of the Post Office and affirmed their belief that this was the last word in transmitting station design. Mr. Vyvyan, the chief engineer of the Marconi Co., also remarked that the achievement was the last word in more senses than one, insinuating that, although only completed a few months, the long-wave Rugby station was already out of date.

He was referring to the short-wave beam stations that were in the course of erection by his company under the guidance of that remarkable engineer, C. S. Franklin. Most of those present, though they were not in the position to contradict effectively Mr. Vyvyan's prophecy, through lack of experimental evidence at their disposal, were well known to be very sceptical regarding the prospects of the employment of short waves for commercial purposes. The last three years have shown that this prophecy, however rash it appeared at the time, was substantially correct for point-to-point transmission.

It is barely two years since the General Post Office took over the pioneer installations of the Marconi Company, and there are now short-wave beam stations almost all over the civilised world, and more are constantly being added to the number already in existence.

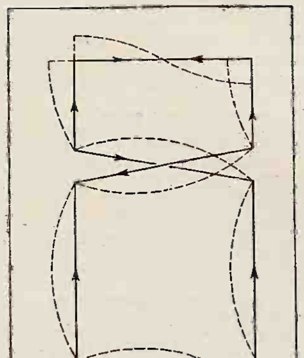


Fig. 1.—An element of the transmitting aerial. The dotted lines show the current distribution.

One of the latest installations is that designed by the Bell Telephone Laboratories of America for the American Telephone and Telegraph Company. They have been described in a recent number of the *Bell Records* by the principal engineers in charge of the design.

These stations are of considerable interest and in many ways differ from the original stations built by Franklin. The requirements in these American stations were more stringent, since they were required for telephonic communication, and, in order to obtain reliable service, it was considered that it would be necessary to employ a number of wavelengths, so that when one failed to convey intelligible speech via the Heaviside layer, another wavelength would be used. Each of the transmitters erected by the Bell Laboratories can be used on three different wavelengths of approximately 16, 22, and 33 metres. The transmitters can be readily altered for different wavelengths by changing the coils, but the problem is not so simple for the aerials. These beam aerials can only be designed for a single wavelength, so that each trans-

American Beam Stations.—

mission channel has three separate aerial arrangements and a single transmitter. At Lawrenceville, near New York, there are three channels pointing towards England, making a total of nine aerial arrangements, each of which is 500ft. long.

These had to be arranged in a line in order that they might not interfere with one another. The total area of land covered is 800 acres. The aerials are supported on steel towers 180ft. high. Each of them is considerably smaller than those originally erected by the Marconi Company, which used towers 275ft. high and an aerial spread of 1,300ft., but in most cases only a single wavelength, and never more than two, were used, so that the total system for each channel was smaller, but no doubt did not give as high a degree of reliability. The principle of the aerial design differs somewhat from that of Franklin.

An element of the aerial is shown in Fig. 1, in which the dotted lines show the current distribution. The currents in the vertical portions by this arrangement flow in the same direction, while the currents in the horizontal portions practically cancel one another, so that only the vertical portions are effective in producing radiation.

This special form of construction was employed in order to guard against certain dangerous climatic conditions. In the neighbourhood of New York considerable quantities of sleet are liable to condense on wires. To prevent dangerous overloading of the aerials it is proposed to melt the sleet by warming the aerial wires with alternating current at power frequencies. For this purpose it is essential that the aerial should form a complete metallic circuit, a condition which is obtained in the design shown in Fig. 1. A current of 150 amperes at nearly 1,000 volts is used for the purpose. The power generator is connected across a large condenser, which effectively short-circuits the high-frequency current. This condenser is connected at the end of a quarter-wave line. The reason for this is that such a line, when short-circuited at its end, has a very large input impedance. The combination of this line, condenser, and generator connected directly across the high-frequency generator is of such high impedance to the high-frequency that it will barely affect it.

The reflector system is a similar arrangement situated a quarter of a wavelength behind the transmitting aerial, and excited by direct induction from it. The correct phase relation between the current in the reflector and the aerial is obtained by slightly detuning the reflector system.

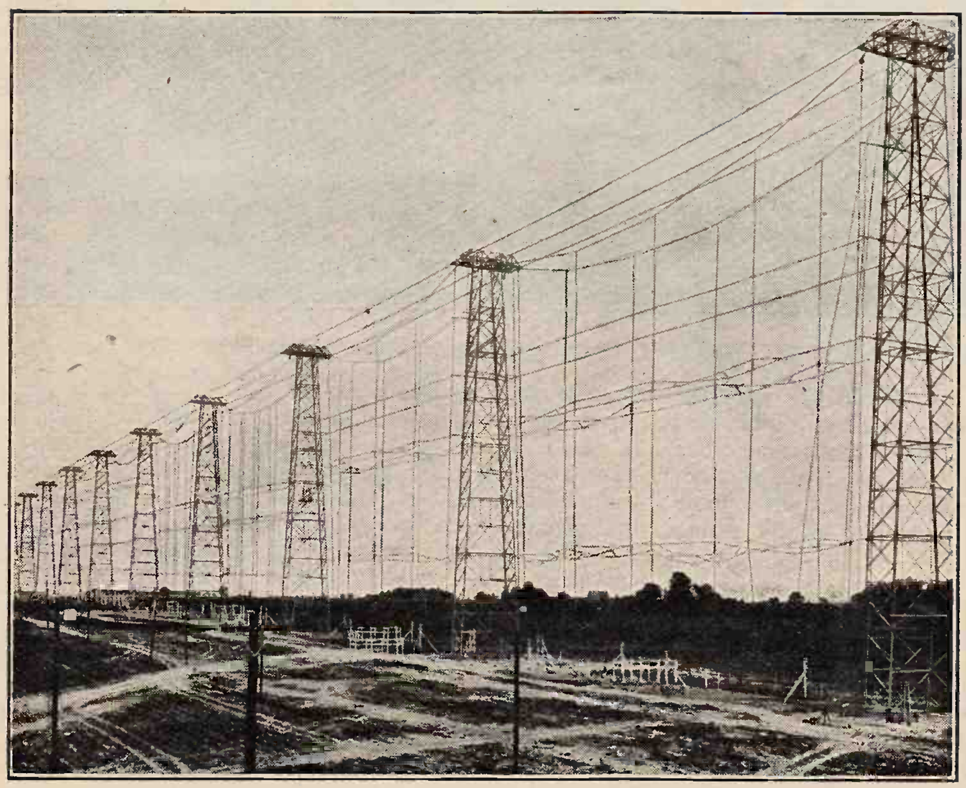
Quartz Oscillator Control.

The whole aerial system consists of a number of elements such as shown in Fig. 1 situated side by side in a line.

A general view of the grounds at Lawrenceville is shown in the title illustration. The long line of aerials are the three channels for European transmission, the shorter one at right angles to it is a channel for transmitting to South America. The photographs give a closer view of the aerial system. It will be noted that in general outward appearance the construction is very similar to that of the original beam aerial designed by Franklin.

While the thousand-kilowatt station of Rugby is controlled from the almost infinitesimal power of a vibrating tuning fork, these high-frequency 15-kilowatt transmitters are controlled by an even smaller source of power, namely, that derived from a piece of quartz vibrating at the rate of 3,300,000 cycles per second. From these the third harmonic is picked out, and then the second of the result, giving finally the highest frequency used, corresponding to approximately 16 metres wavelength. This is modulated by a two-stage speech amplifier and again amplified by large water-cooled valves, of which there are four in parallel in the last stage.

The construction of the oscillator is apparently straightforward, but the designers had to overcome



A part of the line of towers supporting the transmitting aerials at Lawrenceville.

