The Wireless World
AND RADIO REVIEW

VOLUME XVIII

JANUARY 6th—JUNE 30th, 1926

Published from the Offices of "THE WIRELESS WORLD"
ILIFFE & SONS LTD., DORSET HOUSE, TUDOR ST., LONDON, E.C.4

INDEX—VOLUME XVIII

JANUARY 6th to JUNE 30th, 1926

ILLUSTRATIONS

AUTHORS

BOOK REVIEWS

Printed in Great Britain by The Cornwall Press Ltd., Paris Garden, London, S.E.1.

The Wireless World AND RADIO REVIEW

(13th Year of Publication)

No. 334. WEDNESDAY, JANUARY 6TH, 1926. VOL. XVIII. No. 1.

Assistant Editor: F. H. HAYNES. | Editor: HUGH S. POCOCK. | Assistant Editor: W. JAMES.

Editorial Offices: 139-40, FLEET STREET, LONDON, E.C.4 - Telephone: City 4011 (3 lines).

Advertising and Publishing Offices: DORSET HOUSE, TUDOR STREET, LONDON, E.C.4. - Telephone: City 2847 (13 lines).

Telegrams: "Ethaworld, Fleet, London."

COVENTRY: Hertford Street. Telegrams: "Cyclist Coventry." Telephone: 10 Coventry.

BIRMINGHAM: Guildhall Buildings, Navigation Street. Telegrams: "Autopress, Birmingham." Telephone: 2970 and 2971 Midland.

MANCHESTER: 199, Deansgate. Telegrams: "Iliffe, Manchester." Telephone: 8970 and 8971 City.

Subscription Rates: Home, £1 1s. 8d.; Canada, £1 1s. 8d.; other countries abroad, £1 3s. 10d. per annum.

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.

THE NEW VOLUME.

THE present issue of *The Wireless World* introduces to our readers Volume XVIII. and brings us towards the close of our thirteenth year of publication. To many readers whose association with wireless dates only from the introduction of broadcasting, it must come as a surprise to know that there was any justification for the existence of a wireless paper before broadcasting was started, but although in the early days the number of readers was insignificant as compared with the total to-day, yet the interest in wireless amongst the few was certainly no less than it is to-day amongst the many. It must be remembered, too, that *The Wireless World* dates from before the valve came into use, when the crystal detector or the obsolete coherer and magnetic detector were the only devices known for detecting signals, and neither the possibilities nor even the principle of wireless telephony had yet been heard of.

The changes which have taken place since then, and the advances made in the useful applications of wireless are now so well known and recognised that it is not necessary to make reference to them. Just as in the past, *The Wireless World* has kept pace with the times and has endeavoured to educate in theory as well as to satisfy the interest of the reader in practical directions, so on these lines it will be our policy to conduct the volume upon which we are now entering. We welcome most cordially suggestions from our readers as to articles or features which they would like to see incorporated, and we invite every reader to make full use of our Information Department, through which it is our endeavour to solve the little problems and difficulties which the reader encounters in the course of his work and experiments.

CONTENTS.

oooo

OUR SISTER JOURNAL.

COINCIDING with the commencement of the new volume of *The Wireless World*, a new volume starts also with the appearance of the January issue of our sister journal *Experimental Wireless and The Wireless Engineer*. In addition to the commencement of a new volume, *Experimental Wireless* also undergoes a change in the editorial management. The journal has already achieved a reputation as the premier and, in fact, the only technical wireless publication in this country which caters for the requirements of the wireless engineer. This reputation already achieved will be enhanced by the appointment which we are pleased to announce of Prof. G. W. O. Howe, D.Sc., M.I.E.E., to be Technical Editor, whilst the Editorship passes to Mr. H. S. Pocock, who has, for many years, been associated with *The Wireless World* in a similar capacity. The appointments also as Assistant Editors of Mr. W. James and Mr. F. H. Haynes will facilitate close co-operation between the two journals on lines which we believe will be much to the advantage of the readers of both.

With the appointment of Prof. Howe an old association is renewed, for he acted as Editor of the *Radio Review* from its first publication until its amalgamation with *The Wireless World*.

Prof. Howe, who was for many years Assistant Professor of Electrical Engineering at South Kensington and later Head of the Department of Electrical Measurements, including Radio Telegraphy, at the National Physical Laboratory, is now Professor of Electrical Engineering at Glasgow University. He was Chairman of the Wireless Section of the Institution of Electrical Engineers from 1921 to 1923. He has been a Vice-President of the Radio Society of Great Britain from its inception, and is a member of the Radio Research Board of the Department of Scientific and Industrial Research.

oooo

AN OFFICIAL INDISCRETION.

IT is unfortunate that all too frequently persons in official positions seem to make it their business to rush into print on controversial matters which are altogether outside their proper sphere of activity. Capt. Eckersley, the Assistant Controller and Chief Engineer of the B.B.C., is an extremely popular personality, but from time to time he throws discretion to the winds and records his innermost thoughts in print so openly that one suspects that the impulse of the moment is responsible and not the mature consideration of the Chief Engineer himself.

In a recent issue of the *Radio Times*, under the title, "A Talk to Home-Makers," Capt. Eckersley discusses the wireless industry and the home-constructor in terms which are calculated to astonish even those who for some time past may have suspected his lack of sympathy with those who make their own sets. If the policy which he advocates were enforced, we foresee that there would be considerably more "home-wrecking" than "home-making." He states that the home-construction of sets hampers the wireless industry, and that the publication of instructions on how to build a particular set is unfair to those whose livelihood it is to sell sets at a legitimate profit to the public, and he proceeds to blame the amateur constructor without qualification for all the oscillation ether interference.

Capt. Eckersley seems to have totally overlooked how much the industry owes to the popularising of wireless, which, unquestionably, has been brought about, to a very large extent, by encouragement and the offer of facilities to the public to build their own sets by way of a hobby. There was a time, in the early days of broadcasting, when sets produced by the manufacturer, including even the simplest of crystal sets, were only available at exorbitant prices, and had it not been for the encouragement of home construction as a hobby, we think it is very doubtful whether the B.B.C. and the wireless industry as a whole would ever have arrived at its present state of development.

The Hobby of Constructing.

Undoubtedly, there is a very large proportion of the wireless public which derives far more entertainment from the construction of sets than from actual listening-in. To pursue Capt. Eckersley's policy would be to abolish not only wireless construction as a hobby, but a very large number of other hobbies; and it might be construed, if his argument is followed to its logical conclusion, that the amateur gardener is acting unfairly towards those who get their livelihood from looking after gardens, and certainly no one should drive his own car because that is a pleasure which should be reserved strictly for the professional chauffeur, who, because he is trained at his job, would, according to Capt. Eckersley, cause less trouble on the road than the amateur motorist who may be productive of more street accidents!

But, apart from all this, the remedy is in the hands of the manufacturer of wireless sets for whom Capt. Eckersley seems to be acting as spokesman. The time will shortly come when the sets available on the market will be so priced and of such a quality that to make a set for your own use will be a sheer waste of time, unless the making is a hobby. Admitted that a large proportion of the manufactured sets of to-day are superior to the *average* home-constructed set, there are still many exceptions, and the manufacturer can still be held responsible for at least a fair proportion of the oscillation trouble because of the type of set which he places on the market.

What does the Manufacturer Think?

Capt. Eckersley has, apparently, "briefed" himself to plead the cause of the manufacturer, but we doubt very much whether this action has been taken with the sympathy and approval of the manufacturer. We think that almost every class of wireless manufacturer recognises that he is indebted to the wireless journals for having stimulated an interest in the home construction of sets, resulting, as it has, in popularising wireless to an extent far beyond anything which could have been achieved if the use of any but manufactured sets had been made illegal.

We still wish to look upon Capt. Eckersley as a friend of the amateur, and we would like to see an acknowledgment by him that his article was written on the impulse of the moment, and does not represent his mature and considered judgment.

oooo

A PICTORIAL CIRCUIT SUPPLEMENT.

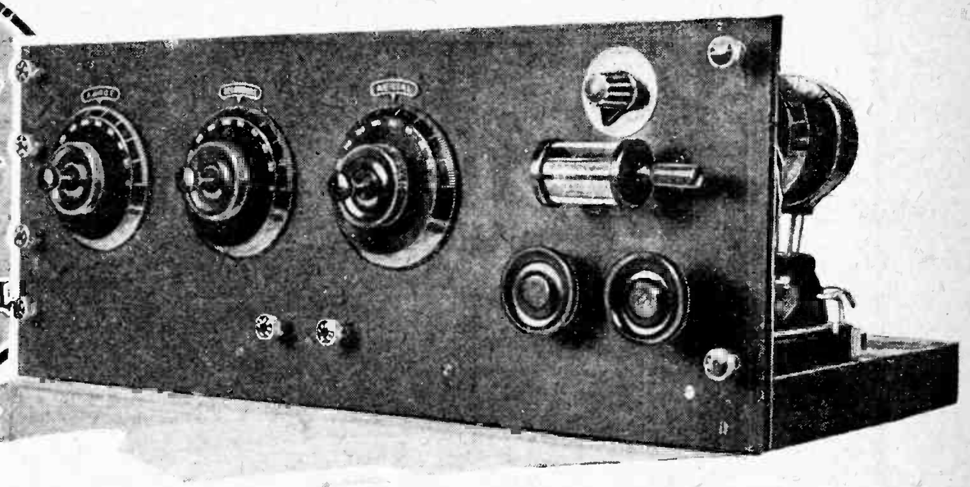
THE enquiries which we are constantly receiving from readers for pictorial reproductions of the theoretical circuit diagrams in *The Wireless World* have prompted us to include in the present issue a special Supplement giving a pictorial representation of one or two typical theoretical circuits, and we hope that a study of these examples will serve to assist all those readers who have had difficulty in the past in following out the usual circuit diagrams which we regularly include in the general pages of the journal.

We do not feel that we should be justified, even on questions of space alone, in including regularly pictorial circuits of this character, and we therefore hope that this supplement will be retained as a guide and used for reference whenever difficulty is encountered in the future by those who are not so familiar with theoretical circuits.

The circuits selected for pictorial representation show typical receiving sets which have become standard for broadcast reception. Readers skilled in constructional work can, therefore, take a circuit to meet their requirements, but deciding for themselves the actual lay-out.

RANGE with PURITY

H-F & CRYSTAL RECEIVER



By N. P. VINCER-MINTER.

THERE are a very large number of people to-day in the unfortunate and somewhat irritating position of residing just on the fringe of the useful crystal range of a broadcasting station, and a moment's thought will enable us to realise that, no matter how great the efforts of the broadcasting authorities in the matter of increasing the range of their existing stations or multiplying their number, this unfortunate class of people will, like the poor, be always with us, unless, indeed, the augmentations of power were carried to such an absurd limit that the existing commercial wireless services were literally drowned out in the pandemonium that would ensue. The writer defines the useful crystal range of a broadcasting station as the extreme range at which comfortable reception can be obtained on at least two or three pairs of headphones attached to a crystal receiver employed in conjunction with the normal aerial and earth system of low efficiency, habitually used, at any rate, by the town dweller.

Experience teaches that, in the case of a main station, this appears to be about fifteen miles, and seventy-five miles in the case of 5XX. The writer has, unfortunately, no experience of crystal reception from a relay station. In order to forestall an avalanche of letters from readers who habitually receive 2LO on six pairs of headphones at fifty miles, and Daventry anywhere when using their "'Louderphone' crystal set, price 7s. 6d., regenerative catwhisker 2s. 6d. extra," the writer would state that he also has obtained the ranges mentioned, using a considerably less sensitive receiver than the one mentioned, by substituting the ordinary "Hertzite" crystal by a piece of "Ananite," which is, fortunately, quite inexpensive and can be obtained from advertisers in various technical publications, the home-prepared variety being, however, equally effective. It is only fair to state, however, that in certain localities he has failed to obtain satisfactory results, even when using the useful commodity mentioned adjusted to its most sensitive state, the reason being that in certain localities near to a broadcasting station reception is notoriously bad, due, more often than not, to unavoidable screening of receiving aerials. In the country, on the other hand, where facilities exist for the erection of a lofty and unscreened aerial, astonishing ranges can sometimes be achieved. These exceptions, however, have no bearing on the average useful crystal range of a broadcasting station mentioned by the writer.

H.F. or L.F. Amplification?

To revert, however, to the unfortunate class of people whom, in our digression, we have left in an exasperated state, trying to listen attentively to the News Bulletin from 2LO twenty miles or more away, through the "mush" and local interference of the "noises off" produced in the same room by children, newspaper rustlers, and other provokers of evil thoughts, it may be said that in most cases they do one of two things, namely, they either invest in a single-valve amplifier, or a single-valve receiver with reaction and grid rectification. The single-valve low-frequency amplifier certainly increases the strength signals, but, unfortunately, it is usually far from satisfactory, since the amplifier increases not only the volume of signals, but also renders audible all those faint, subdued noises due to

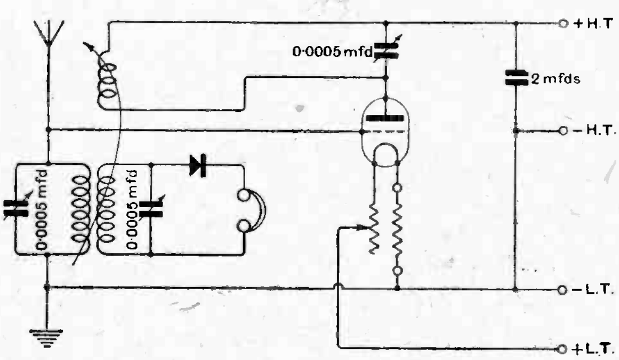


Fig. 1.—Circuit diagram. The three tuning coils are mutually coupled together in a three-coil holder.

Range with Purity.—

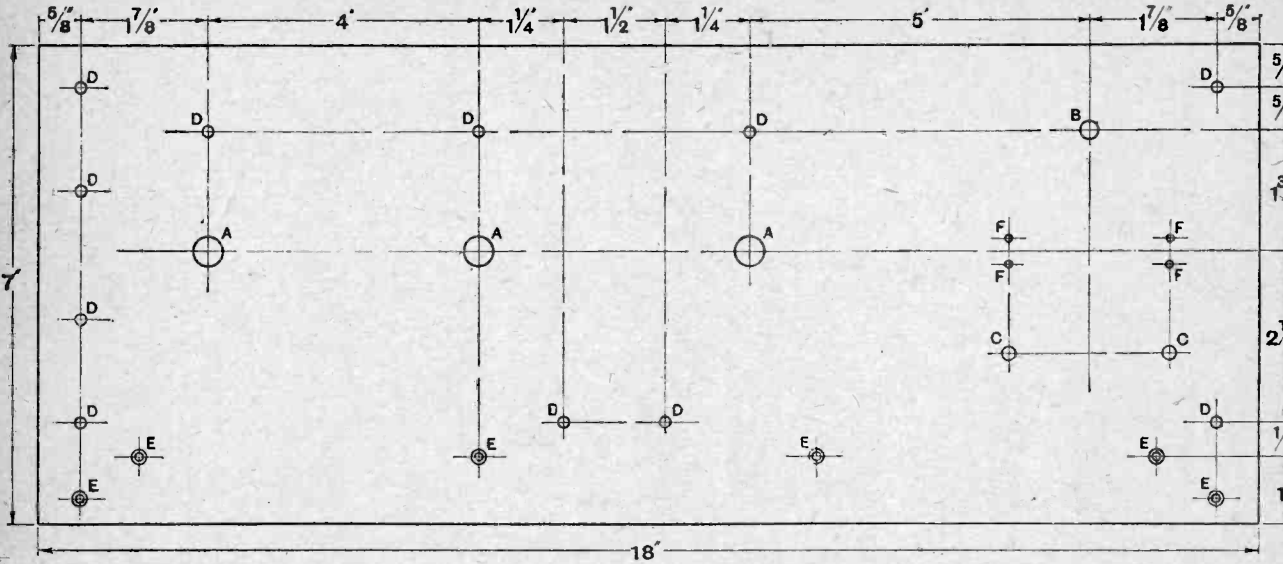


Fig. 2.—The front panel. Sizes of holes are as follow; A, 3/8in. dia.; B, 1/4in. dia.; C, 3/16in. dia.; D, 5/32in. dia.; E, 1/8in. dia. and countersunk for No. 4 wood screws; F, 1/8in. dia.

atmospherics, noises from electric light mains, and other obscure causes, which before were not sensibly audible on the crystal set alone. In addition, the L.F. transformer itself is apt to produce a certain amount of indefinable noise of its own, coupled with a certain amount of distortion. The low-frequency amplifier has the added disadvantage that it brings no alternative programmes into the home of the listener in return for all the trouble and expense of purchasing and maintaining its batteries. With regard to the conventional single-valve receiver, however, whilst it certainly gives the advantage of range, the quality obtained from it in the hands of the average person is apt to disappoint him if he has been accustomed to a crystal receiver, and to

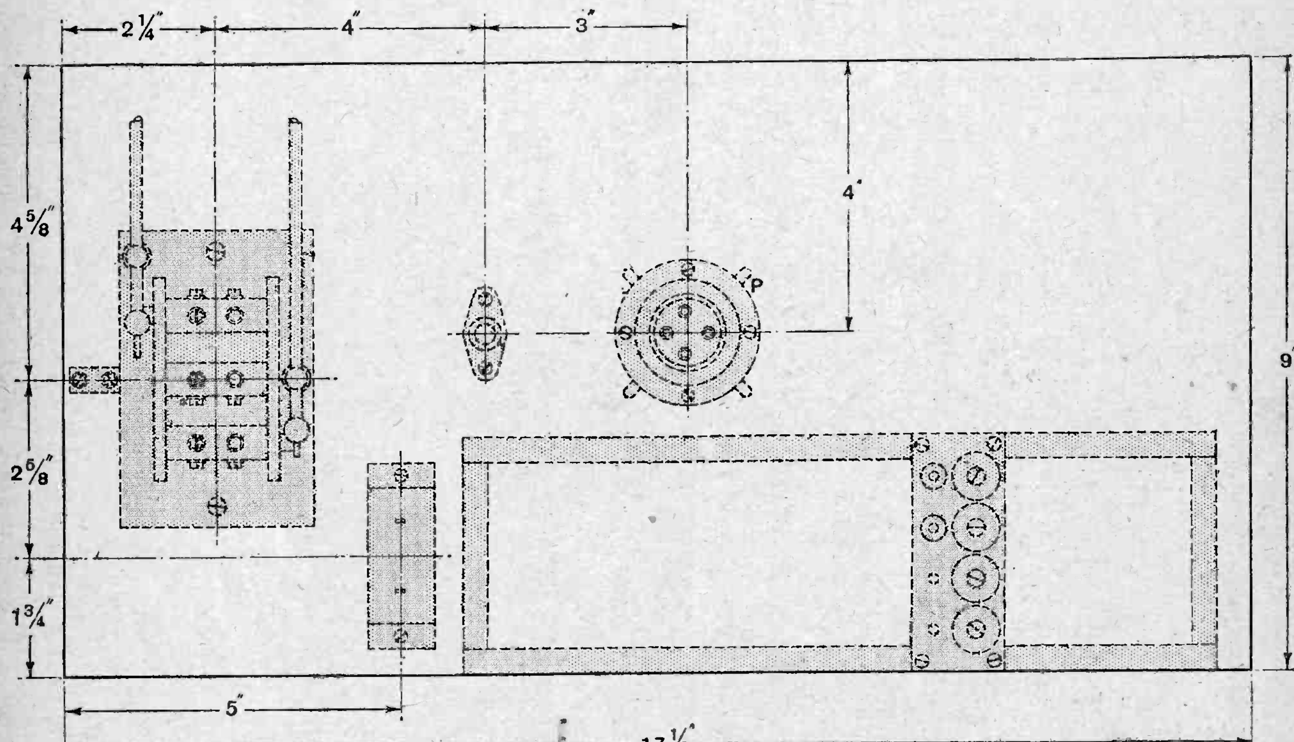
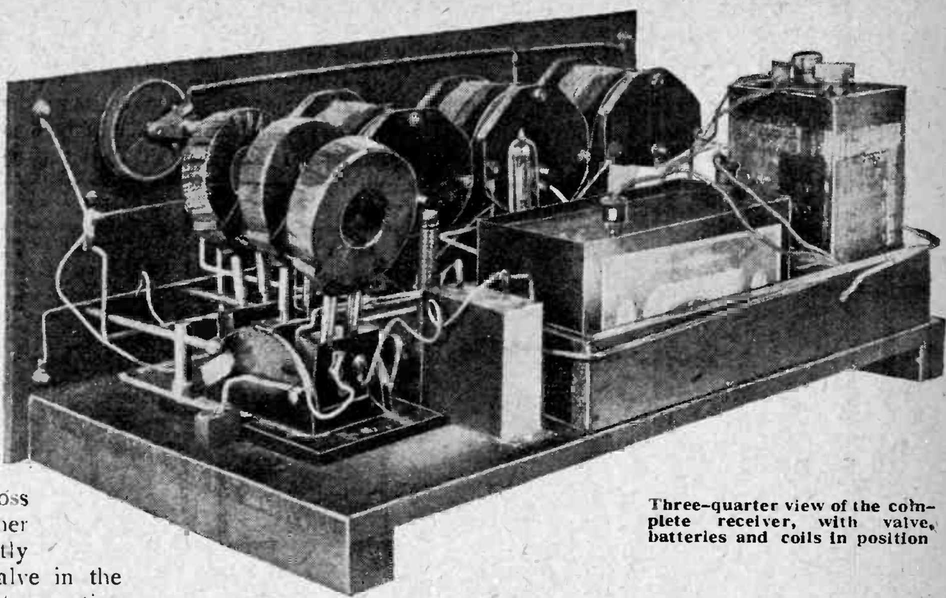