American Beam Stations.—

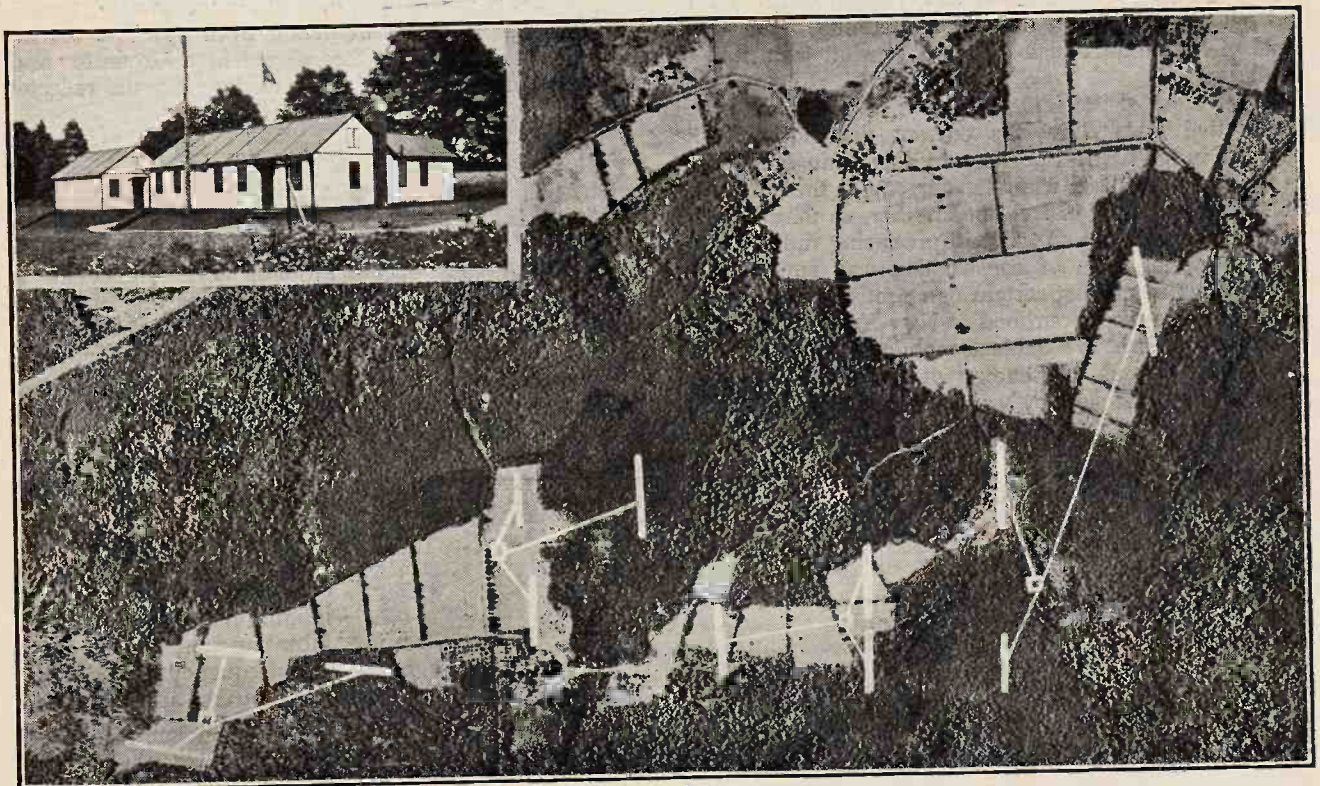
considerable difficulties owing to the fact that some of the leads in such large systems are of length comparable to the wavelength and need special coaxing, and also because these high-frequency circuits are liable to break out into various types of oscillations. These may contain extremely high frequencies produced by stray inductances in leads and valve capacities, but they can usually be prevented by the judicious use of resistances.

In construction the power supply and arrangements are along standard lines. One is faced with a bevy of beautifully arranged instruments, switches, knobs, relays, which give the impression like all unfamiliar switchboards of being lost in a large city. An explanation is given of the mechanism of the foolproof devices consisting of interlocking switches, lights that go on when something is wrong, lamps that go out when something is right, bells that ring when the operator falls asleep, cages that one cannot enter without making cabalistic signs, and all the remainder of the safety devices.

Minimising Atmospheric Disturbances.

So much for the transmitter. The receiving aerial is of a different design first suggested by Mesny. The construction is shown schematically in Fig. 2, in which the dotted lines show the current distribution. As in the case of the transmitting aerial, it will be seen that the vertical portions carry current flowing in the same direction, while the currents in the horizontal portions are small and largely neutralise each other, so that only the vertical portions are effective for reception. The reflector is an identical system situated one-quarter of a wavelength behind the aerial, and departs from the usual arrangement in that it is connected to the receiving set in such a way that the E.M.F. induced in it is shifted in phase by 45° before it reaches the receiving set.

The same shift, but in the opposite direction, is given to the signal from the aerial, resulting in a relative phase shift of 90° between the two. This, combined with the distance of separation of a quarter of a wavelength, gives the ideal theoretical condition for a reflector, namely, that it should double the signal received from the required direction, and reduce it to zero if it comes from the opposite direction, the direction of the incoming ray being assumed to be horizontal. Actually this phase shift is adjustable, so that minimum reception is in the direction of the most disturbing atmospherics. Each aerial is six wavelengths long; such a system, it is claimed, receives forty times the power (16 decibels) as that received from a simple half-wave aerial. The whole receiving station, comprising four communication channels, each capable of reception on three different wavelengths, covers an area of 400 acres. An aerial view of the station is shown, together with a closer view of the aerial systems.



Aerial view of the receiving station at Netcong, New Jersey, showing location of receivers and transmitting aerials.

The receiver proper is built on the superheterodyne, double-detection principle. The signal is first amplified by means of two stages using screen-grid valves, the frequency is then demodulated to one of 400 kilocycles, which is passed through a narrow band-pass filter, and the signal further amplified through six stages

The receiving aerial at Netcong.

at this intermediate frequency. Between the first and second of these stages is inserted an attenuator, which serves the double purpose of volume control and for carrying out certain measurements. Before the last demodulator, from which the speech frequencies are

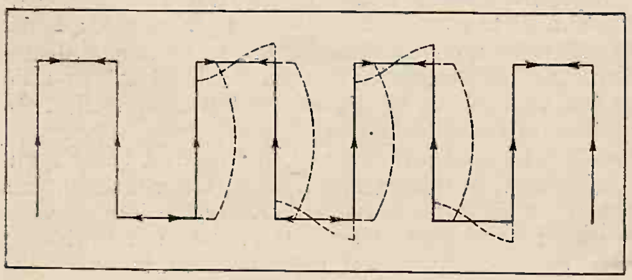


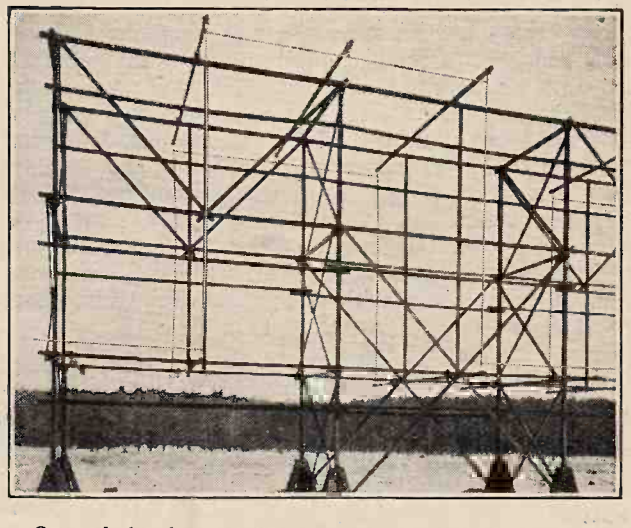
Fig. 2.—Mesny aerial for reception. The current distribution is shown by the dotted lines.

obtained, another band-pass filter is inserted. A single stage of audio-frequency amplification is employed.

The speech is then transmitted along wires to a central building, where it is further amplified and transmitted over land lines to New York. After this our interest completely disappears, but our imagination may allow us to visualise some impossibly square-chinned business man being disturbed in order to listen over the roar of the electrons and the cracklings of Jupiter to some probably unimportant remarks. (Fortunately, the roar is subdued, and the cracklings not too frequent.)

With the help of the photographs kindly lent by the Bell Telephone Laboratories, the author has been able to describe briefly a great engineering success. The use of short-wave beam stations, with the further improvements in design that are likely to accrue through the research work which is continually going on, will in time bring long-distance telephony within the financial reach of nearly all. In America already he who lives without a telephone lives in Diogenian bliss, but his race is practically extinct.

It is indeed a pity that the transmission of speech over which so much thought, so much work, so much



One end of a short-wave receiving aerial erected by the Bell Telephone Laboratories.

energy has been spent should reach the end of its journey in the common land line and desk telephone, of the reproduction qualities of which even a parrot would be ashamed.

CATALOGUES RECEIVED.

Messrs. Wingrove and Rogers, Ltd., Arundel Chambers, 188-9, Strand, London, W.C.2.—Illustrated folder of "Polar" condensers and components.

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"M.P.A." Wireless, Ltd., 62, Conduit Street, London, W.1.—Illustrated folder of new season's receivers, accessories and components.

Fuller Accumulator Company (1926), Ltd., Woodland Works, Chadwell Heath, Essex.—12-page illustrated booklet on the care and maintenance of Fuller accumulators.

Carrington Manufacturing Co., Ltd., Camco Works, Sanderstead Road, South Croydon. — Descriptive leaflet of "Camco" "Paxflat" cabinet for the "1930 Cossor Melody Maker."

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Messrs. J. R. Morris, 15, 17, 19, Kingsway, London, W.C.2.—Illustrated folder of Columbia dry-cell H.T. batteries.

Part XV.—Properties of Tuned Circuits.

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

(*Continued from page 704 of last week's issue.*)

THERE is still a good deal to be said regarding the series type of tuned circuit discussed in the previous part where the conditions for obtaining the highest voltage step-up effect were mentioned. It was found that for optimum signal strength the resistance of the tuned circuit should be low and the ratio of inductance to capacity as high as possible within practical limits. The *product* of inductance and capacity is determined by the frequency or wavelength to be received.

Selectivity.

In these days when some valves are capable of giving an actual high-frequency amplification of the order of 200 times or more in a single stage, the voltage step-up effect given by the circuit itself is not nearly so important as it was a few years ago when it was a difficult matter to obtain a high-frequency amplification of only twenty times in a single stage. The most pressing problem at the present time, as every reader knows, is that of obtaining a circuit sufficiently selective to enable him to listen to a desired transmission without interference from other transmissions perhaps more powerful than the desired one and operating at a frequency removed by a few kilocycles per second only from that to which the circuit is tuned.

By more or less elaborate arrangements involving two or more tuned circuits it is possible to obtain a very high degree of selectivity, but as we are studying the general theory of a single tuned circuit at the moment, such refinements must be left for subsequent consideration.

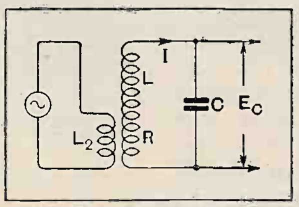

Fig. 1.—Simple series tuned circuit. If a voltage E is induced into the closed circuit L R C the voltage E_c is built up across it at the resonant frequency. $\frac{E_c}{E}$ is the voltage magnification *m* of the tuned circuit and is equal to $\frac{1}{R}\sqrt{\frac{L}{C}}$.

The selectivity of a tuned circuit is not very easily expressed as a numerical quantity on account of the peculiar shape of the resonance curve. There are two ways in which one could judge the selectivity of a circuit, and a definition could be given according to which viewpoint is taken. For instance, in tuning the receiver to a given station the object in view is to cause the signals from this station to build up the maximum possible voltage across the tuned circuit whilst at the same time preventing as far as possible any other station, operating on a neighbouring frequency, from setting up a voltage across the circuit. From this point of view the selectivity of the tuned circuit might be defined as the ratio of the voltage obtained across it at the resonant frequency to that obtained at some other frequency differing by a stated number of cycles per second from the resonant frequency, the voltage induced into the circuit being the same in each case.

Since the present frequency separation of broadcasting stations in Europe is 9 kilocycles per second, a figure of this order suggests itself for use in the above definition. So the selectivity could be defined as the ratio of the voltages set up across the tuned circuit by two stations of equal strength and where frequency separation is 9 kilocycles per second, the receiver being accurately tuned to one of them. But, unfortunately, this definition, although conveying clearly the idea of what is meant by degree of selectivity, does not lend itself very easily to numerical calculation in terms of the constants of the circuit.

In these circumstances it is better to define the selectivity from the point of view of the change in frequency from the resonant value necessary to reduce the voltage across the circuit to a stated fraction of the maximum value. In the October 16th issue of *The Wireless World* Dr. R. T. Beatty gave a definition on these lines, and explained how a number could be obtained for expressing the selectivity of a tuned circuit as a numerical quantity, and how it could be used for practical calculations. This he called the "selectivity number" of the circuit. It is defined as the ratio of the resonant frequency to the change in frequency necessary to reduce the voltage across the circuit to a value of 10 per cent. of the maximum value. The way in which this selectivity number depends on the constants of the circuit will be explained after we have considered the resonance curves of some actual circuits.

The Effect of Resistance on Selectivity.

The degree of selectivity necessary to ensure reception of any given station free of interference by another station on a neighbouring wavelength or frequency

Wireless Theory Simplified.—

depends on (*a*) the difference between the two frequencies, and (*b*) the relative strengths of the two transmissions as measured in the locality of the receiver. The closer the two wavelengths are together and the more powerful the effects of the unwanted station, the greater will the selectivity have to be.

The resonance curves given in Fig. 3 of the previous part show very clearly that when the resistance of the tuned circuit is reduced, the peak of the resonance curve is increased in height *without appreciably changing the width of the hump near the base.* This means that, by decreasing the resistance, we are increasing the strength of the wanted "signal" at the resonant frequency without appreciably increasing the strengths of any signals whose frequencies lie outside the band covered by the hump in the curve. In other words, we are increasing the selectivity by reducing the circuit resistance.

The effects of the resistance, however, on the selectivity of the circuit can be made very much clearer if, instead of plotting the resonance curves to actual values of the voltage, each is plotted to values which are a percentage of the respective maximum values, thereby making all the curves coincide at the maximum point. Accordingly this has been done in Fig. 2 for a series-tuned circuit such as that shown in Fig. 1, where the inductance is 2532 microhenrys and the capacity 0.00025 microfarad, for resistance values of 10 ohms, 50 ohms, 200 ohms and 500 ohms respectively, as indicated on the curves.

These resonance curves show very clearly that reducing the resistance of the circuit has the effect of narrowing down the peak of the resonance curve and so increasing the degree of selectivity. Since the curves have been plotted to scale, we can read off directly the frequency at which the voltage across the circuit is 10 per cent. of the maximum value, and from this we can obtain the selectivity number formulated by Dr. Beatty. For instance, from the resonance curve corresponding to a circuit resistance of 50 ohms, the voltage falls to 10 per cent. of the resonant value at a frequency of 184.3 kilocycles per second. The difference between this and the resonant value of 200 kilocycles per second is 15.7, and so the selectivity number of the circuit is

$$\frac{200}{15.7} = 12.72.$$

When the circuit resistance is increased four-fold to 200 ohms, we find that 10 per cent. of the maximum voltage occurs at a frequency of 137 kilocycles per second. The difference between this and the resonant frequency is $200 - 137 = 63$ kilocycles per second. Hence the selectivity number is $\frac{200}{63} = 3.18$. This is just one-quarter of the value obtained for the 50-ohm circuit. By taking further resistance values and the corresponding resonance curves we find that *the selectivity number is inversely proportional to the resistance of the circuit.*

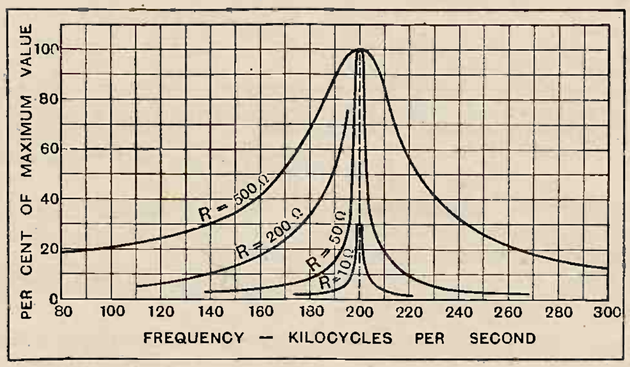

Fig. 2.—Voltage resonance curves for a series tuned circuit showing how the resistance affects the selectivity. Coil inductance 2532 microhenrys, capacity 0.00025 mfd. Resistance values as indicated on the curves.

Effects of L and C on the Selectivity.

It was shown that the voltage step-up or voltage magnification of the tuned circuit is *also* inversely proportional to the resistance, and so *both the signal strength and the selectivity vary inversely as the circuit resistance.* We can conclude, then, that the selectivity of a circuit is directly proportional to the voltage magnification obtained at the resonant frequency. Now the voltage across the circuit at this frequency is equal to the current in the closed circuit multiplied by the reactance of the condenser or by the reactance of the coil, because these are equal at the resonant frequency—that is, voltage across the circuit is $E_c = I \times 2\pi f L$, where $I = \frac{E}{R}$ at the frequency of resonance, E being the voltage applied to the circuit. Hence $E_c = E \times \frac{2\pi f L}{R}$ volts, and so the voltage magnification of the circuit is $m = \frac{2\pi f L}{R}$ at the frequency of resonance. But we already know that $f = \frac{1}{2\pi\sqrt{LC}}$ or $2\pi f = \frac{1}{\sqrt{LC}}$, and therefore the voltage magnification given by the circuit when tuned to resonance is

$$m = \frac{1}{R}\sqrt{\frac{L}{C}}.$$

and the selectivity number is proportional to this quantity, which may be looked upon as a sort of figure of merit of the circuit.

For the circuit considered above, with $L = 2532\ \mu H$ and $C = 0.00025$ mfd. for a resistance value of 50 ohms the voltage step-up is $m = \frac{1}{50}\sqrt{\frac{2532}{0.00025}} = 63.6$ times. The selectivity number for this circuit was found to be 12.72, which is *exactly one-fifth* of the voltage magnification.

Similarly for the 200-ohm circuit the voltage magnification works out to 15.9 and the selectivity number was 3.18, also exactly one-fifth of the voltage magnification. Hence for a selectivity number calculated on a 10 per cent. basis, as explained above, its value is given for any tuned circuit by $\frac{1}{5R}\sqrt{\frac{L}{C}}$.

Conditions for Maximum Selectivity.

Thus from the point of view of obtaining good selectivity with a single tuned circuit, it is a matter of the first importance to make the *effective* resistance as low as pos-

Wireless Theory Simplified.—

sible and to choose a ratio of $\frac{L}{C}$ as large as possible compatible with practical conditions. The effective resistance of the circuit is the *equivalent series resistance* which, when multiplied by the square of the current, gives the total power absorbed by the circuit; it is made up of the actual high frequency resistance of the coil together with an added resistance accounting for any incidental loss of power associated with the circuit but not actually in the coil or condenser. For instance, if the tuned circuit is followed by a detector valve operating on the leaky grid principle as shown in Fig. 3(a), it is actually shunted by a high resistance "load," and the simplified circuit is shown at (b) in Fig. 3, where r is the effective resistance in parallel with the condenser of the tuned circuit and R_1 is the actual high-frequency resistance of the closed circuit itself. Now since the external resistance r has a high value, the current in it will be very small compared with the current I in the coil L, and so we can still take the current as being of equal value all the way round the closed circuit without introducing any appreciable error.