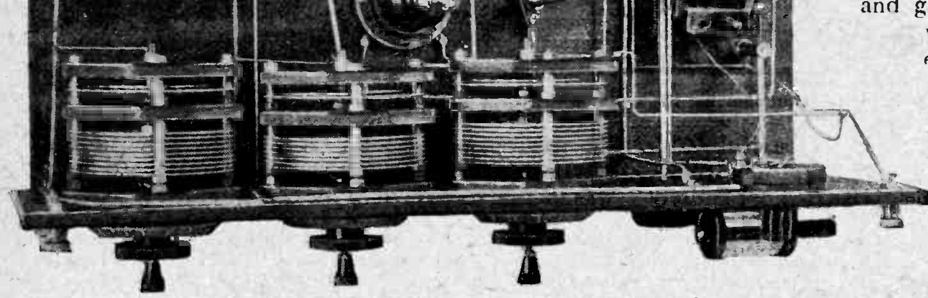
Fig. 3.—Layout of components on the baseboard. The dimensions of the battery compartment are made to fit the particular type of H.T. and L.T. batteries adopted.

Range with Purity.—
completely belie the title of this article. Unfortunately, it does not seem to be generally realised that all the advantages mentioned in connection with the two methods discussed, and none of their disadvantages, can be attained by using the valve in front of the crystal as an H.F. amplifier. By this method we have range (and quite a good range, too, if the receiver is carefully handled), and at the same time we get greatly increased signal strength from our local station without the slightest loss of purity. Selectivity is another useful property which is greatly enhanced by the use of the valve in the manner suggested. The next question which arose in the writer's mind was the most convenient method of using the valve as an H.F. amplifier, and it occurred to him that the connections could be so arranged that if, in the midst of the local or Daventry programme, the accumulator suddenly failed in its duty, reception would be carried on quite successfully *without the listener adjusting even one knob or switch*, no portion of the programme being lost. Naturally, of course, there will be a slump in volume immediately the valve ceases to function. The whole instrument, however, has no expensive components, and is simple to construct. Furthermore, should the user have the misfortune to burn out his valve at any time when financial considerations inhibit its immediate replacement, he still has in his possession a perfectly efficient crystal receiver. We can now proceed to constructional details.



Three-quarter view of the complete receiver, with valve, batteries and coils in position

Having obtained all components, necessary attention should first be turned to the baseboard. It is supported underneath by two rectangular pieces of wood, the length of which is equal to the breadth of the baseboard, the remaining dimensions being both $\frac{3}{4}$in. No wiring is, however, carried out under the baseboard, as it was thought that this presented too many difficulties to the average home constructor. The sides of the tray for containing the batteries should first be constructed. The height of the tray is $1\frac{1}{2}$in. The strips of wood forming the tray are merely glued to the baseboard. A word concerning the type of batteries to be used in the tray will not be amiss at this juncture. The writer decided that it would be well to include all batteries inside the set in order to make it as compact as possible; he therefore sought a valve which would operate on a minimum of H.T. He found that 30 volts H.T. was ample for the valve actually used (a Wecovalve) when employed for H.F. work, and, since the valve requires slightly less than one volt of L.T., a small 2-volt accumulator of well-known make costing 5s. was found suitable. The receiver can be used equally well with a D.E.R. or "Wuncell" valve without requiring any alteration. The writer did not forget, however, that readers might have other types of valves by them, which they desired to use, and, accordingly, external H.T. and L.T. terminals are provided, so that external batteries may be used with valves requiring other plate and grid voltages. The terminals and wander-plug holes on the small ebonite platform dividing the H.T. and L.T. batteries are "dummy," their purpose being to "anchor" down the flexible leads to the internal batteries when not in use, otherwise they might easily cause a short-circuit by accidentally coming into contact with other wiring in



Plan view with coils and L.T. battery removed.

Range with Purity.—

the set. The coil holder should be carefully chosen; many types of *three-way* coil holder do not permit of being used inside a receiver, since the general arrangement of the coils causes a large amount of room to be taken up. All components can be mounted on a base-

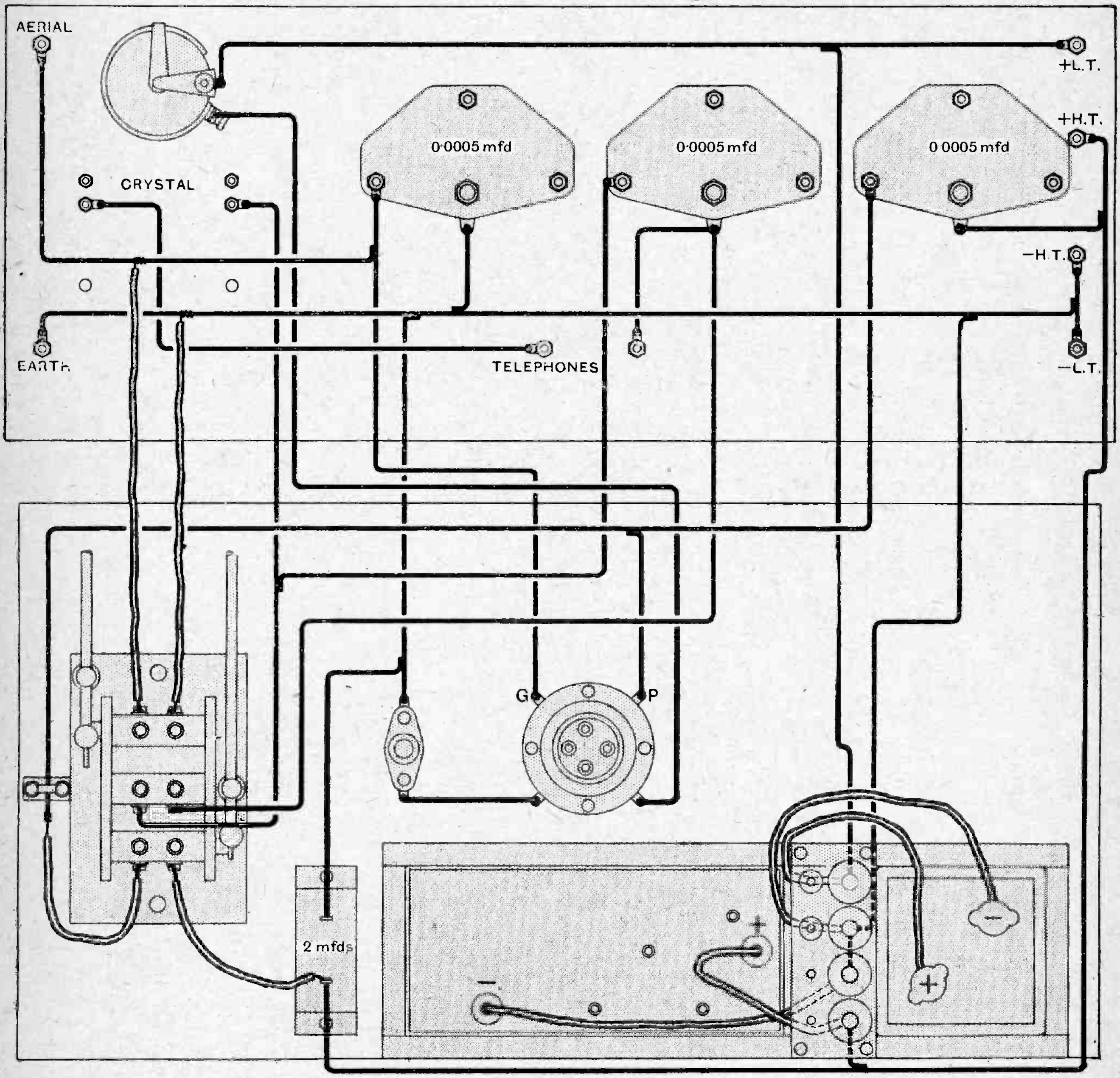


Fig. 4.—Diagram showing the method of wiring up the receiver.

board or panel in their correct positions by carefully following the details given in Figs. 2 and 3. The subsequent wiring of this receiver, which is carried out entirely by means of *stiff* rubber-covered cable, should present no difficulties whatever, there being absolutely no awkward corners in the receiver calling for delicate work with a fine-pointed soldering iron.

With regard to tests carried out with this receiver, it was first tried out a few miles distant from a main broadcasting station. When normally using an outdoor aerial and a conventional direct-coupled crystal set, the local station can still be heard even when a No. 150 plug-in coil is used and the receiver tuned to Daventry. Using the receiver as a crystal set only, no trace of the local station was heard when Daventry was tuned in. This was to be expected, since the crystal in use is loose coupled and entirely isolated from other circuits in the receiver. In this respect the writer would heartily commend loose coupling to crystal users unable to separate the local station and Daventry when using the usual direct-coupled

Range with Purity.—

LIST OF COMPONENTS.

1 Ebonite panel, 18in. × 7in. × ¼in.
1 Ebonite sub-panel, 3¾in. × 1¼in. × ¼in.
1 Baseboard, 17¾in. × 9in. × ⅜in.
1 Piece of white-wood, 14in. × 3in. × ¼in.
3 Variable condensers with vernier, 0·0005 mfd. (Peto-Scott).
1 Three-way vernier coil holder (Ward & Goldstone)
1 Valve holder (Sterling)
1 Rheostat, 30 ohm, (Lissen).
1 Fixed resistor, 5 ohm, and holder (Burndept).
1 Crystal detector (Burndept).
1 Fixed condenser, 2 mfd. (T.C.C.).
8 Indicating terminals Aerial, Earth, H.T.+, H.T.−, L.T.+, L.T.−, Phones +, Phones − (Belling Lee).
2 Small brass terminals with spades.
2 Wander plugs.
1 Wecovalve (Western Electric Co.).
1 D.T.G. Accumulator (Exide).
1 30-volt H.T. battery (M.A.L.)
Length of red and black flex.
Length of No. 18 rubber-covered cable (Ripault).

Approximate cost, including valves and batteries, £5.

set. The circuit is entirely stable, and invariably successful in achieving this object. The receiver was then tried with the valve functioning, and a marked increased in signal strength obtained.

An almost exhausted accumulator was then substituted. and after almost twenty minutes' use the accumulator peacefully expired, but the local programme still came in at comfortable "crystal" volume without the tuning controls being touched. At a later date this instrument was tested at a distance of thirty miles from the local station. Using the crystal alone, the news bulletin was perfectly readable on one pair of phones, but not sufficiently loud to give enjoyable reception. On turning on the valve filament, signal strength came up to a very good strength with very pleasant tone, and other pairs of phones were connected up. Coils were changed to those suitable for the Daventry wavelength, the valve still being lit, and upon tuning the controls Radio-Paris came in at quite good telephone strength, Daventry being for the moment silent. Upon extinguishing the valve all signals from Paris ceased, and after a moment Daventry recommenced transmission.

A search was then made on the shorter wavelengths for other B.B.C. stations. During the brief time at his disposal the writer tuned in two other main B.B.C. stations and one Continental without suffering any interference from the local station. It must not be forgotten, of course, that this receiver employs reaction as well as H.F. amplification, and in the interests of good quality this should not be abused. Although, when used as a crystal receiver alone, the aerial circuit becomes loose coupled, it should be pointed out that when the valve is lit the aerial automatically becomes direct-coupled; thus all possibility of instability is eliminated, selectivity being obtained owing to the fact that the crystal circuit is always loosely coupled. Since the crystal is entirely isolated from any circuit associated with either the H.T. or L.T. batteries, no fear need be entertained of damaging it by means of a voltage from the H.T. battery being accidentally applied to it.

As a rough guide, the writer would mention that the correct values of plug-in coils to use on the average aerial and earth system are as follow:—

For the local station, aerial No. 25 or 35, secondary No. 50, anode No. 50.

For Daventry, aerial No. 150, secondary No. 250, anode No. 250.

In conclusion, the writer would like to add that in all of the foregoing tests an ordinary type of crystal was used throughout, and not the super-sensitive type referred to by him earlier in this article.

TRANSMITTING NOTES AND QUERIES.

General Notes.

Communications for amateur transmitters in Austria may be sent via Oesterreichischer Versuchssenderverband, Klubsaal des Hotel de France, Schottenring 3, Vienna 1. The national prefix used is Ö (— — — -). and the call-signs of the Austrian transmitters at present operating are: AF, AR, AW, BE, BH, CP, DA, FG, FH, FL, HF, HI, HR, JA, JL, KH, KK, LA, LM, LP, MH, NA, OA, OP, RF, RH, SF, SJ, SV, TA, TM, TO, TW, WA, WM.

We hope at some future time to be able to publish the names and addresses of some or all of these transmitters.

oooo

Mr. A. G. S. Richards, "Hill Brow," Chorleywood West, Herts, is carrying out a series of tests during the early hours of each day from January 3rd to 8th inclusive with regard to the reception of American broadcasting stations on their normal waveband and to compare the strength of their signals with that of the last two years. He will welcome reports from other listeners giving particulars of apparatus, conditions prevailing and results obtained.

Our readers are reminded that a large number of French amateurs send their QSL cards to the office of our contemporary, the *Journal des 8*, Rugles, Eure, which publishes, every week, a list of those cards waiting to be claimed. Communications should be accompanied by an International Reply Coupon to the value of 1 franc to defray postage, and a fully addressed envelope.

oooo

Mr. C. Prosser (6YS), Pleasant Harbour, East Aberthaw, near Cardiff, will welcome reports of his tests on Sundays at 0930 G.M.T.

oooo

New Call Signs.

G 5FF.—R. Ferguson, "El Nido," 23, Cavendish Avenue, Finchley, N.3.

G 6VO.—D. Simpson, 18, Bank Street, Lerryhill, Aberdeen.

G 6CJ.—F. J. H. Charman, 76, Salisbury Street, Bedford, 45 and 90 metres.

G 6XR.—T. Mitchell, Bentfield, Newhey, near Rochdale, 440 metres.

oooo

Stations Identified.

G 6DA.—S. D. Davy, 80, Essendine Mansions, Maida Vale, W.9, 90 metres week-days, 185 metres Sundays.

H BXB.—Communications may be sent via E. Pienemont, 2, Avenue des Alpes, Lausanne, Switzerland.

oooo

Change of Address.

G 2BM.—H. L. Garfath advises us that the address of his station is now 166, Birchanger Road, South Norwood, S.E.25.

oooo

QRA's Wanted.

A7, A3KB, A3AK, BZ2AF, BZ1IN, BZ3JW, E1BH, GB1, G2AYP, G2BAV, G2BL, G2ST, G2ZA, G5BO, G5BY, G5FP, G5RS, G5VC, G6BL, G6CR, G6MB, YHBK.

PROGRESS IN MAST DESIGN.

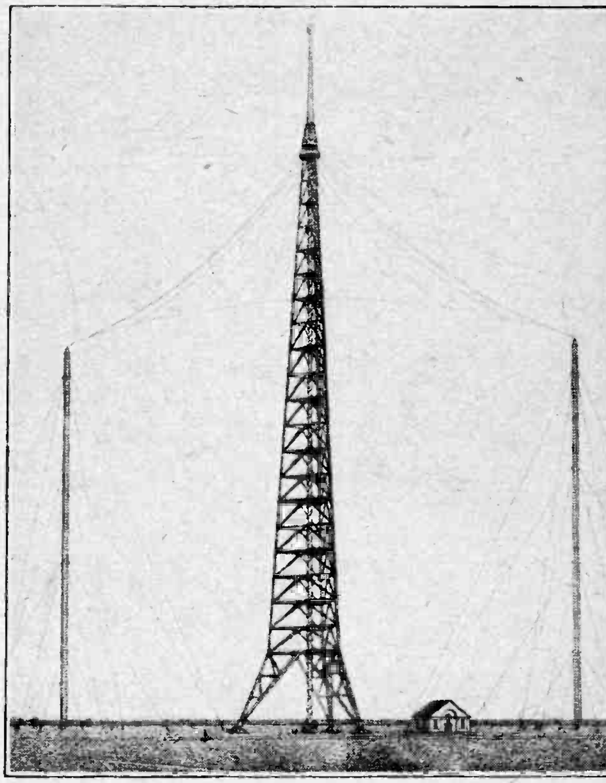
The New Tower at Königswusterhausen.

AT the Königswusterhausen Wireless Station, near Berlin, known to amateurs chiefly for its broadcast transmissions on 1,300 metres, a new mast has been erected which embodies many novel features. Although more than 900ft. high, the mast is entirely self-supporting, tapering from a substructure 70 yards wide to a platform at the top measuring about 32ft. across. From the summit extends a further small mast some 14ft. high, which supports the aerials.

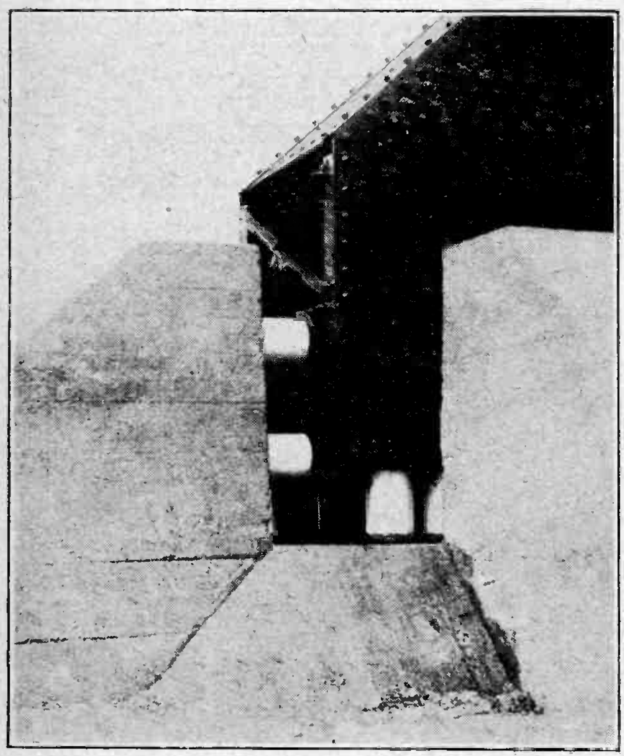
The cross section of the mast is triangular, a shape which has been found to possess many advantages over a square cross section. In the event of the mast sinking on one side only, the stresses on the framework are less severe when the triangular cross section is adopted.