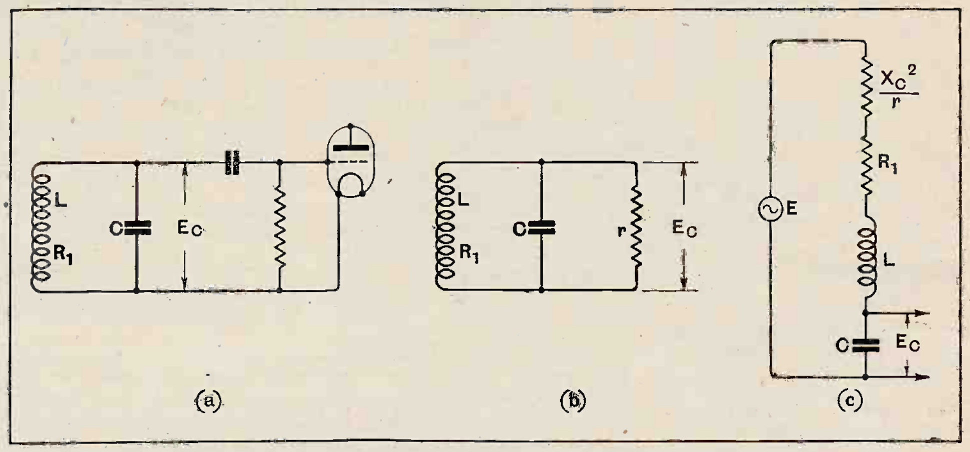

Fig. 3.—When a tuned high-frequency circuit feeds a leaky grid detector it is shunted by an equivalent resistance r as shown in (b). This in turn is equivalent to adding an extra resistance $\frac{X^2_c}{r}$ in the tuned circuit itself.

The power loss in the closed circuit is I^2R_1 watts and that in the external resistance r is $\frac{E_c}{r}$ watts, where E_c is the voltage across the circuit at resonance, being equal to $I \times X_c$, where $X_c = \frac{1}{2\pi fc}$. Hence the power expended in the external shunt resistance r is $\frac{I^2X^2_c}{r} = I^2 \times \frac{X^2_c}{r}$ watts; and so a high resistance in parallel with the tuned circuit is equivalent to an extra series resistance of $\frac{X^2_c}{r}$ ohms within the closed circuit itself.

Thus if R_1 is the effective resistance of the unshunted tuned circuit, and if this circuit is then shunted by a high resistance r, the effective resistance of the circuit becomes

$$R = R_1 + \frac{X^2_c}{r} \text{ ohms,}$$

and in consequence both the selectivity and the signal strength are reduced. The equivalent circuit is shown in Fig. 3(c).

Damping Effect with Leaky Grid Rectification.

As a practical example we can consider the same tuned circuit cited previously, namely, where $L = 2532$ microhenrys, $C = 0.00025$ microfarad, and assume that the effective resistance of the circuit itself with the valve disconnected is 50 ohms. The voltage magnification obtained would be $m = \frac{1}{R}\sqrt{\frac{L}{C}} = 63.6$. Suppose now that the leaky grid detector valve is connected across the circuit and that it introduces an equivalent shunt or parallel resistance of 1 megohm or 10^6 ohms. This is equivalent to increasing the *series* resistance of the circuit by $\frac{X^2_c}{10^6}$ ohms. The resonant frequency is 200 kilocycles per second, and therefore the condenser reactance X_c is 3182 ohms. Hence the extra resistance imparted to the circuit by the valve and its grid leak is

$$\frac{X^2_c}{r} = \frac{3182^2}{10^6} = 10 \text{ ohms.}$$

So the total effective resistance of the tuned circuit is increased from 50 ohms to 60 ohms in this case, and the voltage magnification reduced from 63.6 to 53. Obviously the lower the effective resistance of the tuned circuit itself the more pronounced will be the "damping" effect of a leaky grid detector or any other shunting resistance. Thus when a high frequency tuned circuit is designed to have the maximum possible efficiency, it should preferably be followed by an "anode bend" detector if the selectivity is to be unimpaired, because anode bend rectification introduces very little damping.

(*To be continued.*)

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WORLD-TIME INDICATOR.

Messrs. J. H. Willis and Co., Ipswich Road, Norwich, have sent us their new model World-Time Indicator. A description and illustration of this device appeared in our issue of May 8th, 1929. In the new model several more countries have been included, the wording of the instructions slightly amended, and the edge of the dial is now milled. The price is 1s. 6d.

BROADCAST - BREVITIES.

By Our Special Correspondent.

A Programme Dilemma.—The King at the Microphone.—What Will 1930 Bring?

To Be or Not to Be?

The New Year finds the B.B.C. Programme Department in a disturbing predicament. The ordinary task of filling programme time for six weeks ahead is sufficiently harassing; add to it the possibility, but not the certainty, that an extra full-blown daily programme will be required in a month or two, and the worried looks at Savoy Hill are fully accounted for.

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Watch the Educationists.

The outcome of the present twin transmission tests from Brookmans Park will determine whether an additional programme is to be available, and already a number of optional items have been pigeon-holed for use at a moment's notice. I understand that these include a good sprinkling of talks; in fact, it looks as if the alternative regional programme might easily be commandeered by the educational group. Possibly listeners are in favour of such a step, but I very much doubt it. No one denies that broadcast education is handicapped at present by lack of programme time, but the B.B.C. would do well to ensure that the educationists are not allowed too big a bite from the new cake.

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H.M. The King.

The outstanding broadcast event in January is, of course, the relay from the International Disarmament Conference at the House of Lords on the 21st, when H.M. The King will use the microphone again for the first time since his illness.

I hear that the B.B.C. will install no fewer than ten microphones in different parts of the Royal Gallery These will be operated from a control point just outside the Chamber, linked to the Post Office "PBX" (Private Branch Exchange), and thence to Savoy Hill.

The relay, which will last two hours, will begin at 11 a.m. with the King's opening speech, after which His Majesty will leave the Royal Gallery, his place being taken by the Prime Minister. The broadcast is expected to include speeches by representatives of the great naval powers and delegates of the Dominion Governments.

A Bumper Broadcast Year.

It is doubtful whether any year can eclipse 1929 for the importance and variety of its broadcast events. On the constructional side the year saw the practical completion of the first regional station, the installation of a new listening post at Tatsfield, and the spade work preliminary to the erection of Broadcast House, Portland Place.

In the North work was started on the site for another regional transmitter.

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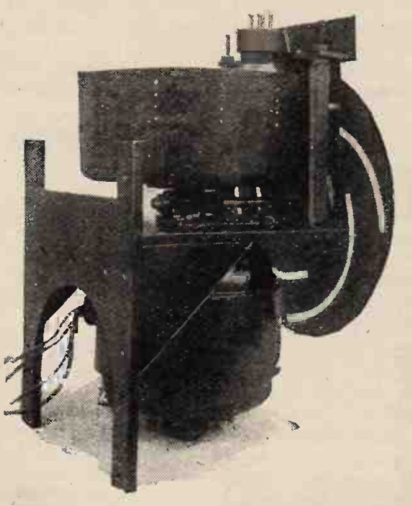
Programme Progress.

On the programme side, the B.B.C. deserve congratulation for several really "star" features during 1929. At the top of the bill came the broadcast of the Schneider Trophy Race, carried out in a masterly fashion by an "O.B." staff who are now masters of the game of bringing outdoor events to the home of the listener.

The list of notable speakers who faced the microphone in 1929 is formidable enough. It includes the Prince of Wales, the Duke of York, the Prime Minister, Mr. Philip Snowden, Sir James Barrie and Sir Henry Segrave, to name only a few.



TELEVISION IN AMERICA. Regular television programmes are now broadcast by W2XCR, New Jersey, using the Jenkins apparatus. The photograph shows the interior of a Jenkins receiver. Note the rotating drum with its vertical scanning holes and neon lamp.

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Can Savoy Hill Maintain the Standard?

Radio drama discovered a new technique in "Squirrel's Cage," which fully deserved its repeat performance, while the Talks Department amply justified its existence by the introduction of the "Points of View" series.

Taken all round, it has been a good year for broadcasting, and I am afraid that the B.B.C. may have some difficulty in maintaining the standard. Anyway, here's good luck to them!

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Old Bore's Wireless Almanac for 1930.

January.—Old Bore sees a million listeners resolving not to listen again until B.B.C. improves programmes.
February.—Unhappy million resume listening to see if programmes have improved.
March.—Still listening.
April.—Coming to a decision.
May.—Dissatisfied; another million switch off.
June.—B.B.C. loses patience and closes down. Public outcry.
July.—A nation starving for entertainment.
August.—Cabinet meeting discusses plans for emergency programmes.
September.—Rugby, Northolt and Wick Radio broadcast Clapham and Dwyer. Adult education from Cleethorpes.
October.—B.B.C. behind barbed wire at Brookmans Park. Aberdeen station opens subscription list for announcers' families.
November.—Tactful mediation of Postmaster-General brings B.B.C. back to Savoy Hill. Programmes resumed.
December.—Old Bore sees a million listeners resolving not to listen again until programmes are improved.