Tests for Safety.

To test the safety of the erection, some interesting tests have been conducted. With a lateral pull at the summit of 16 tons and a wind pressure of 550 lb. per square metre, there still exists a safety margin of 50 per cent. That the mast withstood these strains is a testimony to the soundness of its design, having regard to the comparatively small sub-structure and the fact that the total weight of the tower is approximately 700 tons.



This drawing shows very clearly the general design of the new wireless tower at Königswusterhausen, which is the largest of its kind in Germany.



A massive concrete anchorage supporting one of the three feet of the Königswusterhausen mast. Note the porcelain insulators, which have been tested to withstand a strain of 400 tons.

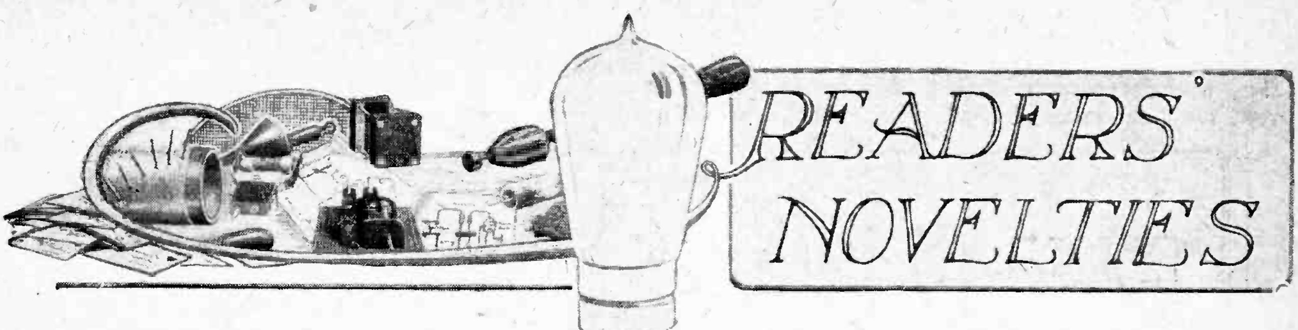
The feet of the tower are insulated from earth by large porcelain insulators tested at a pressure of over 400 tons.

At a height of 750ft. a small platform 32ft. in diameter is installed, and from this are suspended aerials for long wave traffic. On the same platform is a machine room containing the electric motor for operating the lift, which runs in the central shaft. Immediately above the platform is a totally enclosed chamber, 7ft. high, housing a short-wave transmitter.

A Commercial Short-Wave Service ?

A point of special interest is that the summit of the tower, which extends some 150ft. above the platform, and is reached by a spiral stairway, will be employed for short wave experiments. A short-wave transmitter is to be installed, and it is understood that the first tests will be carried out by engineers of the State Telegraph Department. In view of the unusual height of the tower, it is hoped that the experiments will throw fresh light on many short-wave problems. Should these researches prove successful, it is probable that a regular commercial service will be inaugurated.

A searchlight is to be installed at the top of the mast for the benefit of aircraft.

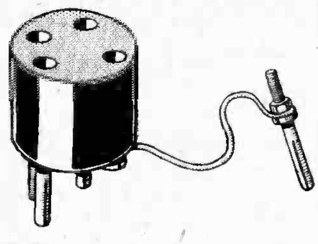


READERS NOVELTIES

A Section Devoted to New Ideas and Practical Devices.

EXPERIMENTAL VALVE HOLDER.

The diagram shows a valve holder in which the plate leg has been cut short and connected by means of a short length of flex to a standard valve pin. To cut out the last valve in a two-valve amplifier, it is then only necessary to remove both valves and to insert the adapter in the first valve holder. The power valve is then inserted in the adapter and the flexible valve pin connection is plugged into the plate socket of the last valve. The adapter will be found useful for testing the plate current of individual valves in a receiver, since a break is provided in the anode circuit into which a milliammeter may be connected. By changing the short leg to the filament the tapping provided by the wander lead may be used to supply 2-volt valves in a circuit fitted elsewhere with valves having a filament rated at 6 volts.—R. K.

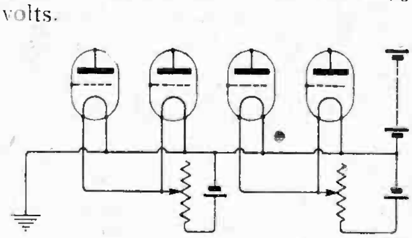


Experimental valve holder.

oooo

TWO-VOLT VALVES.

Due to the resistance of the wiring in the receiver and to the internal resistance of the accumulator, it is very difficult to derive a sufficiently high voltage from a single accumulator cell when more than three valves of the 2-volt, 0.35 amp. type are employed. With a total current exceeding 1 amp. flowing from the L.T. battery, it will be realised that if the wiring of the L.T. circuit has a resistance of 0.25 ohm, the maximum filament voltage obtainable from a 2-volt accumulator will be 1.75 volts.



Duplicate filament supply for 2-volt valves.

It is possible to overcome this difficulty by using two L.T. batteries, one for each pair of valves. Not only will the voltage drop in the leads be considerably reduced, but losses due to internal resistance of the supply battery will be negligible.—W. J. G.

oooo

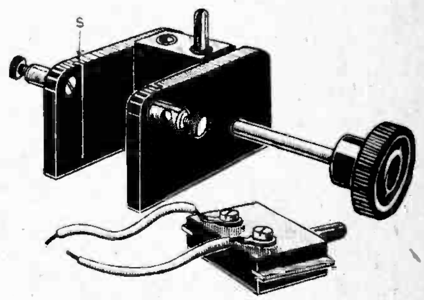
SHORT-WAVE COIL-HOLDER.

When receiving on short wavelengths it is essential that the coil connected between the grid and filament of the detector valve should have a low self-capacity, and on this account it is desirable to avoid the use of plug and socket connections of standard design in which the narrow spacing and use of ebonite dielectric produce a comparatively large capacity between the ends of the coil.

The coil-holder shown in the diagram has been adapted for use with either standard plug-in coils or short-wave coils of special construction. The ebonite block containing the plug and socket for the fixed coil (A.T.I.) was removed from the coil-holder and fitted with narrow brass strips forced into saw cuts running down each side. The vertical slots S were then cut in the inside faces of the coil-holder, the saw being held so that the slots tapered slightly towards the bottom. This ensures that the fixed coil-holder will be a good driving fit to prevent lateral movement of the coil. Two short flexible leads from the set screws of the plug and socket are taken to terminals screwed into opposite sides of the coil-holder.

For short wavelengths special self-supporting coils are constructed with stiff wire of, say No. 16 S.W.G. The bare ends of the coil are then inserted in the terminals after withdrawing the standard coil-holder.

N. S.



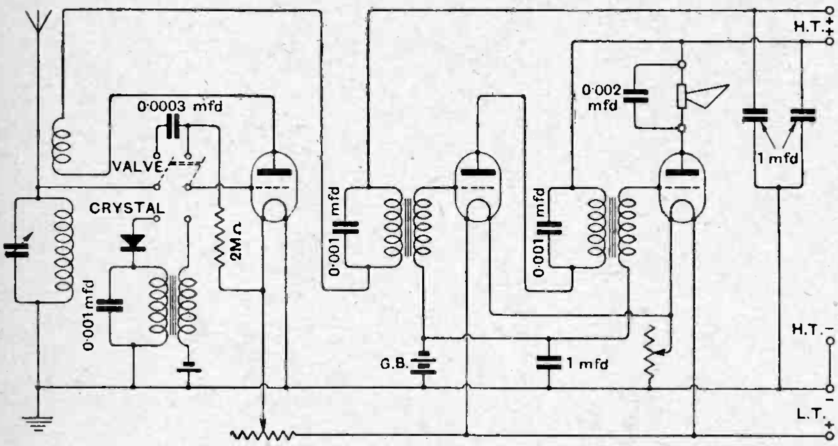
Plug-in coil-holder adapted for short-wave coils.

oooo

VALVE OR CRYSTAL RECTIFICATION

A complete circuit is given in the diagram for a two-valve transformer-coupled amplifier preceded either by a crystal detector or a valve detector with reaction.

The change between the alternative methods of detection is carried out by means of a double-pole change-over switch. The left-hand set of contacts connects the aerial side of the A.T.I. either to the crystal detector or to one side of the grid condenser; the right-hand set of contacts connects the grid of the first valve either to the secondary winding of the crystal transformer or to the grid condenser. If, in the case of the first valve, a compromise is effected between the best value of H.T. for detection and amplification, it will be possible to change from one circuit to the other without making any alteration in the adjustment of the receiver.—E. T.



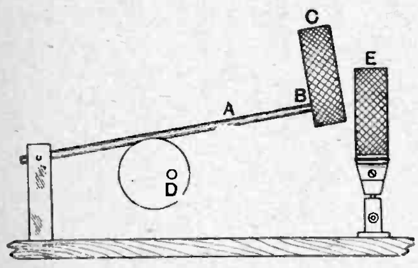
Alternative valve or crystal rectification.

oooo

VARIABLE COIL-HOLDER.

A particularly smooth and effective method of varying the coupling between two plug-in coils is shown in principle in the diagram. The moving coil C is fixed at B to an arm A pivoting at the other extremity in a support screwed to the baseboard of the receiver.

The arm rests by its own weight on a disc mounted eccentrically on the spindle D passing through a bush in the front panel of the receiver. The rotation of the spindle D will obviously cause the coil C to rise and fall, thus varying the coupling with the fixed coil E. The amount of movement provided by a cam of any given dimensions will depend upon the point at which the cam makes contact with the arm A. The spindle D must be provided with a smooth-working friction washer where it passes through the bush in the front panel.—W. M.

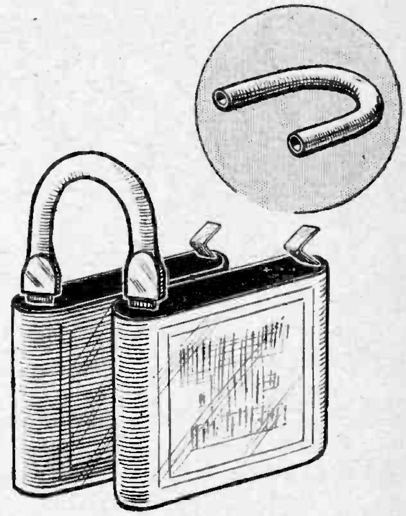


Coil holder adjustment.

CONNECTING FLASH LAMP BATTERIES.

In building up H.T. batteries from flash lamp battery units great care must be taken to ensure perfectly noiseless connection between each cell. The best method is first to solder each connection, but this has to be done quickly and skilfully otherwise damage may result from the heat conducted to the interior of the cell through the brass strip contact.

A method of connection which gives results quite equal to soldering is shown in the diagram. Short lengths of lead compo. tubing about ¼in. internal diameter, are bent to form a U shape. The contacts of the batteries are then cut off to a length of ½in. or ⅜in. and given a slight bend, as shown in the diagram. The lead tube is then slipped over the appropriate contacts and permanent contact is made by squeezing up the end of the tube with pliers. The bend in the contact strip and the springy nature of the brass will ensure a perfect contact even though the interior of the tube is not completely closed.—J. F. H.



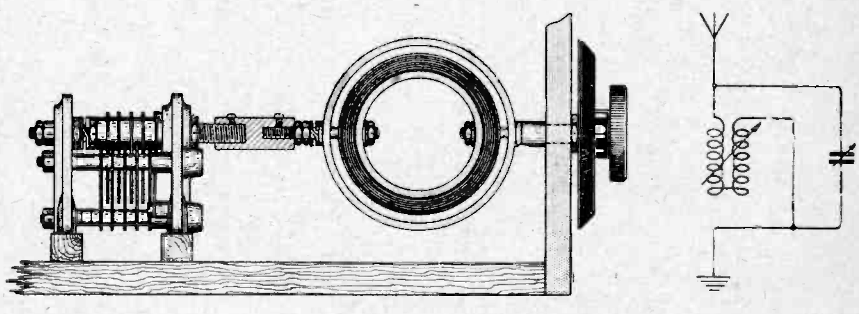
Flash lamp battery connections.

WIDE RANGE TUNER.

The wavelength range of a tuned circuit may be greatly extended by making provision for the variation of both the inductance and capacity in the circuit. In practice this can best be accomplished by connecting together the spindles of a variometer and variable condenser in such a way that the capacity and inductance are increased or decreased simultaneously.

The diagram shows a convenient method of connecting the variometer and condenser by means of a short length of ebonite rod drilled at each end to fit the spindles of the two components.

The variometer should be preferably of the type not fitted with stops and capable of continuous rotation. There will then be no difficulty in arranging that the inductance increases as the condenser capacity increases.—G. H. T.



Variometer and variable condenser coupled to give increased wavelength range.

TONE CORRECTION IN L.F. AMPLIFIERS.

Introducing Controlled Distortion to Correct Loud-speaker Defects.

By H. LLOYD, M.Eng.

IN a recent article entitled "Realistic Loud-speaker Reproduction,"[1] the writer discussed some of the problems encountered in attempting to obtain a more life-like reception of broadcast programmes. This has elicited a number of enquiries for further practical information, and it is the purpose of these notes to describe in greater detail some of the principles to which only a brief reference was then made.

A large amount of the attention which is being given to the improvement of broadcast reception is directed—quite rightly—towards the betterment of the audio-frequency amplifier. Faithful reproduction, however, cannot be assumed to follow automatically from distortionless amplification. Indeed, if it could, most of the problems of good reception would now be non-existent, because the means of obtaining almost truly uniform amplification are already at our disposal. We can design an amplifier capable of dealing impartially with all input voltages within audible limits of frequency, and which will behave in such a way that the relative magnitudes of the applied voltages are preserved in the output. But when all this has been accomplished, the remaining trouble is that the head-telephone or the loud-speaker, as the case may be, never behaves with the same consistency in its duty of transforming the electrical energy into waves of sound in the air. The intensity of the sound emitted by a loud-speaker, when a note of frequency, say, 500 vibrations per second, is made before the broadcasting microphone, is often forty or fifty times as great as it is when a note is broadcast with the same original loudness, but having a frequency several octaves lower. This defect occurs whether the two notes are played one after the other, or simultaneously, and the result in either case is a lack of proper balance in the reproduction.

Loud-speaker Distortion.

Faults of this nature in an amplifier can be attacked at their source and removed, but when the loud-speaker is the culprit, prevention seems impossible, and cure, or at any rate partial cure, has therefore to be considered. The usual method is to introduce into the music, during the process of amplification, an appropriate amount of distortion, and to adjust the degree and the nature of this distortion so that it neutralises as nearly as possible the irregularities in the response characteristic of the loud-speaker or the telephone. Having done this, it can then be said that for equal input voltages applied to the amplifier, the loud-speaker will give out equal sound wave amplitudes, irrespective of the frequencies of the musical notes represented. As a simple case, imagine a loud-speaker which gives out sound waves with a magnitude that varies inversely as the frequency; that is to say, that if the frequency of the input to the loud-speaker is doubled, whilst the magnitude remains unchanged, the amplitude of the sound wave produced is halved. By employing, in conjunction with this loud-speaker, an amplifier which steps up the various impulses in *direct* proportion to their frequencies, we have an arrangement which behaves on the whole as though it were independent of frequency. The same principle is made use of in order to correct for microphone distortion in transmission. One type of microphone widely used for broadcasting has an inverse frequency characteristic, and this is compensated for by using in conjunction with it an amplifier having a factor directly proportional to the input frequency. Thus the output from this amplifier is independent of the frequency of the sounds picked up by the microphone. Unfortunately, the pitch-response curves of loud-speakers do not obey such simple laws, and a complete correction for their distortion is therefore not so easy to accomplish, but the addition of suitable accessories to the low-frequency amplifier of the receiving set can be made to yield a marked improvement in reproduction.

[1] *The Wireless World,* Oct. 14th, 1925.

Resistance-coupled Amplifiers.

Transformer-coupled and choke-coupled amplifiers do not lend themselves to the application of these correcting devices, but now that valves having a high amplification factor and low filament consumption are available, there is no longer any excuse for condemning resistance capacity coupling on grounds of relative inefficiency. The great advantage of the resistance-coupled amplifier for audio-frequencies is that its performance can be predicted with accuracy by very simple calculations, based on the valve characteristics, and, moreover, such an amplifier can be fitted with tone-adjusting circuits to produce predetermined effects upon its output.

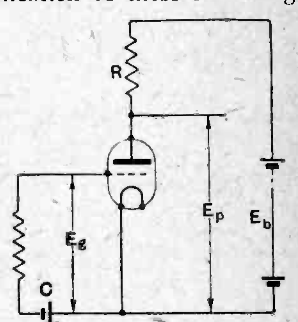


Fig. 1.—Single-stage resistance-coupled amplifier.

Fig. 1 represents one stage of a resistance-coupled amplifier. The alternating voltage to be amplified is applied to the grid of the valve on a base line fixed by the E.M.F. of the battery C.

If the battery E_b is driving a current I_p around the anode circuit of the valve, there will be across the anode resistance R a voltage drop of I_pR. The actual anode potential E_p of the valve will therefore be less than the battery voltage E_b by an amount equal to I_pR; *i.e.* :—

$$E_p = E_b - I_pR \quad \text{.................} \quad (1)$$

If E_g is raised, due to the application of a positive half-wave of input voltage, I_p will increase, and E_p will therefore be reduced. The extent of this variation of E_p will depend upon the constants of the valve, and also

Tone Correction in L.F. Amplifiers.—
upon the magnitude of the resistance R, according to the equation :—

$$E_p = E_g \frac{R}{R + R_p} \mu_o \quad \ldots\ldots\ldots\ldots\ldots \quad (2)$$

The amplified voltage-change E_p is then passed on through the medium of a suitable coupling condenser to the grid of the next valve in the amplifier.

Amplifier Characteristics.

A graphical illustration of this process is very helpful, and for this purpose all that is required is a set of characteristics of the valve to be employed. The most convenient way of plotting the curves for this particular

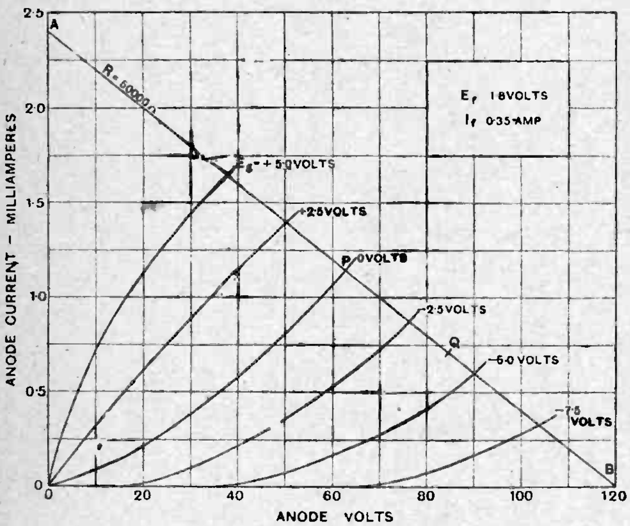


Fig. 2.—Curves indicating the performance of a resistance–coupled amplifier.

purpose is shown in Fig. 2, where each curve represents the variation of I_p with actual anode potential, the grid potential remaining fixed at a definite value. Fig. 2 represents the characteristics taken for a valve of the two-volt dull emitter class. From this diagram we can read off the amplification that will be obtained when using a given resistance in the anode circuit, and a given value of high-tension battery voltage. The correct grid-bias to use under these conditions can be decided immediately, and also the maximum input voltage the valve will handle without producing distortion.