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Things We Want to Know.

Whether a certain artist often visits the Queen's Hall, and, if so, whether he still sees the organ pipes as sausages in mass formation.

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.

SUPPLY REGULATION AND MAINS UNIT.

Sir,—May I make the suggestion that users of D.C. units on mains which are expected to be changed over to A.C. should apply to their local electricity works to approve of the unit? The local authority can only refuse to approve the unit on certain obvious grounds (an anticipated change over to A.C. is *not* a reasonable objection). Having approved the unit, the supply company is, I believe, bound to provide an A.C. unit when they change over to A.C. ERNEST J. BATY.

Luton, Beds.

ARE AUTUMN SHOWS TOO LATE?

Sir,—It is common knowledge that those who attend the annual Motor Show at Olympia, and order new motor cars, frequently have to wait until the following spring before they obtain delivery. Luckily, the spring is just the time when most people desire to put new cars into commission. With the wireless public the position is less fortunate. The annual Wireless Exhibitions in London and elsewhere are held about October, and those who attend and order new sets or new components naturally expect to be able to use them during the coming winter.

My experience may have been unusual, but it has been as follows :—

(1) A month or so ago I made enquiries about a new moving-coil loud speaker which received much favourable comment at the recent exhibition at Olympia. I was told that, if I decided to wait so long, I might be able to obtain one next January.

(2) I found the published characteristics of a certain new power valve met my requirements. Upon asking my local dealer about it I was told that he had ordered some of these valves weeks ago, but had not been able to obtain any.

(3) For some unknown reason, the English manufacturers appear content to allow the Americans to hold more or less a monopoly in the sale of variable wire-wound resistances and power potentiometers, though these components are required in practically every home-made wireless set and H.T. unit. To my joy, I recently saw an advertisement of an English power potentiometer. I ordered one. I am still waiting for it.

All these components were advertised for sale by firms of first-rate standing.

Now, I quite appreciate that the manufacturers may say that, until the Wireless Exhibitions are held, they do not know what the demand for any particular component is likely to be, and they do not want to manufacture goods wholesale unless they are satisfied that there will be a ready market for them.

If this is their attitude I suggest that the annual Wireless Exhibitions are held at the wrong time of the year. They should be held earlier, so that those who order goods may have some hope of obtaining them at the time when they are most wanted, the autumn. A. H. GREGSON.

Westcliff-on-Sea.

THE SUPERHETERODYNE.

Sir,—The superhet receiver can scarcely be said to have ever enjoyed a popular vogue in Britain, but by serious experimenters it has long been held to be a valuable instrument; nor do those who have had experience of its use consider that its sphere of usefulness is past. It was therefore with some surprise that many read, in two separate articles published by you in November—"Radio in France" (6.xi.29) and "Receiving Sets of To-day" (20.xi.29)—remarks which appeared to convey that the authors of the articles thought the superhet obsolete. So little did the present writer believe that this was the considered opinion of the technical experts of *The Wireless World* that he confidently expected (following Mr. Cocking's recent article on bandpass filters) that the next *Wireless World* set would certainly be a superhet with bandpass filters, probably based on the "Record Three," *i.e.*, with a single high-magnification I.F. stage, or the "Kilo-Mag" with two I.F. stages.

Selectivity and high-quality production are the most urgent needs. The selectivity of the superhet has never been questioned; that it can also give the highest quality of reproduction may not be so well known, but one would have thought it to be evident from a study of Mr. Cocking's article on bandpass filters in your issue of October 30th, 1929. Obviously the easiest application of the bandpass filter having a constant channel-width is to fit it to the input of the I.F. stages of a superhet.

Since Easter the writer has experimented with superhets in which carefully tuned bandpass filters and I.F. transformers were embodied, and for quality the present hook-up is hard to beat. The eminent organ-builder and master of acoustics, Mr. John Compton, hearing the writer's set, likened it to a big chorus of Schulze diapasons—a term which conveys to those familiar with organ design and technique a tone picture of a quality not to be mistaken, and which may be explained as connoting the presence of solid foundation tone from 16ft. pitch upwards, accompanied by the fullest harmonic development of which the upper members of the family are present in such power and brilliance as to constitute a perfect blaze of tone.

It may be that the superhet in question differs from the usual type somewhat, but there is neither magic nor secret about it. Anyone could build it without much trouble; possibly, as did the writer, largely out of parts from previous sets. There is not an excessive number of valves, and two of them (the modulator and the detector) have no H.T. on their plates. What perhaps is unusual is the intermediate frequency, which, to obviate repeats and harmonics, is fixed at 478.4 kh. Aerial and oscillator coils, bandpass filters, and I.F. transformers are accurately tuned, the filters and transformers by a fixed condenser, a semi-variable condenser, and a small variable condenser, all in parallel. The filter and transformers, of course, only require this to be done once for all. There is in all cases a very high ratio of inductance to capacity. J. T. H. BURREL.

Millbank, S.W.1.

Sir,—One of your correspondents who signs himself "Super Het" wants three reasons for the unpopularity of the superhet type of receiver in England. As a superhet enthusiast, may I be allowed to state my opinion on the matter? Of the several available reasons, here are what I consider the three more important :—

(1) Insularity. The superhet is essentially a long-distance receiver, and the bulk of the listening public in England takes not the slightest interest in events outside her shores.

(2) The mistaken idea, chiefly prevalent in England, that the superhet is incapable of high-quality reproduction.

(3) The absence on the British market of efficient valves of low price and low upkeep cost.

With regard to (2), the superhet is peculiar in that there is no other circuit capable of giving more appalling reproduction if badly designed. If due precautions be taken, however, it would be difficult to equal, let alone surpass, the good quality this circuit is capable of. With regard to (3), British valves are from 30 to 50 per cent. dearer than corresponding Continental types. Moreover, the latter are considerably more economical in both filament and anode consumption (wattage). No one in his senses on the Continent would consider a H.F. valve with a filament consumption of more than 0.06 rating (at 4 volts), whereas in England this type (at 6 volts) is the exception.

Nice, France. I. F. A.

Sir,—Your correspondent "Super Het" in your issue of December 4th writes a short letter on a stupendous subject.

One reason why the superheterodyne is not in use here is because the wireless Press have not devoted time or space to its development.

They despise the super and condemn it as being obsolete, instead of adapting its use to the new order of things, *i.e.*, S.S. valves, pentodes, etc. A combination rightly adjusted would produce the ultimate in receivers.

Another reason is the difficulty of getting really good transformers. The only ones that can be called "good" are the American.

A third reason is that of cost. Factory-made receivers are good, bad and indifferent, and their price prohibitive to the average man—£60, £80 and £100 being the list price of several "obsolete" British makes.

Lastly, upkeep costs are supposed, quite wrongly, to be terrific for eight or nine valves, regardless of the fact that modern valves consume but 0.1 of an amp.

I have many more reasons and plenty more to say, but time and space are valuable. FRAME AERIAL SUPER 8.

FOREIGN WIRELESS GOODS.

Sir,—For some days I have been trying to purchase various wireless components which are in general demand, and it has been brought home to me very forcibly how the conservatism of British manufacturers is losing for our country the considerable trade in wireless goods.

It is a source of amazement to me how they can sit back and allow foreign articles to oust their own from the market. One finds, on asking for British makes, that the shops are invariably out of stock, and can offer no reassurance as to when delivery of the British article can be expected.

I was recently offered a German equivalent of a certain component, and one certainly cannot in most cases follow the maxim "Buy British Goods" in the wireless trade, as the Germans particularly are alive to the possibilities of the British market and appear to be flooding us with their goods to the great detriment of the wireless trade throughout this country, to say nothing of various other trades.

Can nothing be done to remedy this sad state of affairs?

Herts. F. NICHOLS.

PICTURE TRANSMISSIONS.

Sir,—The discontinuance of these transmissions by the B.B.C. must have come as a disappointment to many like myself who had purchased or constructed the necessary apparatus.

The B.B.C. may retort that there are still the Continental transmissions to be received. This is true, and I myself have received some excellent pictures from Vienna in the evenings from Königswusterhausen, but atmospherics and other disturbances are always apt to spoil the picture.

On the other hand, I should imagine that the majority of people constructed their apparatus on the strength of the B.B.C. transmissions, and were hardly influenced at all by the thought that Continental stations would also transmit on the same system.

If the B.B.C. are going to treat television enthusiasts in the same way the average man will not bother his head about it, and true television will be further off than ever.

Cheadle, Cheshire. WALTER ADDEY.

TRACKING H.F. RESISTANCE.

Sir,—In studying the subject of H.F. resistance in some of your back numbers recently, I was much impressed by the articles by A. L. M. Sowerby, M.Sc., in *The Wireless World* for December 19th and 26th, 1928.

In these definite measurements were given for commercial apparatus, and comparisons made between different models of the same class of article.

The results are so remarkable that I consider it worth while to see if an improvement could be effected in my "Empire Broadcast Receiver" (*Wireless World*, June 29th, 1927).

The detector valve holder appeared to correspond with the description of valve holder "A" in the article referred to.

The valve sockets were cut out of the bakelite moulded centre-piece, there being still sufficient length to make them serviceable. The H.F. end of the grid-leak was disconnected from its clip and left free.

The improvement in strength and quality was marked, and in consequence it was decided to go a step further and remove the valve cap. After this had been removed there was a still greater improvement in performance, but an unlooked for trouble cropped up—that of extreme microphonic resonance, which was bad enough on the telephone, but impossible with the moving coil loud speaker.

In all, three attempts were made to overcome this trouble, as the results achieved justified the expenditure of a little research to see if it were possible to overcome this defect.

In the third attempt the valve connections were sheathed in rubber sleeving (bicycle valve tubing) and the pinch tube packed tightly with cotton wool. The glass was mounted in a light brass cage, for the purpose of holding it, by means of Sorbo sponge pads. The valve and holder were then placed in a cardboard tube with a lid, and packed as tightly as it was possible to do so without damage to the glass, with cotton wool.

All attempts failed to cure the trouble, and whether the aluminium container was open or shut loud speaker reception was practically impossible and telephones little better.

On recapping the valve, a DEL610, its behaviour was normal.

So far as this particular sample was concerned, it would appear that the "inferior quality" cap was essential to its success, and that microphonic effects come from other avenues than the glass envelope of the valve, as every precaution was taken to damp this out, and certainly the glass itself could not possibly have been a contributory cause.

Any suggestions from readers will be welcome.

WILFRED H. MILES.

Zaria Province, Northern Nigeria.

TELEVISION.

Sir,—Mr. H. Graham Mallett, your correspondent, whose letter appeared in your issue of November 27th, overlooks the fact that Dr. Lee De Forest has not, evidently, seen the state of television in England. His remarks, presumably, are based upon the American results. The shadowgraphs of Jenkins bear no resemblance to true television such as is now being demonstrated in London. The images in this country are now so extremely clear that it is possible, as mentioned in a recent editorial of *The Wireless World*, to read the time on a watch.

Sir Ambrose Fleming, the inventor of the valve, bears views entirely contradictory to those of Dr. Lee De Forest, and Sir Ambrose Fleming has had the opportunity of thoroughly inspecting British television, and can, therefore, speak with authority.

Without in any way detracting from the pioneer work of Dr. Lee De Forest, surely it is better to take the facts as they stand in this country. Television by the Baird process is being broadcast by the B.B.C. for 5½ hours each week, and the results have been so satisfactory that this time is now to be increased by a further 2½-hour period per week.

Added to this, comes the *authentic* news that a minimum of a thousand Baird "Televisor" receivers are now in course of manufacture, and will be available very early in the New Year. Many more can then judge this science for themselves instead of coming to conclusions as a result of hearsay.

As one who has been privileged to witness many demonstrations of television, both by wire and wireless in this country and abroad, and can pay tribute to the wonderful progress that has been made in the Baird system, I should like to add my humble meed of praise to that of Sir Ambrose Fleming.

Mill Hill, London, N.W.7.

H. J. BARTON CHAPPLE.

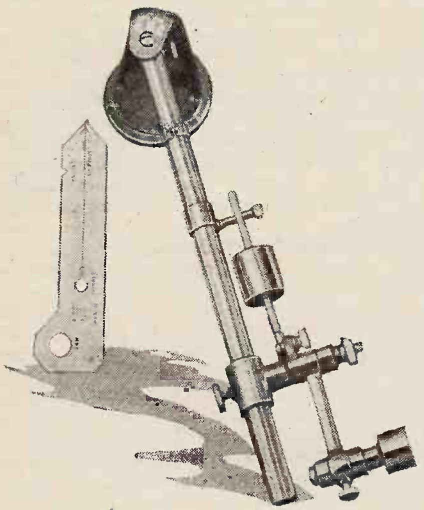
LABORATORY TESTS.

A Review of Manufacturers' Recent Products.

COUNTERBALANCED PICK-UP ARM.

A gramophone pick-up arm designed to take most of the well-known makes of electric pick-ups has been placed on the market recently by the E.M.G. Hand-Made Gramophones, 11, Grape Street, New Oxford Street, London, W.C.2. Its principal features lie in the number of adjustments that can be made: the length of the arm is variable, the pick-up carrier can be changed to suit the particular model favoured, and the pressure of the needle on the record can be varied by means of an adjustable counterweight.

Having provided all these adjustments, it is a pity that the designers have not added one more which would permit the pick-up to be set at an angle to the carrier arm, thereby affording an adjustment for track alignment.



The E.M.G. pick-up arm with a multiplicity of adjustments.

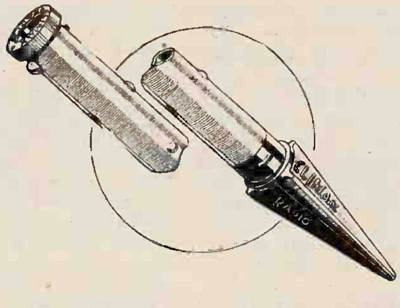
The E.M.G. pick-up arm is handsomely finished, the pivot support being oxidised, and all other parts heavily nickel-plated. It is marketed at 45s. The makers recommend for use with this arm the Phonovox E.M.G. pick-up, which has been especially designed for fibre needles and is priced at 40s.

oooo

"CLIMAX" EARTH TUBE.

The importance of a good earth connection cannot be overstressed, as, in addition to improving reception, it affords a greater factor of safety when the aerial is "earthed" during electrical storms. A direct connection is preferable to a water-pipe earth, but achieving this ideal is less arduous than may at first be thought.

The "Climax" earth tube offers a ready solution, and it costs 5s. only. It is made of hard drawn copper tube, reinforced to prevent buckling, and provided with an iron-shod tip to facilitate driving into hard soil. Holes are drilled at intervals along its length, and during dry spells water can be poured down the



"Climax" earth tube with iron-shod tip and reinforced stem.

hollow centre. Percolation into the surrounding soil takes place and thus a good earth is maintained.

The makers are the Climax Radio Electric Co., Haverstock Works, Parkhill Road, Hampstead, London, N.W.3.

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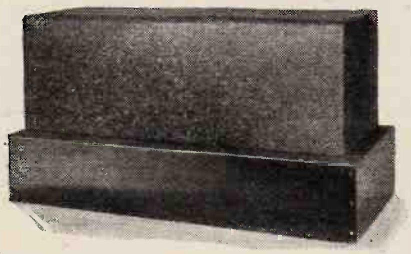
EATON SCREENING CABINETS.

Metal cabinets of standard dimensions, in which the functions of screen and container are combined, are now being produced by Messrs. Samuel Eaton and Sons, 66-72, Barr Street, Birmingham. These are fitted with a wooden base, and are made in conformity with suggestions put forward in the pages of this journal.

Two distinct types are produced: one is a double-compartment container intended primarily for "*The Wireless World* Kit Set," while the other has four compartments, and its dimensions are suitable for housing the "Kilo-Mag Four," "1930 Everyman Four," or "Record III." These are priced, respectively, at 38s. 6d. and 46s. 6d.



Eaton metal cabinet, with two screened compartments.

Metal channels are fitted round the outer edges of the removable cover, and also to the edges of the crosswise partitions, and as one of the lips of each of these channels is sprung inwards contact is made between the cover and the corresponding edges of the base projections at a number of points. Electrical "sealing" will be adequate for average requirements, but where complete isolation is necessary rolled strips of metal gauze or similar material can be readily inserted in the channels.

External metal-work is finished in crystalline enamel, several colours being available. To compensate for the fact that the plywood sub-base is sunk into the base compartment, the depth of the plinth is somewhat greater than usual; this is all to the good, as the extra space afforded will often be useful, but this must be borne in mind when determining the positions of condenser control dials.

oooo

I.D.S. REJECTOR.

Those unfavourably situated with respect to a Regional Station need not despair, as a rejector should help to overcome any difficulty they may have in receiving alternative transmissions. In fact, the I.D.S. "Regional Station Eliminator" has been introduced to cope with such cases. It consists of two coils, wound concentrically on a former;

For unselective sets—the I.D.S. Rejector.

one coil is connected in series with the aerial lead to the set and the other is tuned by a variable condenser. The tuned circuit forms an absorption type rejector.

A practical test was made on a rather unselective receiver, on which 2LO could not be tuned out at any part of the 250-600 metre waveband. With the rejector in use the interference was restricted to a small band of wavelengths between 344 metres and 367 metres only; transmissions above and below these limits being received free from interference from the Regional Station.

The rejector is built into a moulded case 3in. in diameter and 4½in. high, with two terminals on the side for attachment of aerial lead and connection to set respectively. The rejector tuning control is mounted on the top.

The price of this useful accessory is 10s. 6d., and the makers are The I.D.S., Ltd., 4, Golden Square, Piccadilly Circus, London, W.1.

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.

Increasing Selectivity and Range.

With regard to the addition of a tuned aerial circuit to the New Kilo-Mag Four, will you please say if this would have any noticeable effect in increasing range? B. W. R.