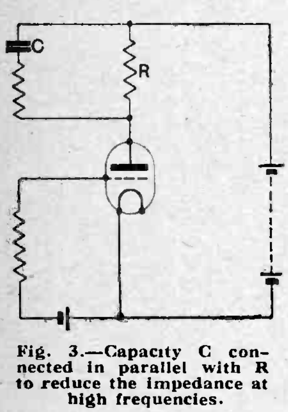


Fig. 3.—Capacity C connected in parallel with R to reduce the impedance at high frequencies.

Let us suppose that we intend to use a valve having curves like Fig. 2, with a high-tension battery of 120 volts and an anode circuit resistance of 50,000 ohms.

Equation (1) can be written in the form :—

$$\frac{E_p}{E_b} + I_p \left(\frac{R}{E_b} \right) = 1.$$

This equation represents a straight line making intercepts on the axes equal to E_b and E_b/R respectively. This line is shown by AB in Fig. 2. The point B is the battery voltage of 120, and A is at E_b/R, which in this case is $\frac{120}{50,000} = 2.4$ milliamperes.

The successive curves of this diagram are seen to correspond to grid potentials rising in equal increments, viz., 2.5 volts. For distortionless amplification, any change in grid voltage must produce a proportionate change in the anode potential, and this condition is being fulfilled when the intercepts on the line AB between successive curves on the diagram are equal. Measurement on the diagram shows that this desired proportionality ceases to be maintained whenever the grid acquires a positive potential, thus fixing one of the limits to the range over which the grid may be permitted to be carried. The other limit is represented by the point B, but it is not usually desirable to approach too near to this end of the range, because of the changes which take place in the valve impedance in this region. The correct grid bias to use then for most purposes will be found by taking a point on AB about two-thirds of the way from B to P, and estimating the

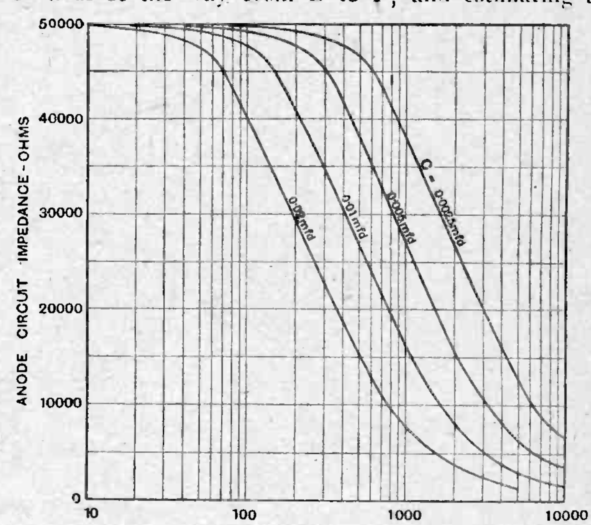


Fig. 4.—Impedance curves for the arrangement shown in Fig. 3, with the series resistance omitted.

grid voltage to which a characteristic curve passing through this point would correspond. On Fig. 2, a grid voltage of about − 4, as shown by the position Q, will be about right.

Adjusted according to this plan, an amplifier will be equally effective over the whole audible range, but for the purpose of correcting in some measure the irregularities of the loud-speaker or telephone, we wish to know how to introduce just the right kind and the appropriate amount of distortion into the current operating the reproducing device. Equation (2) does not contain any term involving frequency. The anode resistance is assumed to possess negligible reactance, and so far as audio-frequencies are concerned, the inter-electrode capacities of the valve can also be ignored. If, however, the anode circuit possesses inductance or capacity, or both, in addition to resistance, equation (2) becomes :—

$$E_p = \mu_o E_g \frac{\sqrt{R^2 + X^2}}{\sqrt{(R + R_p)^2 + X^2}}$$

Tone Correction in L.F. Amplifiers.—

and the amplification is no longer independent of the frequency. By making the anode circuit suitably reactive, its impedance can be caused to be quite low at those frequencies to which the loud-speaker responds with undue strength. These notes will then be relatively weaker when

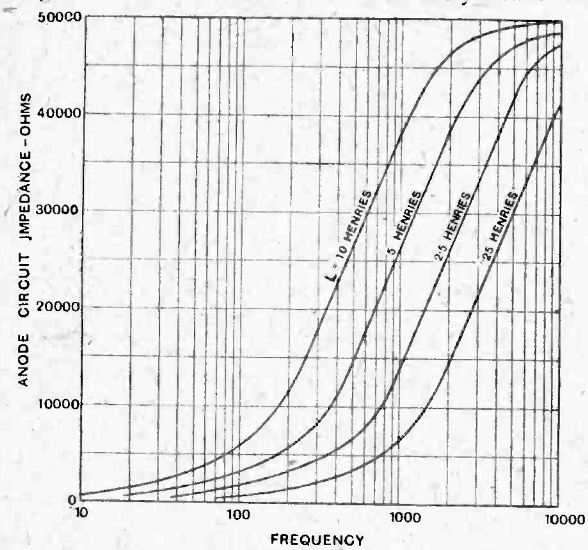


Fig. 5.—Impedance curves, showing the effect of inductive reactance in the anode circuit.

they reach the loud-speaker, and the reproduction will be improved as regards tonal balance.

If condensive reactance is employed, the capacity must be connected in parallel with the anode resistance, as in Fig. 3; if it were put in series, the high-tension supply would be interrupted. The effect of shunting an anode resistance of 50,000 ohms with condensers of various capacities is indicated in Fig. 4. The impedance of the anode circuit begins to fall off quite rapidly at a frequency depending upon the size of the condenser, until at the highest audible frequencies the impedance is almost

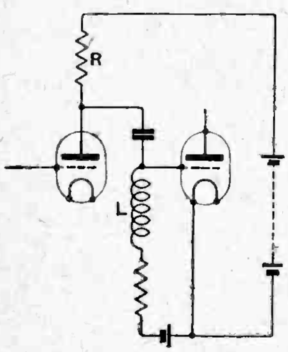


Fig. 6.—Practical method of introducing inductive reactance.

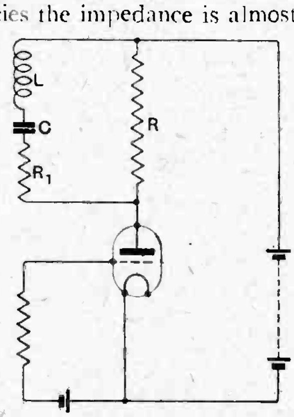


Fig. 7.—Circuit for suppressing frequencies in the middle register of the musical scale.

negligible. Since the amplification depends upon this value of the anode circuit impedance, the high-pitched sounds will no longer be amplified so much, and the lower notes of the musical scale will gain preponderance. Such a circuit as this will tend to correct the reproduction of a loud-speaker very sensitive to the high frequencies, but only feebly responsive to low notes. If the cut-off of such a circuit proves too sharp, the slope of the impedance curve can be reduced by putting in series with the condenser a resistance. A variable resistance of 10,000 ohms maximum value is satisfactory for most purposes.

Band Filters.

Fig. 5 shows the effect of inductive reactance in the anode circuit. This kind of correction circuit is not usually required with loud-speakers of the types at present prevailing, because it has the effect of cutting down the amplification at the lower end of the scale of frequencies. It produces an effect somewhat similar to that noticed when intervalve transformers having an insufficient primary impedance are used in an amplifier.

The method of application of this circuit to a resistance-coupled amplifier is of interest, however, for experimental purposes when using certain types of loud-

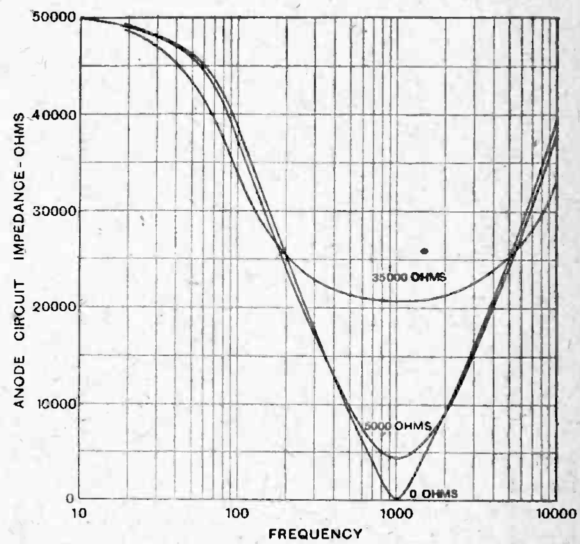


Fig. 8.—Curves for the circuit of Fig. 7 with different values of R_1.

speaker. The reactance should not in this case be shunted across the anode resistance, as the mean anode potential of the valve would be raised, and its operating characteristic altered. A more convenient and satisfactory method is to connect it in the manner shown in Fig. 6. Electrically, this connection is practically equivalent to putting the inductance in parallel with the anode resistance, because the impedance of both the intervalve condenser and the high-tension battery are negligible compared with that of the anode resistance unit. The curves shown in Fig. 5 represent the impedances obtained when a low-resistance choke is used, but here, again, if the cut-off effect occurs too suddenly

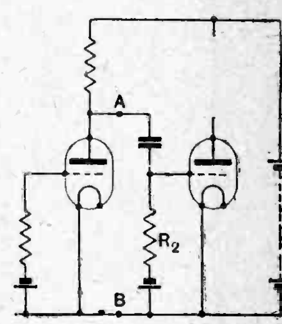


Fig. 9.—Connections of coupling condenser and leak in resistance-coupled amplifier.

Tone Correction in L.F. Amplifiers.—
on the frequency scale to produce the desired raising of the general tone, a resistance may be inserted in series with the inductance.

Most loud-speakers and telephones exhibit a decided preference for the middle register of the musical scale of frequencies. To effect a reduction in the amplitude of these frequencies, whilst allowing the very high and the very low sounds to be magnified to the full extent, the circuit shown in Fig. 7 may be applied to one or more stages of the amplifier. Impedance curves corresponding to a few values of C, L, and R_1 are given in Fig. 8. From these it can be seen that, over a certain range of frequencies, depending upon the proportions of the circuit, the amplification will be very small, and that by suitable adjustment of the correcting circuit this range may be made to coincide with the band of frequencies to which the loud-speaker is unduly responsive. Several of these band filters may be used, tuned to the same frequency or to different frequencies, but they should be applied to different stages of the amplifier to obviate interaction between the circuits. The extent to which the middle register is weakened depends upon the resistance of the band filter circuit, and about 35,000 ohms is a suitable maximum value for this. The inductance should be air-cored for the best results, but quite an effective choke can be made by fitting a winding of spaced slab coils on to the core of a good make of intervalve transformer. As a rough guide, 600 turns of wire on such a core gave an inductance of about one henry. The inductance for other sizes will vary approximately with the square of the number of turns of wire. The largest size of wire which the core will accommodate should be used, so as to keep the resistance of the choke low. The most convenient type of condenser to use for this circuit is the 0.01 mfd. ebonite dielectric variable condenser from certain obsolete marine receivers. Such a condenser, in conjunction with three or four fixed condensers of the same capacity, gives a useful range of adjustments when used with a one-henry choke. The frequency corresponding to the minimum amplification of such a valve circuit as Fig. 7 is given approximately by the equation :—

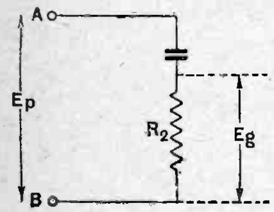


Fig. 10.—Distribution of E.M.F.s in the coupling condenser and leak.

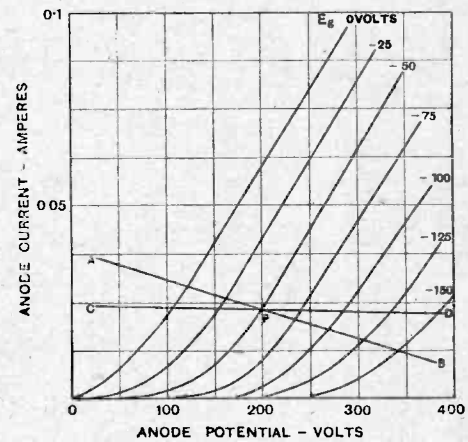


Fig. 12.—Curves indicating the performance of an L.S.5A valve as a power converter.

$$f = \frac{1,000}{2\pi\sqrt{CL}},$$

where L is in henries, and C in microfarads. The use of a variable condenser in this circuit is very desirable, as it is then much more easy to make exact adjustments. Listening to the sounds from the loud-speaker or tele-

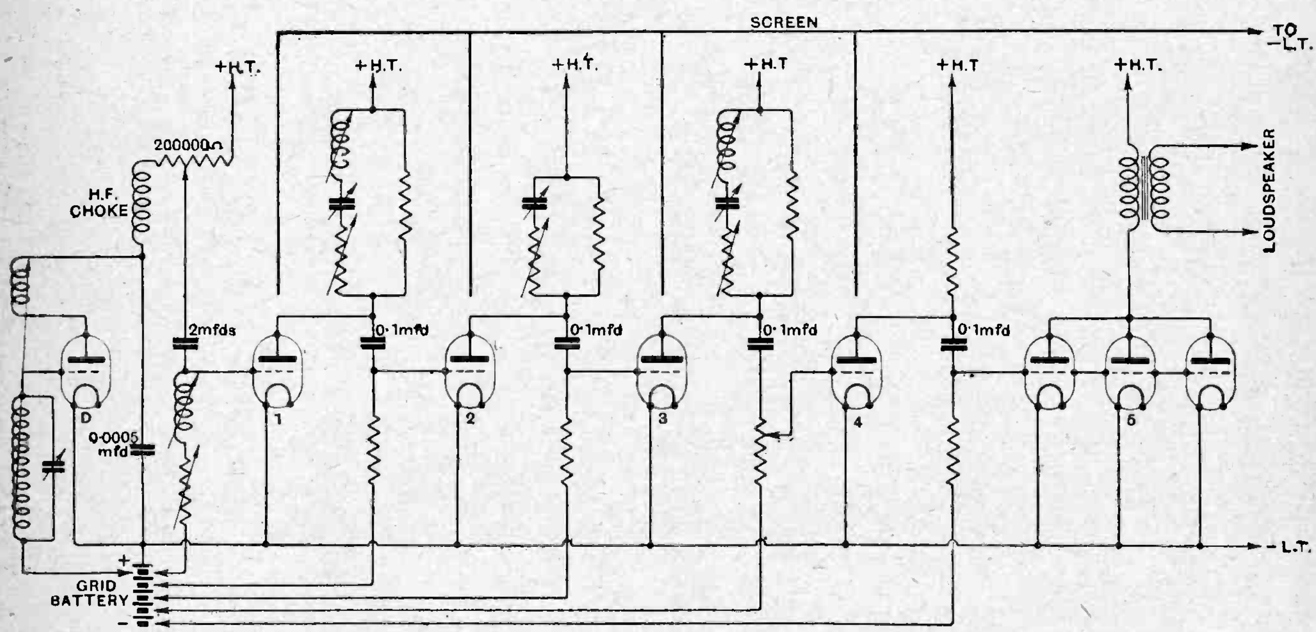


Fig. 11.—Connections of a practical amplifier equipped with tone correcting devices.

Tone Correction in L.F. Amplifiers.—

phones whilst slowly changing the condenser value, one notices a region where the character of the sound changes quite definitely from nasal to muffled. The correct adjustment of the circuit lies within this region.

The foregoing matter applies to individual stages of resistance amplification. A multi-valve resistance-capacity amplifier consists of a number of these stages coupled together in cascade by means of condensers. The coupling condenser is connected as shown in Fig. 9, so that the changes of anode potential of the first valve are communicated to the grid of the second valve. The condenser must be large enough to offer a negligible impedance to the lowest frequency likely to be dealt with, and the minimum capacity necessary to satisfy this condition can be found as follows:—

Fig. 10 shows a simplified diagram of the circuit of the previous figure, and equivalent to it so far as alternating voltages are concerned. The grid-filament capacity of the second valve has been neglected, since the amplifier is for audio-frequencies. Also the resistance of the grid-filament space is assumed to be infinite compared with the grid-leak resistance R_2. This assumption will be justified so long as the grid bias is correct and the valve not overloaded. The values of E_p and E_g are then connected by the equation:—

$$\frac{E_g}{E_p} = \frac{\sqrt{\omega^2C^2(R_2{}^4\omega^2C^2 - 1)}}{R_2{}^2\omega^2C^2 + 1}$$

It will be found, by substituting numerical values in this expression, that a condenser of 0.1 mfd. will make E_g/E_p something over 90 per cent. for frequencies as low as 20, when a grid leak of 0.5 megohm is used, so that a larger capacity is unnecessary, except in such special cases as when a choke is substituted for the grid leak for the purpose of raising the tone of the amplifier. When this is done, the coupling capacity should be increased to 1 or 2 microfarads.

The diagram of a complete amplifier built on these lines is given in Fig. 11. It is shown connected for wireless reception to a D.E.Q. detector valve with reaction and anode rectification. The first anode resistance is tapped as a potential divider for controlling the input to the amplifier. The first valve grid circuit contains a tone raiser, and its plate circuit a band filter. The anode circuit of the second valve is shunted by condensers, for tone lowering, and the third valve is arranged as a second band filter. The grid leak of the fourth valve is tapped for volume control, and for the last stage three power valves are available. Wide volume control is desirable, because the overall sensitiveness of the amplifier is changed considerably by the adjustment of the tone biasing circuits, and it is only by maintaining the loudness level reasonably constant that the effect of alterations in the tone of reproduction can be judged with fairness.

The Ideal Loud-speaker.

The output transformer was described in the article to which reference was made at the beginning of these notes. The processes taking place in the anode circuit of the last stage of the amplifier are very difficult to predict, on account of the complicated electrical load offered by the loud-speaker, and only become comparatively simple when the moving-coil principle is used. Practical results have convinced the writer of the superiority of this principle over many others, and in a future article it is hoped to describe how the impedance of the output circuit of the amplifier can be measured for different frequencies and powers when one of these loud-speakers is being operated. Suffice it to say here that the effective impedance of the output transformer will vary between certain limits according to the frequency and strength of the sounds. The diagram Fig. 12 shows the characteristic curves for a valve of the L.S.5A type, with lines drawn to indicate the performance of the valve as a power converter. The value of E_b is assumed to be 200 volts, with a negative grid bias of 50 volts, the mean anode current, therefore, being 24 milliamperes, as given by the point P. The lines AB and CD through this point represent the extremes in the values of output impedance for all frequencies and powers handled. The slopes of the lines are given by the respective values of $1/Z$. This gives one an idea of the distortion to expect in this circuit, and it will be seen that if the impedance variation is very great, the musical balance will be upset. Every change of impedance of the loud-speaker will be reflected in the primary of the output transformer, and the development of a constant impedance loud-speaker would therefore enable much better reproduction to be obtained from simple apparatus.

TRADE NOTES.

Protection of Trade Name.

Messrs. Brown Brothers, Ltd., the well-known wholesale motor and radio manufacturers, recently figured in an interesting High Court case before Mr. Justice Romer. Messrs. Brown Brothers applied for an injunction restraining Mr. Thomas William Bell and Mr. Alfred Pugh, of Liverpool, from carrying on business as wireless dealers with the name of Brown Brothers. His Lordship granted an injunction, and also ordered that the defendants should pay the plaintiffs the cost of the action.

oooo

Verb. Sap.

An accumulator left to the tender mercies of a novice, however good his intentions, may sometimes suffer from a lack of understanding. This fact has been recognised by A. J. Stevens and Co. (1914), Ltd., in placing A.J.S. accumulators on the market. Attached to each battery is a printed label of the luggage tab type, which gives tactful instructions to the purchaser regarding the methods of treating an accumulator during the early part of its life. The instructions, which apply with equal force to every make, should certainly save many accumulators from an early death.

oooo

Canadian Wireless Demands.

An approximate analysis of the available wireless apparatus in Canada shows 90 per cent. American and only ten per cent. British and Continental, according to a report by Mr. W. A. Brooke, who has recently toured Canada and the U.S. as sales director of the Ashley Wireless Telephone Co., 69, Renshaw Street, Liverpool. Where prices are reasonably competitive, says Mr. Brooke, Canadians express a preference for British apparatus.

oooo

An Exaggerated Report.

The Goswell Engineering Co., Ltd., 95-98, White Lion Street, London, N.1, advise us that exaggerated reports appear to have spread concerning the fire which recently took place at their new premises. The fire was, in fact, confined to a heap of rubbish; no stock or material was damaged, nor was the factory routine interfered with. No delay is taking place in the delivery of "Quality Radio" components.

VALVES WE HAVE TESTED

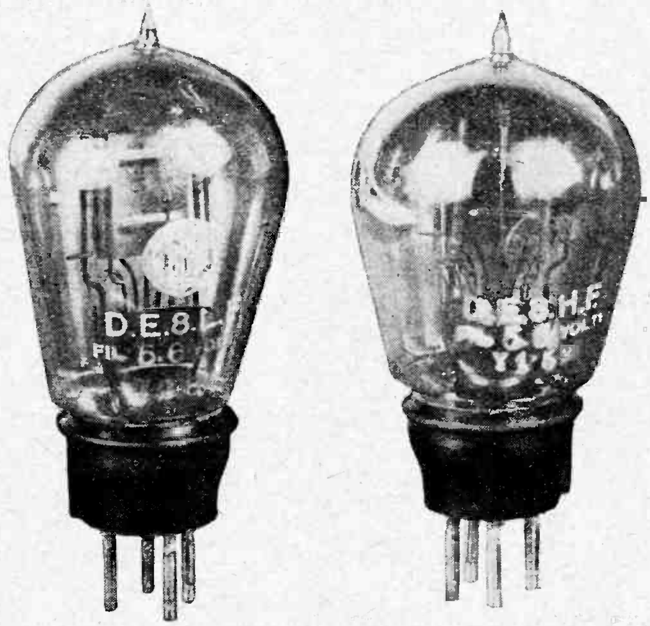
The D.E.8 L.F. and H.F. Valves.

THESE valves are very similar in appearance to the D.E.5 type of valve marketed by the General Electric Co., Ltd., the essential difference between the D.E.5 and D.E.8 valves being that the latter consumes a filament heating current of 0.12 ampere at 5.5 to 6 volts, as compared with 0.25 ampere at 5.5 volts for the D.E.5 class of valve. The manufacturers claim that the operating characteristics are, apart from the different filament rating, practically the same as those of the D.E.5 and D.E.5b. If this be true, the D.E.8 should soon be a popular valve.

The D.E.8 L.F.

This valve is rated by the makers at 5.5 to 6 volts 0.12 ampere for the filament, maximum anode voltage 100, amplification factor 7, and impedance 8,000 ohms. Tests made in our usual manner gave the results shown in the accompanying table, from which it will be seen that with the anode and grid voltages chosen as representative of actual working conditions, the impedance of the specimen tested varied between 13,800 and 9,000 ohms, while the amplification factor has an average value of 6.9.

When used with an anode voltage of 120, the valve will furnish sufficient power to operate an average loud-speaker without overloading. Used in a speech frequency amplifier, a coupling transformer of 4 or 6 to 1 may be employed with good results. The valve is not suitable for use in a resistance or choke-coupled amplifier because of its low amplification factor, unless, of course, very large amplitudes are being dealt with.



Osram D.E.8 L.F. and H.F. valves. The anode pin is easily identified by the ridge on the side of the cap and by the letter "A" marked on the top of the cap.

The D.E.8 H.F.

The makers rate the valve at 5.5 to 6 volts 0.12 ampere for the filament, 120 anode volts, amplification factor 16, and impedance 25,000 ohms; the ratio of amplification factor to impedance is, therefore, not quite so good as for the L.F. valve. It was found that under working conditions the amplification factor and impedance averaged about 40,000 and 18 respectively, which is quite good for a valve consuming a filament power of only 0.7 watt.

This valve is recommended as a detector, when a transormer having a low ratio, such as 2.5 to 1, can be used. The valve is, however, specially produced for resistance or choke amplifiers, two such stages giving a voltage magnification of about 225.

The valve should not be used in the last stage of a speech amplifier for two reasons. First, its impedance is too high, and, secondly, it will only deal effectively with a peak signal voltage of about 3.

D.E.8. L.F. VALVE.

Filament characteristics, 5 volts 0.105 ampere, 5.5 volts 0.113 ampere. 6.0 volts 0.12 ampere.

Anode Volts.	Anode current at zero grid volts. Milliamperes.	Actual anode current. Milliamperes.	Grid Bias.	Amplification factor.	Anode Impedance. Ohms.
40	1.28	1.28	0	6.55	13,800
60	2.9	1.72	−2	6.93	13,650
80	5.2	2.32	−4	6.95	12,590
100	7.7	2.96	−6	6.95	11,400
120	10.2	3.56	−8	6.95	9,300

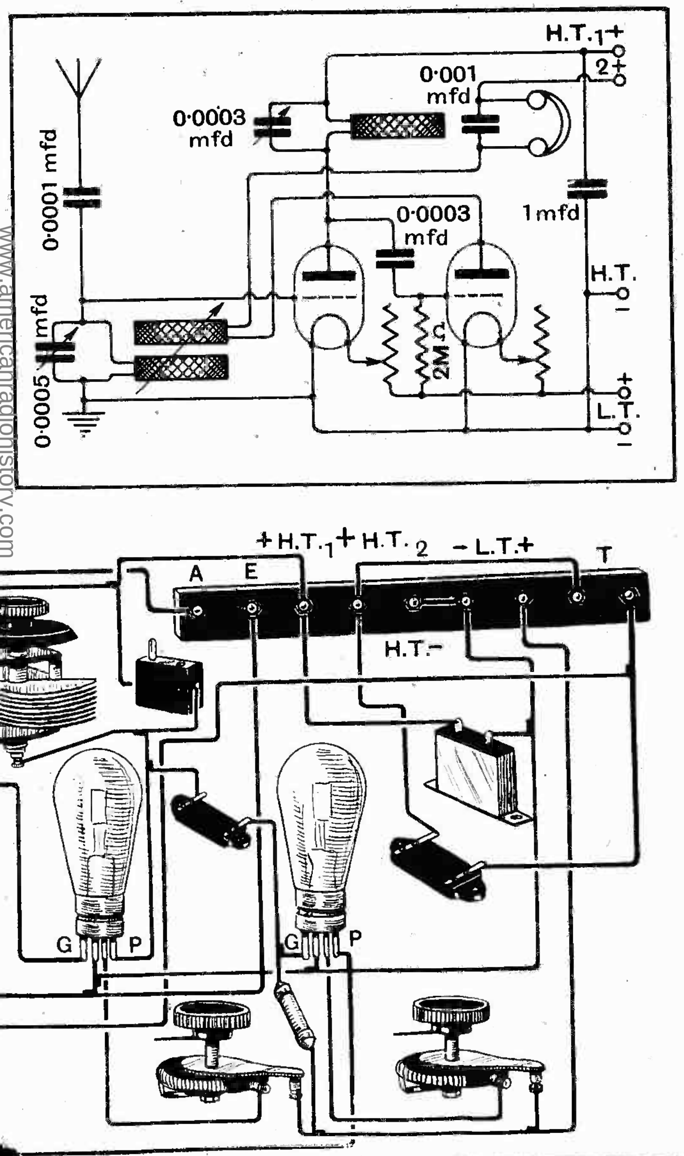
Taken with 6 volts on filament. Grid current starts at about zero grid volts.

D.E.8. H.F. VALVE.

Filament characteristics, 5 volts 0.105 ampere, 5.5 volts 0.112 ampere. 6.0 volts 0.12 ampere.

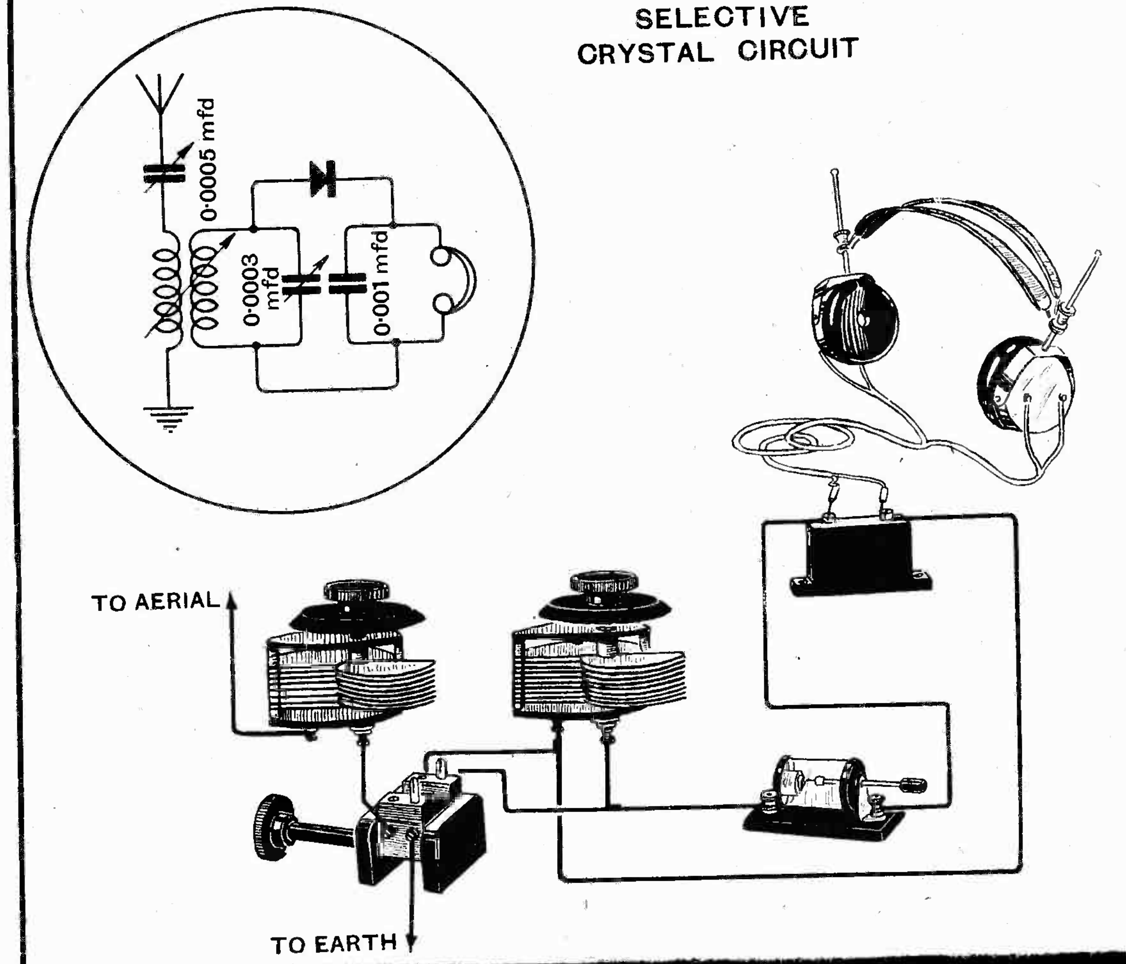
Anode Volts.	Anode current at zero grid volts. Milliamperes.	Actual anode current. Milliamperes.	Grid Bias.	Amplification factor.	Anode Impedance. Ohms.
60	0.87	0.87	0	20.0	50,000
80	1.56	1.25	−1	18.1	40,000
100	2.45	1.35	−2	17.0	36,400
120	3.52	1.66	−3	17.7	34,800

Taken with 6 volts on filament. Grid current starts at about zero grid volts.

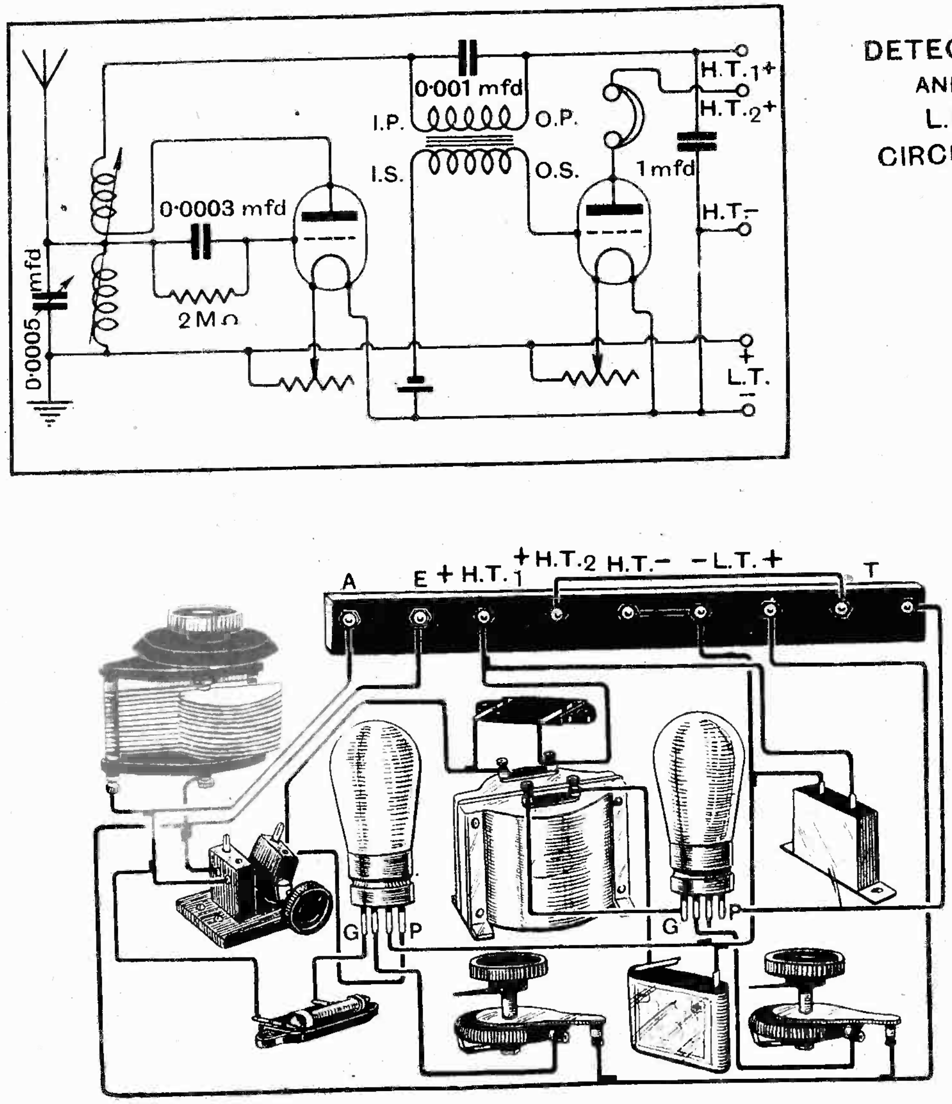


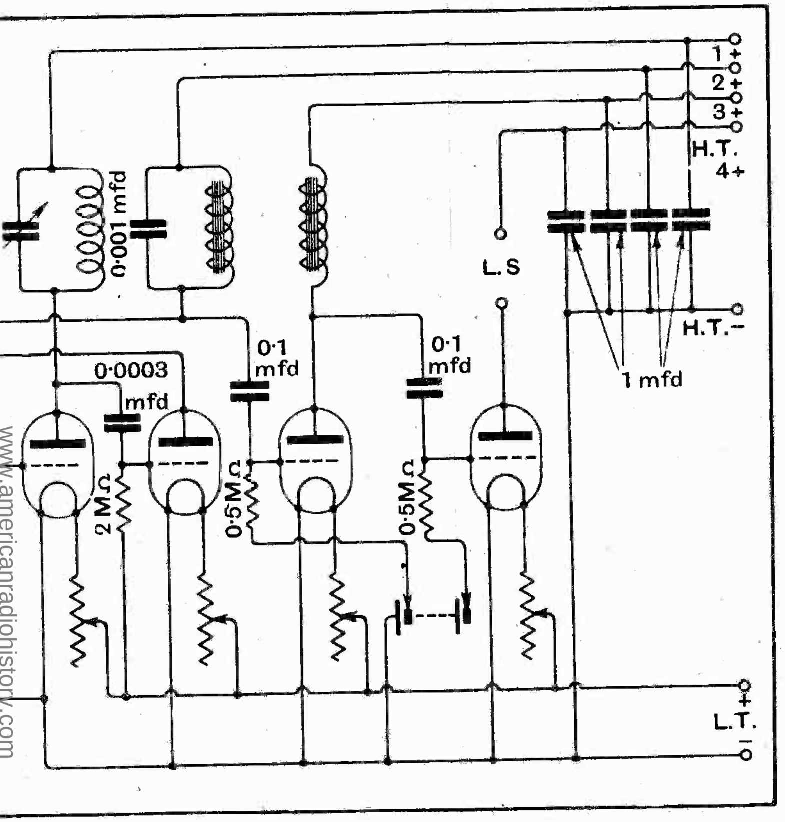
The Wireless World
AND RADIO REVIEW

SELECTIVE CRYSTAL CIRCUIT

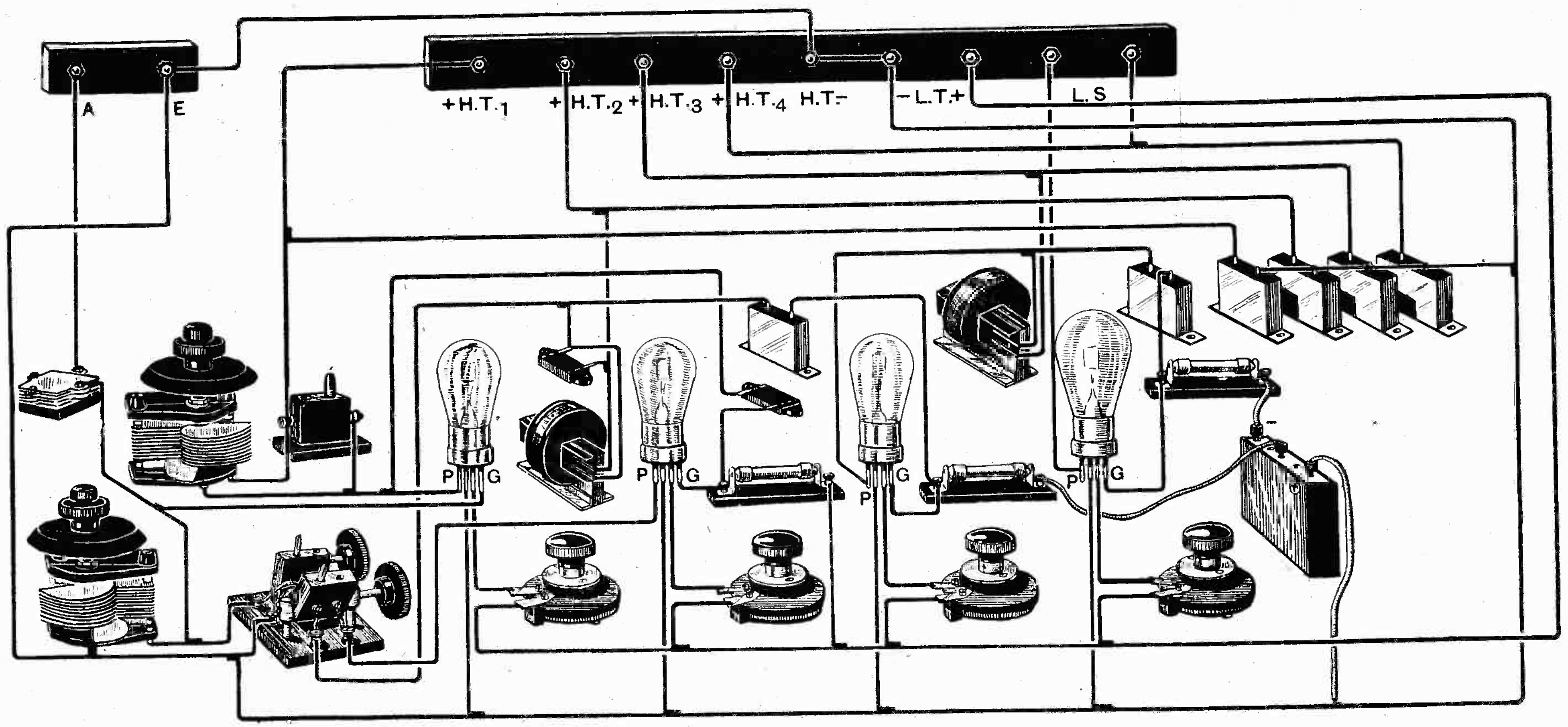


DETECTOR AND L.F. CIRCUIT



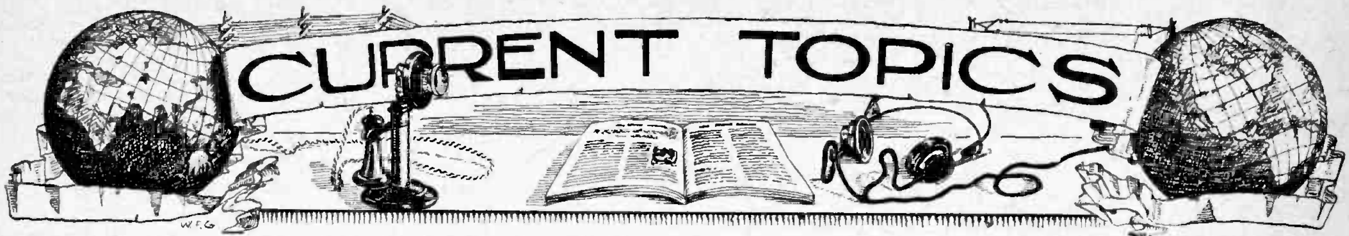


4 VALVE CHOKE COUPLED
CIRCUIT



KEY TO PRACTICAL WIRING OF TYPICAL CIRCUITS

Printed in Great Britain by THE CORNWALL PRESS Ltd., 1-6, Paris Garden, London, S.E.1.