Although the conversion in question is primarily intended to increase selectivity, as compared with that of the original "aperiodic" arrangement, it is a fact that, under average working conditions, the use of a two-circuit aerial tuner adds very considerably to the effective range of the set. This is partly because it is generally necessary, in the interests of selectivity, to reduce the coupling of the "untuned" aerial to a value well below that giving maximum signal strength.

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Improving the Hartley Circuit.

(*Referring to previous correspondence*) *. . . Many thanks for your reply to my last letter; the tendency towards instability on the long waves of my "Hartley" det.-L.F. set has been completely cured by connecting a 0.0001 mfd. fixed condenser directly between anode and negative filament terminals of the detector valve, as recommended by you. There has been also a general improvement in sensitivity, as you suggested would be probable, but your fears that reaction feed-back might be insufficient over the whole medium waveband prove to be justified; it is impossible to provoke self-oscillation over about one-third of this tuning range unless the extra condenser is removed or disconnected.*

Can you suggest a method whereby reaction control may be improved over both wavebands, bearing in mind that, as the set is shortly to be "scrapped" in favour of a more ambitious receiver, I do not wish to spend much time or money on the alterations. B. C. O.

It is suggested that you should replace the fixed anode by-pass capacity by an inexpensive semi-variable condenser, perhaps of the compression type, with a maximum capacity of 0.0003 mfd. This component should be mounted in a reasonably accessible position, and your aim should be to find a setting for it that is suitable for each waveband. Critical reaction adjustment will be effected by the normal control condenser R.C. (see Fig. 1).

It will be realised that C. and R.C. are interdependent: as the value of the latter is increased, a greater proportion of the total oscillatory energy in the detector anode circuit is by-passed to earth, and, for a given setting of R.C., reaction effects are decreased. It is quite easy to find the best setting of C. by trial and error. Properly adjusted, this arrangement is distinctly more sensitive than the conventional "Hartley" detector circuit.

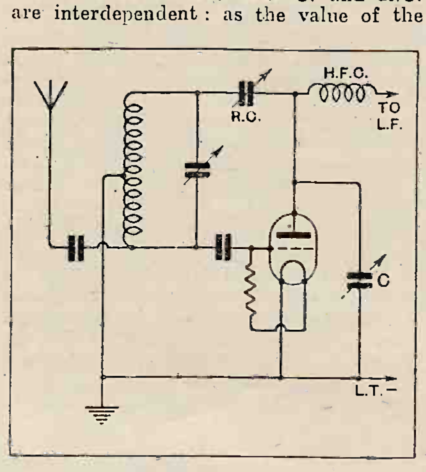

Fig. 1.—Detection efficiency—and sometimes reaction control—may generally be improved by adding an anode by-pass condenser to a "Hartley" circuit.

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.

○○○○

House-Lighting Systems.

I was interested in your recent reply to "V. W. P." on the subject of using a house-lighting plant for charging an L.T. accumulator, as I myself have been thinking of using the end regulating cells of my own installation for this purpose.

Actually, there are four extra cells that are not normally used, and it is assumed that their voltage would be sufficiently in excess of that of my 6-volt wireless battery for satisfactory charging. What value of resistance should be inserted to reduce current to 3 amps? G. A.

A 6-volt battery can certainly be charged quite satisfactorily from four of the comparatively large cells used for house lighting, and, as regulating cells are often overcharged through lack of use, it is all to the good that they should be worked.

A series resistance of approximately 0.7 ohms will be needed.

○○○○

A Neutralised "Kit Set."

Will you please tell me how the H.F. stage of "The Wireless World" Kit Set (which I am about to build) may be neutralised in order to increase magnification? I presume that a very considerable gain should be possible by making this addition to the published design. W. B. P.

We should strongly dissuade you from attempting this alteration, as the design does not readily lend itself to modification in this way. In order to make neutralisation worth while, sweeping changes would be necessary; indeed, an adequate discussion of the matter would be rather beyond the scope of the Information Department.

If you must have a "balanced" set, we think you would be well advised to adopt the main features of the "Record III," but we would assure you that the very considerable H.F. amplification of the Kit Set, plus reaction, provides as much sensitivity as is necessary under average conditions.

Back to the Neutralised Triode?

Although the screen-grid valve has obvious advantages in a set with a single highly efficient stage of H.F. amplification and in the matter of ease of waveband switching, a careful consideration of recent articles and receiver designs published in your journal has led me to form the opinion that in a "2 H.F." set for the broadcast waveband only neutralised triodes would provide all the amplification necessary (with a good aerial) and would be less costly than the expensive S.G. valves.

Thanks to modern developments such as decoupling and to a fuller use of screening than in the days when neutralised intervalve couplings were popular, it should now be an easy matter to attain nearly the full possible theoretical magnification from each stage, using valves costing less than half the price of those customarily used nowadays.

If you agree that a neutralised triode set is still worth while, will you please give me a circuit diagram of a two-stage amplifier with two-circuit aerial tuner, H.F. transformers, and decoupling devices where necessary. If you recommend it, I will screen the valves from the coils and condensers. T. H. W.

There is a good deal of truth in what you say in favour of the neutralised triode, but we think you tend to exaggerate the increased cost of the S.G. valve amplifier, which normally does not require neutralising condensers or the comparatively expensive coil necessary for constructing a superlatively good H.F. amplifier for three-electrode valves.

It is correct enough to assume that two of these valves, used to best advantage, can provide a theoretical amplification quite as great as that of the average set with the same number of screened valves, and that modern stabilising devices make it much easier to attain something approaching the maximum possible gain from each stage.

The circuit diagram given in Fig. 2 should meet your needs; positions of screening partitions and decoupling devices are indicated. With regard to isolating the valves from the apparatus associated with the H.F. circuits, this procedure cannot do any harm, if carefully carried out, but it is hardly likely to confer any very noticeable benefit; it must be remembered that in a neutralised set (as opposed to an S.G. valve amplifier) any stray capacitative couplings can be balanced out.

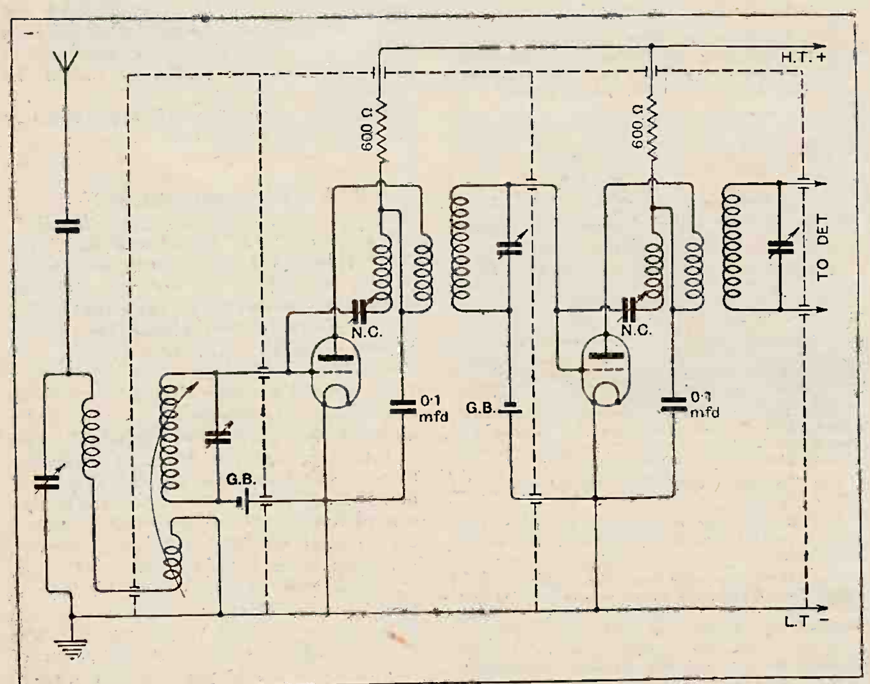

Fig. 2.—An amplification of more than 1,000 times can be attained with two neutralised H.F. stages and three-electrode valves.

H.T. Feed.

I have an eliminator with three positive supply terminals, one marked "power," another "120 v," and a third "0-100 v." The output from the "power" terminal is stated to be 160 volts at 30 mA., while the voltage of the third supply is varied by an external control knob. Will you please tell me how this should be connected to the "Record III"? S. St. G. C.

This set is arranged for a single input H.T. voltage, and it will be quite in order to ignore the 120-volt and 0-100-volt terminals of your eliminator. You should join the high-tension leads from the set to the negative and "power" terminals of the eliminator.

We have assumed that the receiver is constructed exactly as described, with a potentiometer for regulating screening grid voltage; it may be pointed out that if this controlling device is included in your eliminator the set itself may be simplified in an obvious manner by taking this supply direct from the "0-100" terminal of the eliminator. If this modification is introduced, a decoupling resistance must be inserted in the screening grid circuit, in place of the fixed element of the existing potentiometer.

The Southern Railway Again.

On several occasions I have tried my "Everyman Portable" receiver in a train, but have found that reception is generally marred by cracklings and other noises. Does this suggest that the set is at fault, or, if the effect is normal, can it be overcome? H. D.