Events of the Week in Brief Review.

PARIS AERIAL DOWN.

During the heavy snowstorm which swept Paris just before Christmas the aerial of the Eiffel Tower station collapsed. The damage was repaired within twenty-four hours.

oooo

NEW BELGIAN BROADCASTING STATION.

An agreement has been reached between *Radio Belgique* and the Royal Zoological Society, Antwerp, whereby a broadcasting station will be erected at the Antwerp Zoo.

According to the *Daily Mail*, it is hoped that the station will be ready by the end of February. In addition to relaying from the Brussels station, it will transmit its own programmes.

oooo

TACKLING EUROPEAN ETHER PROBLEMS.

There are growing indications that Europe's overcrowded ether may shortly undergo a sufficient clearance to make listening to Continental stations more pleasurable than it is to-day. The Council of the International Radiophone Union at Geneva has approved of the new plan put forward at the Brussels Conference for the redistribution of wavelengths between European broadcasting stations.

oooo

THE DUDDELL MEDAL.

The Physical Society of London has this year awarded the Duddell Medal to Mr. Albert Campbell, formerly of the National Physical Laboratory. Mr. Campbell was one of the first to introduce coils of small self-capacity in wireless receivers.

The Duddell Medal is awarded annually to those who have advanced the science of physical measurements by inventing instruments or parts of instruments of novel design.

oooo

FAME FOR OLD "W.W." CONTRIBUTOR.

Mr. Douglas R. P. Coats, a contributor to *The Wireless World* in those dim and distant days before the war, has just been voted the most popular broadcast announcer in Canada. Mr. Coats, who is manager-announcer of CKY, the station of the Manitoba Telephone System at Winnipeg, has been awarded a silver cup in token of his popularity. Many of the voters reside in the United States.

oooo

TO FALL OR NOT TO FALL.

The Edinburgh Corporation is seeking powers to make by-laws which may affect a number of broadcast listeners. For the prevention of danger or obstruction to persons using any street it is proposed to forbid the erection of posts, tubes, aerials, or any other apparatus in connection with wireless telegraphy or telephony "stretched or placed on or over any premises and liable to fall on to any street or public place."

We can imagine hot disputes on whether an aerial is "liable to fall" or not.

THOSE LOUD LOUD-SPEAKERS.

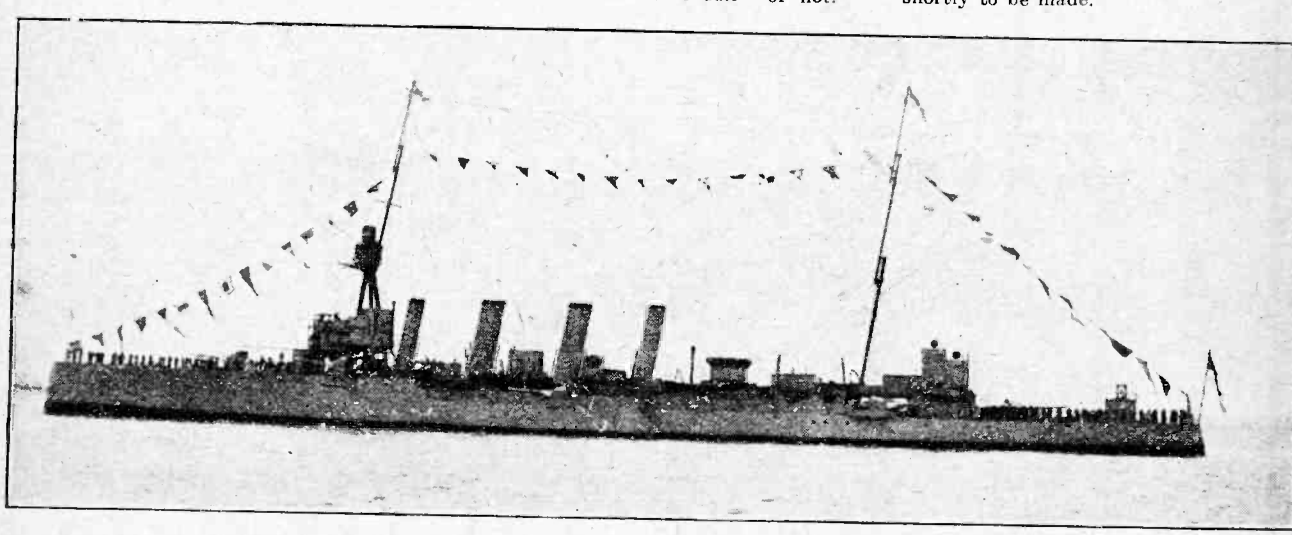
Guildford tradesmen who have resorted to the wily charms of the loud-speaker to entice prospective customers will probably have to direct their energy into other channels in the near future. The Guildford Town Council has asked the Home Secretary whether he will confirm a by-law regarding the use of wireless loud-speakers outside business premises for advertisement purposes.

oooo

OPENING OF THE RUGBY STATION.

Very appropriately, on New Year's Day, the Empire Wireless Station at Rugby made its bow to the world. The largest valve transmitter in existence, Rugby has proved its ability to communicate with all parts of the globe. During the tests, completed in December, excellent signals were picked up in Australia, New Zealand, Java, China, South Africa, and Canada. Without exception, all the receiving stations commented favourably upon the strength and quality of Rugby's transmission.

The immediate tasks of the new station are commercial and official. The Leafield Press transmissions have been taken over, while long-distance code and ship work are also being undertaken. All amateurs will watch Rugby's performance with interest during 1926, particularly in regard to the telephony experiments which are shortly to be made.



AMATEURS IN NAVAL WIRELESS TESTS. *H.M.S. Yarmouth*, now on her way to Hong Kong. During the voyage, we understand, the vessel will endeavour to maintain short-wave communication with amateurs in this country. Co-operation between Government services and wireless amateurs has already proved successful in America.

RADIO DINNER DANCE.

The festive season, now in full swing, is the appropriate time for holding those social events which strengthen the ties of fellowship in club life. This has been realised by The Wireless and Experimental Association, who are giving a Radio Dinner Dance at the Crown Hall, Holborn Restaurant, on Saturday, January 16th. Captain P. P. Eckersley has kindly consented to take the chair, and among the prominent personalities who will grace the assembly will be John Henry, Esq.

The dinner will begin at 7.30 sharp, dancing beginning at 9.30 and continuing until midnight. Dinner and dance tickets are 10s. 6d. each; for the dance only, 4s. They are obtainable, together with fuller particulars, from Mr. A. W. Knight, 167, Rye Lane, Peckham, S.E.5.

oooo

BROADCASTING AND THE BOOK TRADE.

In spite of predictions that the advent of broadcasting would seriously affect the sale of books, publishers' records show that in 1925 more books were published than in any previous year.

oooo

WIRELESS ON AMERICAN FARMS.

The American farmer's appreciation of broadcasting is shown by statistics prepared in regard to the last three years. During the year 1923 the number of sets installed on farms amounted to 145,000; during 1924, 365,000, and in 1925 550,000. The State of Illinois heads the list.

FORTHCOMING EVENTS.

WEDNESDAY, JANUARY 6th.

Institution of Electrical Engineers (Wireless Section).—At 6 p.m. (light refreshments at 5.30). At the Institution, Savoy Place, W.C.2. Lecture with Demonstration: "Frequency Variations in Thermionic Generators."

Barnsley and District Wireless Association. At 8 p.m. At 22, Market Street Reception on Low Waves.

THURSDAY, JANUARY 7th.

Institution of Electrical Engineers.—At 6 p.m. (light refreshments at 5.30). At the Institution, Savoy Place, W.C.2. Lecture: "Past, Present and Future Developments in Wireless Telephony." By Captain P. P. Eckersley.

FRIDAY, JANUARY 8th.

Sheffield and District Wireless Society.—At 7.30 p.m. At the Dept. of Applied Science, St. George's Square. Experimental Work. (3) Measurement of Capacity and Inductance.

Leeds Radio Society.—At 8 p.m. In the Physics Laboratory, Leeds University. Lecture: "Electro Magnetic Induction" (Illustrated). By Mr. S. Eccles, M.A. (Camb.). (Admission free by ticket from Hon. Secretary, 6, Roberts Avenue).

MONDAY, JANUARY 11th.

Swansea Radio Society.—General Talk by Mr. Jenkins (of the British Broadcasting Company).

WEDNESDAY, JANUARY 13th.

Radio Society of Great Britain.—Informal Meeting.—At 6 p.m. At the Institution of Electrical Engineers, Savoy Place, W.C.2

THURSDAY, JANUARY 14th.

Liverpool Wireless Society.—At 7.30 p.m. At the Royal Institution. Lecture: "Fading." By Prof. E. W. Marchant, D.Sc., M.I.E.E. (President).

oooo

BRITISH INDUSTRIES FAIR.

Rapid progress is being made with the organisation of the British Industries Fair, at which, it is understood, a number of leading wireless manufacturers will be represented. The Fair opens next month concurrently in London and Birmingham.

The London event will take place at the White City, where most of the available space has already been booked. In Birmingham the exhibition will be staged at Castle Bromwich.

oooo

MORAL BROADCASTING.

A movement to establish high moral standards in the conduct of broadcasting is being set afoot by the Chicago Broadcasters' Association. A code of ethics has been prepared, says the *Scientific American*, based on the principle that broadcasting is a public service. One of the principal clauses in the code runs: "To realise that a broadcasting station is ambitious to succeed, but that it is first an ethical enterprise and wishes no success that is not founded on the highest justice and morality."

THE PROPOSED WIRELESS INSTITUTE.

Many readers will be interested in the statement, printed below, which has been issued by the Wireless Section of the Institution of Electrical Engineers. The opinion is advanced that the interests of qualified professional wireless engineers are best served by the present Institution.

THE Committee of the Wireless Section of the Institution of Electrical Engineers has further carefully considered the proposal for a new Institute of Wireless Engineers and is definitely of the opinion that the interests of qualified professional wireless engineers are best served by the Institution of Electrical Engineers. The Wireless Section of the Institution has already deprecated the formation of a new Institute of Wireless Engineers, and feels confident that it is unnecessary and will not be supported by representative and qualified professional wireless engineers.

The Institution of Electrical Engineers has already explained that an engineer with adequate wireless qualifications can become a Corporate Member of the Institution, and that other wireless engineers not reaching that standard are eligible as graduates, and as such can attend all meetings of the Wireless Section as well as those of the Institution.

The Committee have taken into consideration the suggestions arising out of the previous correspondence on this subject which appeared in the Press, and with a view to improving and extending the activities of the Wireless Section, and making it more definitely representative of professional wireless engineers, the Committee submitted the following recommendations which have been approved by the Council of the Institution:—

(1) While it is essential that the standard of qualifications for membership of the Institution should be maintained, more opportunity is to be afforded to the physicist engaged in wireless work to become a member of the Institution.

Applications for membership of the Institution based upon the usual general scientific training and wireless professional qualifications to be referred by the Secretary to a Wireless Section Membership Sub-Committee which will make reports and recommendations for the guidance of the Membership Committee of the Council.

(2) The qualifications for membership of the Wireless Section to remain as at present, viz.: "that he is a member of the Institution and is actively engaged in the study, design, manufacture, or operation of Wireless or High Frequency Engineering Apparatus," and the Wireless Section Membership Sub-Committee to scrutinise all new applications for membership of the Wireless Section and decide who shall be admitted to it.

The Sub-Committee to be authorised to call for full particulars as to the nature of the study undertaken by an applicant or for particulars of his work in design, manufacture, or operation in order to satisfy themselves that the applicant is properly qualified in Wireless Engineering.

(3) The fact to be emphasised and more widely published that the meetings of the Wireless Section are open to all members of the Institution.

(4) The Wireless Section Committee to get into direct touch with the local centre committees for the purpose of ascertaining the possibility of—

(a) Starting local wireless sections.

(b) Stimulating efforts to produce local wireless papers.

(c) Suggesting the reading of available suitable papers, or giving of lectures, at local centres.

(5) Each local wireless section, when properly constituted, to be entitled to elect or nominate one wireless member to the Wireless Section Committee. For this purpose a local wireless section shall consist of at least 15 members, who must already be members of the main Wireless Section.

(6) The papers and the discussions of the Wireless Section and other wireless papers, in addition to appearing in the Journal of the Institution, to be issued separately in the form of "Proceedings of the Wireless Section."

(7) The Chairman of the Wireless Committee to be an ex-officio member of Council, in the same way as are the chairmen of local centres, as soon as the necessary alterations to the bye-laws can be made, but in the meantime he will be invited to attend all meetings of the Council.

PHOTOELECTRIC VALVES.

A New Development of the Thermionic Valve.

By A. DINSDALE.

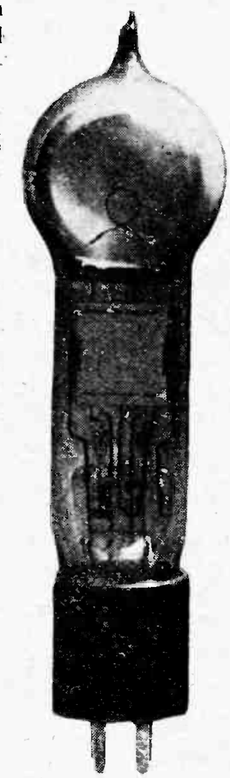
FOR some years it has been known to scientists that when a ray of light falls upon certain metals, notably those of the so-called alkali group, such as sodium and potassium, electrons are emitted. Such an electron stream, as those readers will know who have some technical knowledge of the internal action of valves, constitutes an electric current, and the phenomenon has been termed the "photoelectric effect."

On account of the minuteness of the current produced, this photoelectric effect has remained more or less a scientific curiosity, rarely made use of outside the laboratory, until the development of thermionic valves permitted the amplification of the current to such an extent that it could be usefully employed. G. du Prell (Ann. der Physik, No. 3, 1923), G. Ferrié (Comptes Rendus, November 5th, 1923), and others showed how photoelectric and other impulses of similar dimensions could be magnified as high as a million times by means of a single valve.

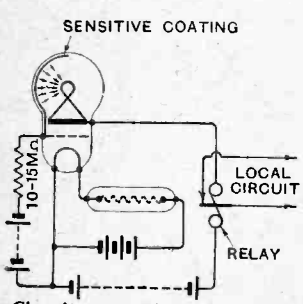
Commercial Development.

For such work, however, careful installation, and even special valves are necessary for best results, and in order to simplify the operation and adapt the photoelectric cell for use by untrained operators, V. K. Zworykin, of the Research Department, Westinghouse Electric Co., East Pittsburg, Pa., has developed the special device shown in the accompanying illustration.

The type of device illustrated consists simply of an ordinary three-electrode valve with a photoelectric cell included within the glass bulb, but in another type described by Mr. Zworykin, a four-electrode valve is employed. In both types the filament is of the oxide-coated dull emitter variety, operated at a temperature so low that there is no visible glow. This feature is necessary on account of the close proximity of the sensitive photoelectric cell.



The photoelectric valve, showing the active coating on the inside of the bulb and the electron collecting wire ring mounted on the plate of the valve



Circuit connections for indicating changes in the light intensity falling on the cell.

Constructional Details and Circuits.

In the three-electrode instrument, the filament is surrounded by the usual form of grid and plate. The inside of the upper or spherically shaped part of the bulb is coated with photoelectric substance (in this case potassium hydroxide), and the coating is connected, inside the bulb, to the grid. In the centre of the top part of the tube can be seen a wire "electron collector." This is connected to the plate. The collector and the metallic coating constitute the photoelectric cell, and it is carefully shielded from the lower or valve portion of the tube, so that there shall be no possibility of light from the filament falling upon the sensitive coating.

In the four-electrode type, the filament is surrounded by an open mesh grid, which is in turn surrounded by a fine mesh grid, and the whole group is enclosed by the plate. The two grids and the plate are co-axial. In this case it is the second or fine mesh grid which is in electrical contact with the metallic coating, the plate being in contact with the collector, as before.

Current Output.

Mr. Zworykin describes several methods of connection which are possible, the simplest being that used in conjunction with the three-electrode instrument, and shown diagrammatically in the figure. A grid resistance of high value (10 to 15 megohms) is connected between the grid and the negative terminal of the grid biasing battery, which is also of high value (30 to 45 volts). The value of the H.T. applied to the plate of this particular valve is between 90 and 150 volts, and a relay is included in the plate circuit, this latter for the operation of external circuits.

Under the above conditions, with carefully adjusted potentials and with the photoelectric cell in darkness, the highly negatively charged grid blocks the flow of electrons from the filament to the plate, and hence no current will flow in the external plate circuit.

If, now, a ray of light falls upon the sensitive coating of the photoelectric cell, a stream of photo-electrons will flow from the coating to the collector. Since the coating is in electrical contact with the grid, this electron flow will discharge the grid, *i.e.*, draw current from it. This flow of current from the grid to the plate will produce a voltage drop across the grid resistance which will lower the potential of the grid. This will upset the careful balance of the circuit, stop the blocking action of the grid, and permit an electron flow from the filament to the plate. The amount of current which will flow in the external plate circuit depends upon the rate of discharge of photo-electrons, *i.e.*, the degree of illumination of the photoelectric cell, and the extent of the negative charge received by the grid through the resistance.