This form of interference is well known, and is due to the electric lighting installations of the train. It is particularly likely to be troublesome with a receiver having a regenerative detector without H.F. amplification, and we fear that there is no simple cure. You must try to choose a train with gas lighting!

FOREIGN BROADCAST GUIDE.

WARSAW
(Poland).

Geographical position: 52° 14′ N. 21° 7′ E.
Approximate air line from London: 900 miles.

Wavelength: 1,411 m. Kilocycles: 212.5. Power: 8 kW.

Time: Central European (one hour in advance of G.M.T.)

Standard Daily Transmissions.

09.15 Sundays Sacred Service from Posen Cathedral; 10.58 Fanfare from Cracow; 18.58 daily Time signal (q.v.); 18.20 Tuesdays relay of performance from Kattowitz or Posen Opera Houses; 19.15 main evening programme; 22.00 Fridays relays of foreign stations; dance music Sundays, Mondays, Wednesdays and Saturdays.

Man and Woman announcers. Call (phonetic): *Hallo! Hallo! Polskie Raadjo Varschava.*

Announcements are made in the Polish language, but when International concerts are broadcast, also in English, French and German.

Interval signal: the letter W in morse (. − −).

Time signal: At 6.58 p.m. G.M.T. one long hoot, seven dashes, followed by: − . − . . − . . . − . . . . − . . . . . − . . . . . . the last dot indicating the full hour 7 p.m. G.M.T.

Frequently closes down with the Polish National Anthem (Dombrovski Mazurka).


RADIOGRAND
12'6
ACE
8'6
TELSEN
L.F. TRANSFORMERS
Radio's Choice
MADE BY TELSEN ELECTRIC Co. LTD BIRMINGHAM
FOLLOW THE LEAD OF THE SET MANUFACTURER
TELSEN
TRANSFORMERS
The Telsen Radiogrand Transformer illustrated herewith is the outcome of an endeavour to place upon the market a transformer at a strictly competitive price, yet possessing equal qualities to the most expensive instrument.
General efficiency is unvarying with high or low input valves; special care has been exercised regarding the windings both primary and secondary, the capacity losses being comparatively negligible. Your set will work better with a Telsen Transformer.—Fit one now.
TELSEN ELECTRIC Co. Ltd., MILLER STREET, BIRMINGHAM.
London Distributors : The Sel-Ezi Wireless Supply Co., Greek St., Soho, W.1

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Edited by F. J. MORTIMER, F.R.P.S.
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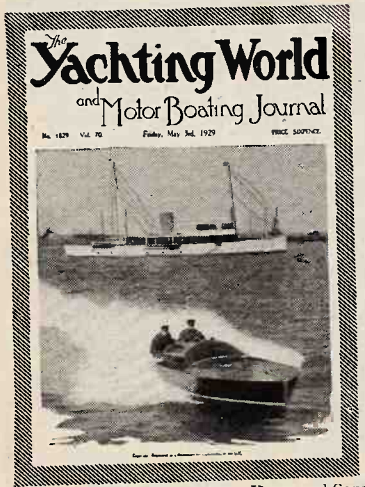

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SCOTT SESSIONS and Co., Great Britain's Radio Doctors.—Read advertisement under Miscellaneous. [0264

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MARCONIPHONE Type 35 Screened Grid 3-valve Sets, brand new; £9, with valves; hire purchase arranged; only a few at this price.—Hall, 91, Fore St., Edmonton. [7722

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McMICHAEL Suit Case, cost £31, just overhauled, new valves; accept 10 guineas; perfect.—Gardener, 53, Alexandra Rd., Wimbledon. [7731

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

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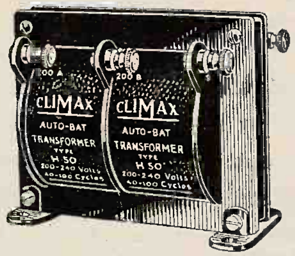

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Coils, Transformers, Etc.—Contd.

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6-VOLT ½-amp. M.C Speaker; list £6, new this year; 29/6; 7 days approval against cash.—Brew, Pytchley, Kettering. [7708

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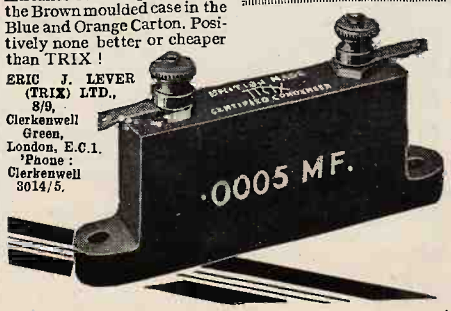

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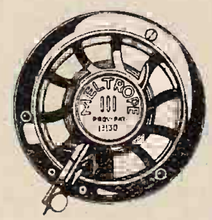

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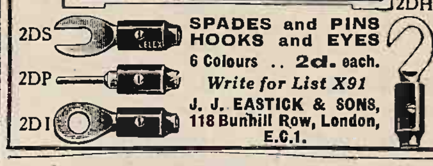

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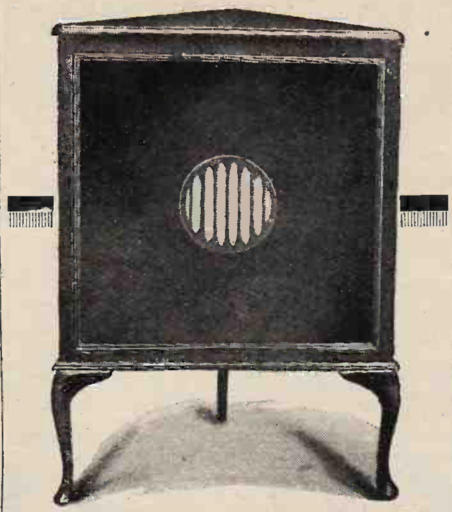

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FREE: Inventor's Guide on Patents.—T. A. A., 253 (W), Gray's Inn Rd., London, W.C.1. [6373

ACCUMULATOR Charging, Maintenance and Repair. By W. S. Ibbetson. A handy guide to the charging and upkeep of accumulator for wireless work or motor cars: 3/6 net.—Of booksellers or Pitman's, Parker St., Kingsway, London, W.C.2. [7068

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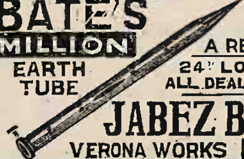

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W.W.73

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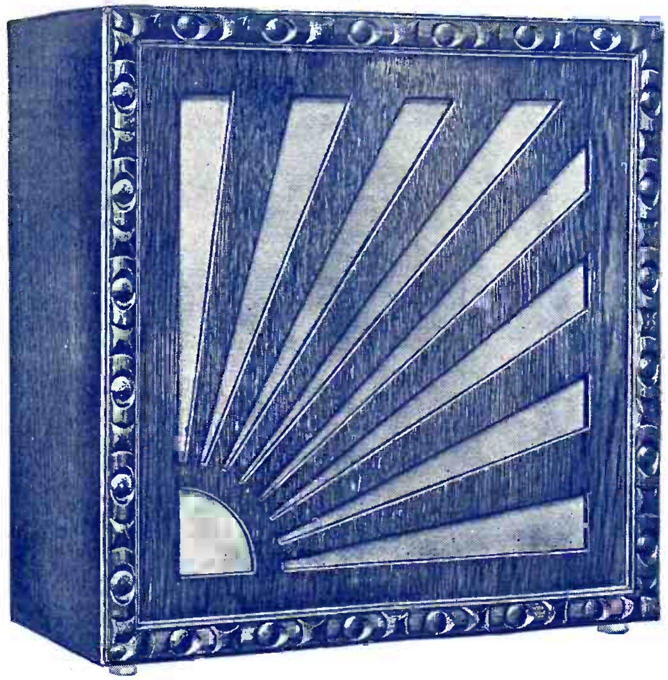
LOUD SPEAKER



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UNITED STATES—The International News Co., 131, Varick Street, New York. FRANCE—W. H. Smith & Son, 248, Rue Rivoli, Paris; Hachette et Cie, Rue Réaumur. Paris. BELGIUM—W. H. Smith & Son, 78, Marche aux Herbes, Brussels. INDIA—A. H. Wheeler & Co., Bombay, Allahabad and Calcutta. SOUTH AFRICA—Central News Agency, Ltd. AUSTRALIA—Gordon & Gotch, Ltd., Melbourne (Victoria), Sydney (N.S.W.), Brisbane (Queensland), Adelaide (S.A.), Perth (W.A.), and Launceston (Tasmania). CANADA—The American News Co., Ltd., Toronto, Winnipeg, Vancouver, Montreal, Ottawa, St. John, Halifax, Hamilton; Gordon & Gotch, Ltd., Toronto; Imperial News Co. Toronto, Montreal, Winnipeg, Vancouver, Victoria. NEW ZEALAND—Gordon & Gotch, Ltd., Wellington, Auckland, Christchurch and Dunedin.

The last image is a repeat of the inside front cover, as I first scanned it upside down.

Sorry.

Dave.