With such an arangement, using a hard valve, an output of the order of one milliampere can be obtained. For higher outputs, Mr. Zworykin uses the four-electrode type of valve, using the first grid as an anode with a

Photoelectric Valves.—
low potential (about 30 volts positive). The second grid and plate are connected as before. By a proper choice of spacing between electrodes and grid mesh, it is possible to obtain a good relationship between the degree of illumination and current output within certain limits. A continuous output of five milliamperes has been obtained, the limiting factor being the heat developed within the photoelectric cell. Since alkali metals are highly volatile, overheating of the cell distills the metallic coating on the transparent and insulating parts. It is stated, however, that this can be remedied to a great extent by improved construction.

The photoelectric cell, of course, has a time lag, which, in the case of one tube made as described above, was of the order of one ten-thousandth of a second, by calculation, and this was verified experimentally up to a frequency of 3,000 cycles. Mr. Zworykin states that this value can be considerably reduced by diminishing the capacity of the second grid and increasing the voltage factor on the first grid.

Practical Applications.

As described above, the Zworykin tube operates as a light detector, but, by reversing connections, it can be made to operate in the reverse manner, so that, with a steady light falling upon the photoelectric cell, no current flows in the external plate circuit. When adjusted in such a manner, the slightest variation in light value will upset the balance of the circuit and allow plate current to flow.

The new tube was demonstrated to the public in October, at the New York Electrical Show, held in Grand Central Palace, the particular application in this case being as a smoke detector. The tube was set up in a suitable position so that a beam of light fell on the cell from a projector situated some distance away. In the plate circuit of the tube was connected an ordinary 150 ohm telegraph relay, the contacts of which closed an alarm circuit. Under the conditions of the demonstration, anything which came between the beam of light and the cell caused the device to function, closed the relay contacts, and sounded the alarm. So sensitive was the apparatus, in fact, that a whisp of cigarette smoke, passing across the light beam, caused sufficient shadow to fall on the photoelectric cell to trigger off the alarm. This demonstration proved conclusively that the apparatus is very suitable for use as an automatic fire alarm in unattended buildings, warehouses, etc. The device worked equally well with either artificial light or reflected daylight.

In addition, this new invention can be used in connection with variations of light intensity for any purpose, such as the exact scientific matching of colours, the detection of flaws in tinplate and textiles, the switching on of street lights at sunset and extinguishing them at dawn, and for innumerable other applications.

In the latest and most improved Zworykin tubes, the time lag has been reduced to the order of one one-hundred-thousandth part of a second, a reaction so incredibly rapid that new and important possibilities immediately become apparent in the direction of the transmission of photographs and even moving pictures by wireless. This is so because, when incorporated in a suitable circuit, the device will send out radio impulses of any desired frequency in direct proportion to the amount of light falling upon the photoelectric cell.

Another suggested application of the invention is in connection with an entirely new type of microphone for broadcasting purposes, which would respond equally to all frequencies.

FRENCH TIME SIGNALS.

From January 1st, 1926, the time signals from the Eiffel Tower (FL), and Bordeaux, Lafayette (LY) were altered to the times given in the table below :—

No.	G.M.T.	Signal.	Station.	Wavelength.
1	0800	International and Rhythmic Signals	FL	2650 spark.
2	0800	Do. do.	LY	18900 C.W.
3	0930	International	FL	2650 spark.
4	2000	International and Rhythmic Signals	LY	18900 C.W.
5	2245	Old Semi - Automatic Signal	FL	2650 spark.

Lyons (YN) will no longer transmit time signals.

This series will continue in force for four months, after which it is probable that No. 3 may be withdrawn and No. 5 replaced by an issue of the International and Rhythmic Signals from FL simultaneously with LY at 2000 G.M.T. By that time it is anticipated that the spark transmissions from FL will be replaced by modulated C.W.

The signals in issues Nos. 1 and 4 are as follow :—

(*a*) Preliminary signal.

(*b*) Times of issue of rhythmic signal of the previous day as determined by the Bureau International de l'Heure, Paris.

(*c*) Commencing at 7h. 57m. 55s., the International Signal as hitherto, except that the three dashes which have constituted the time signal are to be replaced by six dots, commencing at the seconds 55.0, 56.0, 57.0, 58.0, 59.0, 60.0, and lasting each about 0.2 second.

(*d*) Commencing at 8h. 1m. 0s., a new rhythmic issue of 306 signals, falling as follows :—

1m. 0s., 1st dash followed by 60 dots.
2m. 0s., 62nd ,, ,, ,, ,,
3m. 0s., 123rd ,, ,, ,, ,,
4m. 0s., 184th ,, ,, ,, ,,
5m. 0s., 245th ,, ,, ,, ,,
6m. 0s., 306th ,,

The commencements of all these signals are to be evenly spaced; the commencements of the dashes are intended to fall precisely at the commencements of the seconds of mean time, and they will be each about one half-second in duration; the dots will be about one-fifth of a second in duration.

Issues Nos. 2 and 3 will take the same form as hitherto, and for ordinary users the only service withdrawn is the old semi-automatic service from FL at 1045 G.M.T.

In addition to the above, signals similar to No. 1 will be made at 0800 and 2000 G.M.T. simultaneously from FL and LY, on 32 metres and 75 metres, during the four months probationary period. After that period it is probable that one of these wavelengths will be suppressed and the other permanently retained. The probationary period of four months is adopted for the purpose of ascertaining how far the new issues meet both general and scientific requirements, and any communications on the subject may be addressed to the Director, Bureau International de l'Heure, Observatoire National, Paris, or to the President, International Time Commission, Royal Observatory, Edinburgh.

Hints and Tips for New Readers

A Section Devoted to the Practical Assistance of the Beginner.

H.F. STABILITY.

There can be little doubt that the most difficult problem confronting the designer of a tuned H.F. amplifier intended to operate on the broadcast wavelengths is that of preventing self-oscillation. It has already been pointed out in these notes that, if the aerial coupling is loosened sufficiently to be effective, even a single amplifying valve will oscillate when its anode circuit is brought approximately into tune. Some artificial stabilising device therefore becomes necessary; of these, the so-called "neutrodyne" and various damping methods have already been discussed.

There are several other alternatives open to the amateur constructor, one of which is shown in Fig. 1. In this case a loosely-coupled H.F. transformer with a tuned secondary winding is used between the H.F. and detector valves. If the coupling between these two windings is gradually reduced, a point will be reached where the valve and its associated circuits will no longer tend to oscillate, due to the fact that the primary or anode circuit may be said to no longer form a part of the tuned circuit; thus conditions necessary for self-oscillation no longer exist. It is obvious, however, that if the coupling is reduced excessively, the amount of energy handed on to the succeeding valve will be reduced to such an extent that the overall amplification obtainable will be small. The best results will be obtained when the coupling is just weak enough to prevent self-oscillation, but, unfortunately, this adjustment will only remain correct over a very narrow band of wavelengths.

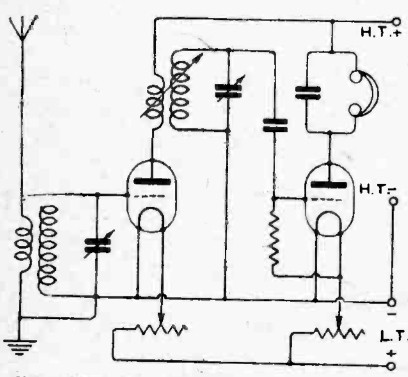


Fig. 1.—H.F. amplifier-detector with loose-coupled transformer.

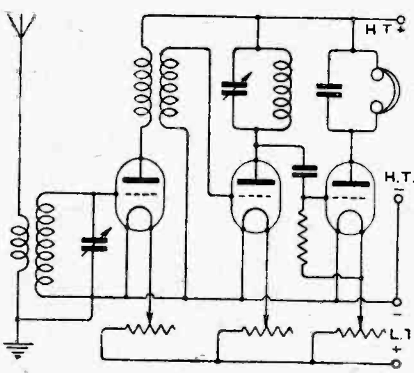


Fig. 2.—Stable H.F. amplifier-detector.

The scheme has the advantage that ordinary plug-in coils, in the usual two-coil holder, may be used as a transformer. The correct size for the primary will best be found by experiment; this will generally have a considerably smaller number of turns than will the secondary.

An ingenious adaption of this principle has been used in an American receiver; in this case the transformer coupling shaft is connected to the tuning condenser through a reduction gear, in such a way that the coupling will be approximately right for any setting of the condenser.

In Fig. 2 is shown another and obvious method of ensuring stability in an H.F. amplifier. Here an aperiodic and heavily-damped transformer is used to transfer energy from the anode circuit of the first valve to the grid of the second. Both these valves are functioning as high-frequency amplifiers, and as in neither case do we have a sequence of tuned grid and plate circuits, there will be no tendency towards self-oscillation, provided that there is not an excessive amount of magnetic coupling between the coils.

The disadvantages of this arrangement are that the amplification given by the untuned stage is small, and that it does not contribute anything towards the overall selectivity of the receiver. This latter point may, to a certain extent, be compensated for by a reduction of coupling between aerial and grid coils, and general attention to the selectivity of the tuned circuits.

In the receiver shown, reaction may be introduced, if required, between the anode circuit of the detector valve and either the tuned anode or grid coils.

○○○○

"REFLEX" ADJUSTMENTS.

It may sometimes happen that, when the contact is removed from the crystal detector in a reflex receiver, an actual increase in signal strength is noticeable. This is due to the fact that damping is reduced when the crystal circuit is broken, and the valve tends to approach more nearly to the oscillation point, the whole receiver thus becoming more sensitive. The valve itself will be rectifying on the "bottom bend." Such symptoms, of course, indicate a serious fault, as the set is obviously not functioning as a dual amplifier.

The trouble may be due to an insensitive crystal, or to incorrect values of high- and low-tension voltages applied to the valve; in these cases the remedy is obvious. Possibly the design of the high-frequency coupling between the valve and crystal is faulty; this is a very fruitful source of trouble. Many of the coupling devices suggested will operate best with a detector of comparatively high resistance, such as the perikon, or carborundum-steel combination, and are hardly suitable for the more popular galena crystals.

oooo

THE MASTER-SWITCH.

It is generally admitted that the life of bright emitter valves is considerably reduced by the sudden application of the full filament voltage, and one is generally advised to turn on the filament rheostat gradually. If this precaution is to be observed, the use of a "master switch" to put the set into operation is not permissible, but a variable master resistance, controlling all the valves, may be used in its place.

Dull emitter valves, with filaments working at low temperatures, probably do not call for this refinement, and the use of a switch, inserted in the positive L.T. lead, will be found convenient, as, by its use, those with absolutely no technical knowledge may be trusted to put the set into operation. In the case of a multi-valve receiver fitted with separate filament controls, much tiresome turning of rheostat knobs will be avoided. It should be remembered that the manufacturers of certain types of dry-battery valves, consuming 0.06 ampere, recommend a gradual application of filament current, so this arrangement can hardly be recommended where this particular class of valve is used.

oooo

COMMON FAULTS.

Experience shows that a very large proportion of the faults which develop in a valve receiver are to be traced directly to the batteries, either high or low tension, but more often to the former. Accordingly, when trouble develops these should first of all be suspected, and without doubt the simplest method of ascertaining whether this suspicion is justified or not is the use of a suitable voltmeter, which should be applied when the batteries are actually supplying current; "open-circuit" tests are of little value; at any rate, in the case of the L.T. accumulator. Dirty and corroded connections on this battery often give rise to complete or intermittent failure of signals.

Another most fruitful source of trouble is found to lie in faulty or loose contacts. These may be looked for at various points, particularly in the valve pins, which should be scraped bright and slightly opened out to ensure their fitting tightly into their sockets. The same remarks apply to the plugs of removable coils and H.F. transformers. Flexible wire connections to the moving sockets of coil holders are an equally prolific source of trouble.

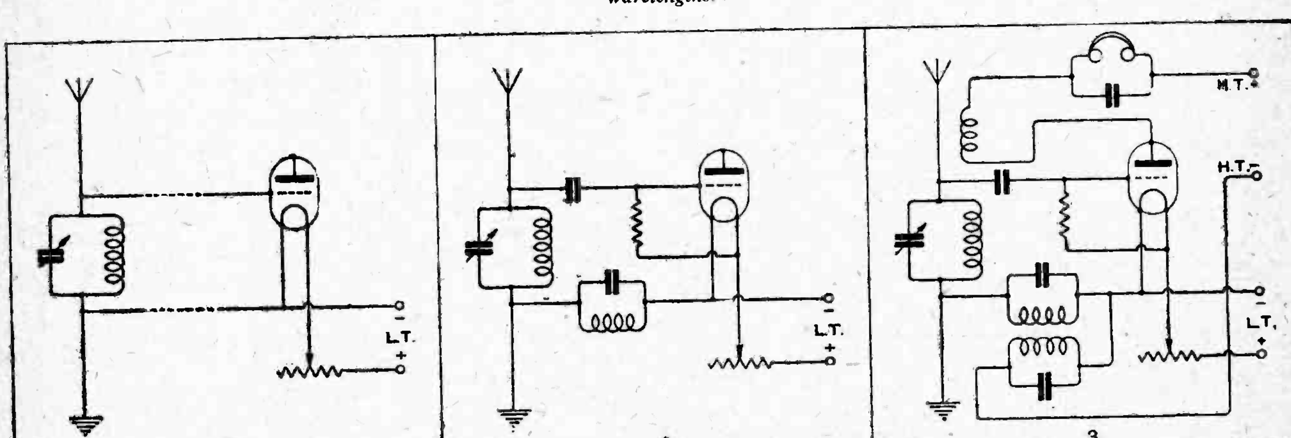
Even the best intervalve low-frequency transformers are likely to break down after a few months' use, and many cases of complete lack of signals are found to be due to a breakdown in the primary windings. Incidentally, it is understood that improved methods of manufacture are now being applied to these components, so it is to be hoped that this all-too-common trouble will soon become less frequent.

No attempt has been made to enumerate all the possible causes of failure to obtain signals; the above-mentioned faults are those which experience shows are most likely to arise in dealing with a set properly constructed with good components.

DISSECTED DIAGRAMS.

No. 13.—An Armstrong Super-regenerative Receiver.

For the benefit of readers who find difficulty in reading circuit diagrams we are giving weekly a series of sketches showing how the complete circuits of typical wireless receivers are built up step by step. The "super-regenerative" principle has great possibilities, particularly on the shorter wavelengths.



1. A tuned oscillatory circuit, connected between grid and filament of a valve. A short indoor aerial, or a frame, is often used, partly to minimise the risk of causing interference by radiation.

2. A leaky-grid condenser is inserted to give rectification, and the long-wave quenching coil, shunted by a fixed condenser, is connected in the low-potential grid return lead.

3. The plate circuit is completed through a reaction coil coupled (generally variably) with the grid coil, the H.T. battery, and the long-wave reaction coil, in the order stated.

PIONEERS OF WIRELESS.

By ELLISON HAWKS, F.R.A.S.

In this series of articles it is proposed to outline the development of wireless science and to describe briefly the researches of men who have laid the foundations of our knowledge of magnetism and electricity. The series will conclude with a short account of the discoveries of contemporary workers in the field of wireless science.

1.—William Gilbert.

THE story of the invention and development of a practical system of communication without wires is one of the most remarkable in the annals of science. Almost everyone knows that radio is not the outcome of the work of any one man, as is sometimes erroneously stated, but is the result of the labour of a number of scientists.

There is no better method of following the progress of any science than by studying the lives of these pioneers, who marked out the trail across the unknown land. In any stage play the characters make the show. The scenery and setting, whilst important, would be useless without the human element. So it is with the story of science—and more particularly so, perhaps, with wireless. By studying the lives of those who devoted themselves to the work, we are better able to appreciate how this great science has been built up, and this knowledge helps us to realise the vast amount of labour and research that has been necessary to achieve our present results. It helps us, also, to understand something of the fundamental physical laws that lie behind even the faintest click of a Morse "dot" or "dash" heard in our receiver.

William Gilbert (1540–1603).

Difficulties of Pioneer Research.

The discovery of wireless came about by gradual evolution. It was more particularly the result of the combined efforts of many eager minds, who for a hundred years had been striving to grasp the prize held out to them. Success was only made possible by persistent and thoughtful study, by the conquest of difficulties and by overcoming obstacles that were at first regarded as insurmountable. Attention to detail, and more particularly patience and perseverance, were also important qualifications of these early workers.

Fortune did not favour any one of them with chance discoveries leading by a short-cut to such brilliant achievements as radiotelephony or super-regeneration. Indeed, developments have been on lines clearly recognised in every other field of scientific achievement. Watt's invention of the separate condenser, which led to the triumph of the steam engine, was no accident. It was the outcome of close and continuous study; the final step in a long journey—a step that could never have been taken had not the road that led to it been carefully and thoughtfully traversed. Palissy's discovery of the process of enamelling earthenware, Gottlieb Daimler's internal combustion engine, the Curies' discovery of radium, the Wrights' first aeroplane. These and a hundred other instances illustrate that steady and persistent research alone results in the reward of discovery—the right to universal recognition as a benefactor to mankind or the builder of a new science.

Early Studies in Magnetism.

As everyone knows, magnetism plays an all-important part in radio. Most of us studied magnetism at school, where we learned that there are two kinds of magnets: (1) the permanent magnet, and (2) the electro-magnet. A specimen of the former may be bought at any toyshop, while the latter has a wide application, being used for many commercial purposes, ranging from ringing

The Pioneers of Wireless.—

a housebell to providing great motive power by means of large electric motors. Permanent magnets were known in olden days, and were regarded as objects of curiosity by the people of many nations. An iron ore, possessing the peculiar property of attracting iron, and called the "lodestone," is mentioned in ancient Chinese records, and is referred to by early Greek and Roman writers.

No serious study of magnetism was made until the time of Queen Elizabeth, however, when Dr. Gilbert investigated the subject and published his famous book.

William Gilbert (1540-1603), or Gilberd as he sometimes spelled his name, was the son of Hierom Gilberd, a Suffolk gentleman and Recorder of Colchester. William was born on May 24th, 1540, at Colchester, then a fishing centre on the banks of the river Colne. Little is known of his boyhood, but at 14 years of age he entered St. John's College, Cambridge, and matriculated four years later. He was elected a Fellow of his college on March 21st, 1561, and later became examiner in mathematics. In 1564 he graduated M.A. and took his degree of Doctor of Medicine in 1569, becoming a Senior of his college on December 21st, 1569. Having spent three years travelling through Europe, he took a house at St. Peter's Hill, London, and commenced to practice in 1573. Three years later he became a Fellow of the College of Physicians, of which Institution he became President in 1599. He was appointed physician to Queen Elizabeth in 1601, and to James I. on his accession, and these appointments resulted in his attaining a considerable practice.

Deviations of the Compass.

Gilbert was not content to follow medicine only, however; he was intensely interested in the magnet and in elementary electricity, and spent his spare time in studying these subjects.

At this time the behaviour of the magnet was somewhat of a mystery. Columbus and Cabot had noticed that the compass needle did not always point directly to true north. Robert Norman had discovered, too, that the needle dipped and that the dip varied according to the latitude. These phenomena were without explanation, although many theories had been advanced to account for them. Some thought the Pole Star acted as an attractive force to the needle; others that there was an immense island of magnetic ore in the Arctic, which attracted the needle. It was even told how, when a vessel approached this island, all the bolts and nails that held the timbers together flew out and the ship fell to pieces!

"De Magnete."

The credulous believed these stories, but not so Gilbert. Casting legend and superstition aside, he collected the observations of Sir Francis Drake and others of his friends, who at his request closely observed the behaviour of the compass when sailing through distant seas. In 1600 he published the result of his investigations in his famous volume *De Magnete,* which incidentally was the first great physical work to be published in England. The book commences with a summary of existing knowledge about the magnet, and gives some account of the lodestone. This is followed by an investigation into the properties of magnets, illustrated by diagrams and experiments. Gilbert deals with the power of attraction, its direction and relation to the poles of the earth, and its variation and declination. He points out the practical bearing of these points on navigation, and suggests how declination may be used in discovering latitude at sea. He comes to the conclusion that the phenomena of magnetism are explained by regarding the earth as a vast spherical magnet, and he verified this theory by experiments, which incidentally cost him £500.

De Magnete aroused considerable interest in scientific circles, and Gilbert's merit as an investigator was at once recognised, both in England and on the Continent. He did not long enjoy the reward of his labour, however, for he died of the plague on November 30th, 1603.

Although Gilbert's contemporary, Sir Francis Bacon, saw fit to belittle his work and to regard him as a man who "made a whole philosophy out of observations on a lodestone," the famous Galileo recognised his genius and scientific attainment when he wrote, "I extremely admire and envy the author of *De Magnete.*"

Thousands of listeners may never have heard of Gilbert or his work, and yet this learned Elizabethan was one of the pioneers whose researches enable us to enjoy our nightly broadcast concert or speech. He made a definite step forward in the early study of the subject of magnetism, and, with Dryden, we realise that "Gilbert shall live till lodestones cease to draw."

Calls Heard.

Extracts from Readers' Logs.

Acocks Green, Birmingham.
(November 28th to December 15th.)
Australia: 2CM, 2YI, 3AD, 3BM, 5BG, 6AG. New Zealand: 2AC, 2XA, 4AC, 4AS. South Africa: A6N. India: HBK. Italy: 1GN ('phone), 1RM, 1FC, 3TR, 1AS. U.S.A.: 6CIX, 6CTO, 9CTR, 9BDW, 9DNG, 9ZT, 9CXX, 9DBJ, 5AHP. Brazil: 1AB, 1AC, 1AF, 1AP, 1AN, 1IA, 5AB. Belgium: U3, S4, K8. Others: NISP (U.S.S. "Detroit"), NISM (U.S.S. "Milwaukee), NRDM, NFV, A7, XGB1, GHA.
(0-v-1)

F. J. Taylor.

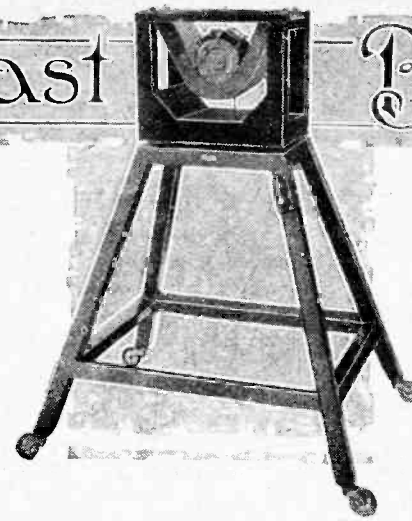
Whitman, Mass., U.S.A.
Great Britain: 2WJ, 2DX, 2LZ, 5LS, 6RY. 2NM. 2XY. France: 8EE, 8WAG. Holland: 2PZ. Italy: 1BD. Mexico: 9A, 1AA, 1AX, 1B, 1K. Hawaii: FX1. Cuba: NVE, 2JT. Porto Rico: 4RL. New Zealand: 4AR, 2AC. Australia: NRRL, 3JU, 3XO, 3BD, 2TM.

S. C. Littlefield (U. 1CMF).

Brockley, S.E.4.
(During November.)
Australia: 3EF. India: HBK. Philippine Is.: 1HR, NAJD. South Africa: O-A6N. Bermuda: BER. Brazil: 1AB, 1AF, 1AN, 1AP, 1AV, 1IB, 5AA, 5AB. Porto Rico: 4JE, 4KT, 4RL, 4SA. Canada: 1AK, 1AR, 2BE, 2BG, 2FO. Morocco: AIN, MAROC. U.S.A.: 3AHA, 3AUV, 3AVK, 3ADB, 3BCT, 3BHV, 3BNU, 3CDV, 3CKJ, 3DH, 3HG, 3HS, 3JO, 3LW, 3OH, 3QL, 3WB, 3WO, 3ZO, 4CH, 4DU, 4TV, 8ADA, 8ADM, 8AJ, 8ALY, 8AWA, 8AZU, 8BGN, 8BPL, 8BTH, 8BUK, 8CCQ, 8CCR, 8DAE, 8DON, 8EQ, 8ES, 8GZ, 8JQ, 8ZU, 9ADK, 9CJW, NAF, NDF, NISM, NISP, NFV, NKF, NPG, NTT, NVE, WIR, WIZ, WQO. Various: GFUP, GHA, GCS, S-T1.
(0-v-1.)

A. J. Perkins.

Broadcast Brevities



TOPICALITIES FROM SAVOY HILL.

Birmingham New Premises.

The new Birmingham studios and offices will be opened on January 20th. These are situated in Broad Street, opposite the Prince of Wales Theatre, and form the first and second floors of a new building.

oooo

Traffic Noises.

It is interesting to note that all new buildings in Broad Street have to be built 55ft. back from the existing building line, as it is expected that in the course of the next ten years Broad Street will greatly increase in importance, and the authorities are arranging for a wider and better street. In consequence of this the B.B.C. studios and offices are placed at a distance of 55ft. from the existing road, and therefore the likelihood of any traffic noise disturbing the transmissions is practically non-existent. In the present inadequate premises in New Street the noise from passing traffic is a vital factor.

oooo

The Main Studio.

The premises themselves are very spacious, being the biggest of any in the provinces. The main studio is 48ft. by 40ft., and is bigger than the biggest studio in London. In fact, it is so large that it is proposed to have some dividing curtains erected so that only part of the studio may be used for small orchestras, etc. This will not be done until the engineers have tested the acoustics more fully; but it will be understood that with an enormous studio such as this the B.B.C. will be able to get the best possible echo effects, according to whatever is being broadcast.

oooo

The Talk Studio.

In addition to the main studio there is a talk studio, 18ft. by 14ft. The Birmingham station will thus be well equipped in its efforts to give the best studio presentation.

oooo

The Control Room.

The microphones used will be those of Western Electric manufacture, the same as are used at the present time. A spacious control room and battery room have been provided, which will be in strong contrast to the very cramped quarters now used. There are sufficient large and airy offices to house all departments in comfort, with room to spare at the moment, although there is no doubt that future expansion will soon fill this.

A Day Younger than 2LO.

The premises are self-contained, with a very attractive entrance hall, and they will provide very excellent accommodation for the staff of the station, which, by the way, opened only one day after London, on November 15th, 1922, and Mr. Percy Edgar is the senior Station Director.

oooo

A More Powerful Transmitter.

The transmitting site will not be changed, but a new and more powerful transmitter was recently installed, as described some time ago in *The Wireless World*, so that within a space of two or three months the Birmingham station studio premises and transmitter equipment have been entirely renewed at an expenditure of some thousands of pounds.

oooo

Thousands of Letters.

If a mass of appreciative correspondence is any guide to the value which listeners place upon the broadcasts of well-known artists, the programme provided by Sir Harry Lauder on the eve of Christmas was far and away better than most other broadcasts of the year 1925. The number of letters and post-cards received ran into some thousands.

oooo

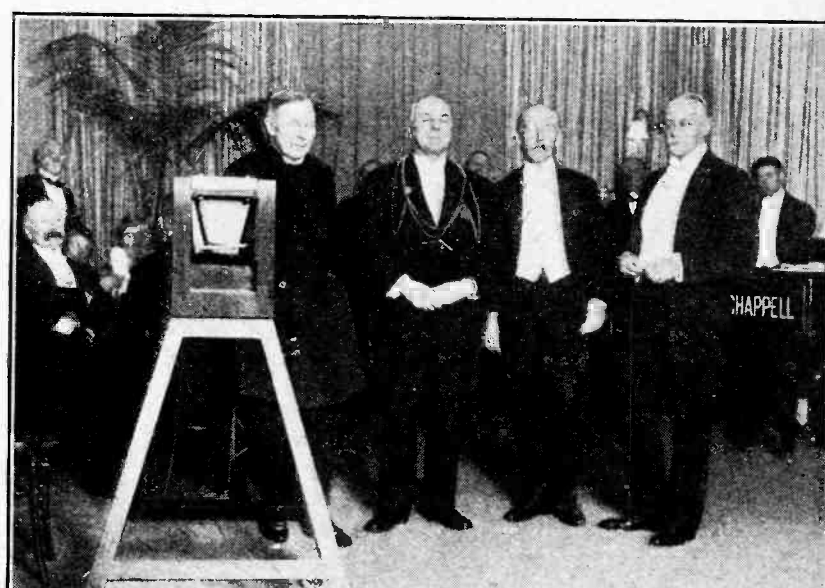
Harry Lauder's Income Tax.

One wonders, by the way, to what extent an argument may develop between the great Lauder and the Income Tax collector over the fee alleged to have been paid to the Scotch comedian by the B.B.C. The figure of £1,500 given by a newspaper was quite wrong.

oooo

Artists' Fees.

Some artists have a rooted objection to stating what fees they receive, and for this reason the broadcasting officials have made it an inviolable rule that no information shall be given on this subject.



THE NEW STUDIO AT 5NO. The largest broadcasting studio in the country was opened at the Newcastle station on Wednesday, December 23rd. The above photograph, taken on the inaugural evening, shows (left to right) Dr. Wild (Bishop of Newcastle), Councillor Anthony Oates (Lord Mayor), Sir Theodore Morison and Lord Gainford (Chairman of the B.B.C.).

The Dynamo Nuisance.

The amount of interference by motors or dynamos of lifts, power stations, etc., is increasing, and the question is asked whether legislation could be introduced in the interests of listeners to deal with the nuisance.

oooo

Ethereal Rights of Way.

It has never yet been declared that either individuals or nations have any rights in the ether. If there is such a thing activities both on the part of national governments and international forces like the Office Internationale de Radiophonie at Geneva are essential to support the holders of those rights.

oooo

Cutting In.

The position generally wants regularising. For instance, when a British station moves away from a certain wavelength, some Continental station proceeds to fill up the wavelength surrendered. An example of the confusion existing among Continental stations occurred last week. In consequence of the heterodyning of Leeds by Petit Parisien, Geneva shifted the latter's wavelength, whereupon San Sebastian immediately adopted the wavelength evacuated and matters were made worse for Leeds. The Spanish Administration has now been asked to avoid interference on British stations during main broadcasting hours, *i.e.*, from 7 to 11 p.m. This sort of thing is of almost daily occurrence nowadays.

oooo

The Broadcasting Committee (1925).

It will be interesting to read any evidence that is given before the Broadcasting Committee (1925) on the subject of alternative programmes on widely separated wavelengths. It is well known that the plans for future development provide for about ten regional stations designed to give alternative services to crystal users, with three or four relay stations to cover less important areas. Certain interests outside the ranks of listeners and broadcasting officials are opposed to the scheme and have expressed a wish to give evidence before Lord Crawford and his colleagues. Normally, one might suppose that it would be extremely difficult, if not impossible, to adduce any reasons why alternative programmes should not be made available to listeners; but apparently an attempt is to be made by the interests concerned to achieve the impossible. The Committee will want a lot of convincing.

oooo

Dublin Jamming.

Dublin station is a newcomer into the field of interference Before the station was started up the wavelength allocated to it by the Geneva Conference was 296 metres, which was almost on the ships' wavelength. Dublin therefore appears to have taken matters into its own hands and gone up to 390 metres, where it is causing trouble to Bournemouth, and if it moves up at all it will probably be too near Newcastle to be comfortable.

FUTURE FEATURES.

Sunday, January 10th.

LONDON.—3.30 p.m., Star Ballad Concert. 9.15 p.m., De Groot and the Piccadilly Orchestra.

BIRMINGHAM.—3.30 p.m., Light Symphony Concert.

ABERDEEN.—3.30 p.m., Symphony Concert.

GLASGOW.—3.30 p.m., "The Hymn of Praise" (Mendelssohn).

Monday, January 11th.

LONDON.—8 p.m., Chamber Music. 9 p.m., The Grand Hotel, Eastbourne, Orchestra.

BIRMINGHAM.—8 p.m., Classical Opera. 9 p.m., Lighter Opera.

BELFAST.—8 p.m., Italian Operatic Music. 9 p.m., Three Short Plays.

Tuesday, January 12th.

LONDON.—8 p.m., "Milestones of Dancing and Romance."

MANCHESTER.—8 p.m., "Over the Open Microphone."

Wednesday, January 13th.

LONDON.—8 p.m., New Works. 9.25 p.m., "Passion, Poison and Petrification" (George Bernard Shaw).

BIRMINGHAM.—8 p.m., Military Band Concert.

BOURNEMOUTH.—8 p.m., Celebrated Concertos and Instrumental Feature.

CARDIFF.—8 p.m., The Creative Genius—(1) The Triumph of Beethoven.

NEWCASTLE.—8 p.m., Community Singing Concert.

GLASGOW.—8 p.m., Orchestral Concert.

BELFAST.—7.30 p.m., Spain.

Thursday, January 14th.

BOURNEMOUTH AND 5XX.—8 p.m., "John Citizen at Home" and the Wireless Christy Minstrels.

CARDIFF.—8 p.m., Sea Spray (1).

MANCHESTER.—8 p.m., Lancashire Talent Series.

NEWCASTLE.—8 p.m., Pianoforte Recital by Irene Scharrer.

ABERDEEN.—9 p.m., "Cavalleria Rusticana" (Mascagni).

Friday, January 15th.

LONDON.—9.20 p.m., Percy Fletcher Programme.

MANCHESTER.—8 p.m., Old Folks' Favourites.

NEWCASTLE.—8 p.m., "Love in a Village," a Comedy by Isaac Bickerstaff.

Saturday, January 16th.

NEWCASTLE.—8 p.m., Sterndale Bennett in his own songs.

How Records are Prepared.

By the way, a board covered with tracing paper is now kept at headquarters, with the names of all known stations in Europe and the day of the month as one pair of variables of a graph, with, in addition, certain distances from which reports on a station are received, making a third variable. This enables the heterodyne position, as well as the wavelengths of all stations, to be ascertained at a glance. The board is designed to cover a month at a time, and a complete record will be obtained for the current and past periods. Another board, arranged in a similar manner, will cover various other forms of interference.

oooo

Two Theatre Broadcasts.

The broadcast excerpt from "Mercenary Mary," which was postponed owing to the Queen-Mother's death, will be relayed from the London Hippodrome on January 15th from 8.50 to 9.20 p.m. On New Year's night, "Bluebell in Fairyland" was relayed from the Chelsea Palace Theatre.

oooo

Short v. Long Wavelengths.

Although the future development of wireless is believed to be in the direction of short wavelengths, a good deal more research is needed before short waves for broadcasting are a thoroughly dependable proposition.

oooo

America's Experiences.

The experiences of station WGY (Schenectady) will be utilised in argument by the opponents of short waves. For many months past the Schenectady station has been transmitting its programmes on four waves, namely: 41.88 metres, 109 metres, 379.5, and 1,560 metres. Observations of the signals obtained on receivers tuned to these various wavelengths have shown that the longest wave transmissions are the best for relay work.

oooo

Daventry's Future.

The fact that the long wave is utilised by the Daventry station confirms the future uses that 5XX may be put to as regards international broadcasts.

oooo

"Drake" is Coming to 2LO.

Mr. Louis N. Parker, writing from Switzerland, says that he will be pleased to take part in a broadcast performance of "Drake" on January 28th, and the officials at Savoy Hill are now going ahead with the arrangements.

oooo

Hardly Suitable.

A prominent broadcasting official who took part in the opening ceremony of Newcastle's new premises had perforce to appear in the studio in the tweed suit in which he had journeyed North, owing to the carelessness of a railway servant who handed him a lady's travelling bag in mistake for his own. The bag was very similar in appearance, but as it was believed to contain articles unsuited to masculine adornment, especially in a broadcasting studio, the broadcast appeal to its rightful owner to claim it as quickly as possible and to render unto Cæsar that which was Cæsar's was like a cry straight from the heart.

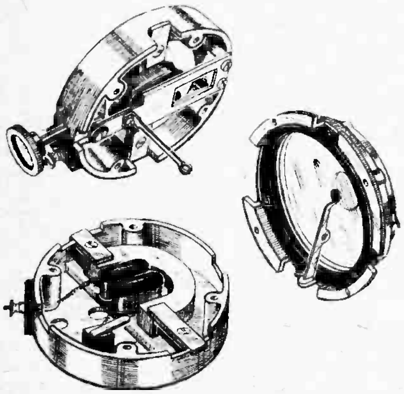
NEW APPARATUS

A Review of the Latest Products of the Manufacturers.

THE PUREMAX LOUD-SPEAKER.

A loud-speaker of original design is now marketed by Lee and Churchill, Ltd., 76, Fore Street, London, E.C.2. In general outline it resembles a typical loud-speaker of the horn type, but an examination of the base piece reveals that an entirely new method is employed for operating the diaphragm.

The illustration shows the three sections of the base lifted apart, which in assembly are placed over one another. As can be seen the lower portion carries an electromagnet of liberal dimensions and fitted with laminated pole pieces. Each spool is wound to a resistance of 1,000 ohms. Above this is assembled another section which also carries a similar electromagnet together with a reed armature, which occupies the space between the pole pieces. The electromagnetic system is thus duplicated and the polarising action of the electromagnets is arranged to influence the reed so that it is both repanelled and attracted between the pole pieces. The reed is securely clamped at one end, the other end being held between a pair of rubber buffers, the position of which is controlled by the adjusting screw.



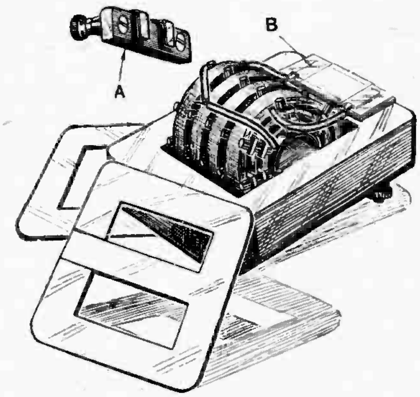
The mechanism of the Puremax loud-speaker, in which a double electromagnetic action is applied to a stiff reed and the vibrations transmitted to a mica diaphragm.

The design of the reed and the method by which it is supported obviously plays an important part in producing the good reproduction which this loud-speaker is capable of giving. The vibrations imparted to the reed are transmitted to a mica diaphragm by means of a light stiff connector, the diaphragm being set up in a very similar manner to that employed in a gramophone sound-box and is supported between rubber cushions.

○○○○

THE NEW FERRANTI TRANSFORMER.

The attention of the amateur has recently been called to a new model of intervalve transformer manufactured by Ferranti, Ltd., of Hollinwood, Lancs. The manufacturers issue a pamphlet giving full details of the performance of the transformer and the manner in which it should be operated. It is not the intention here to discuss the performance of this component on test, and details of construction only are given so that the reader will appreciate the many unique points of design which have been introduced and which undoubtedly go to produce improvement in operation.



The primary and secondary windings of the new Ferranti transformer are supported by ebonite pegs and spacing pieces, while the core departs from the usual form of construction of interleaving the stampings.

The core is of double "D" shape and is very liberal in dimensions, having a cross section area of about ⅝in. square. It is not assembled in the usual manner by interleaving strips of "E"-shaped pieces, but each lamination is a complete double "D," as shown in the accompanying drawing, and in order to permit of the insertion of the stampings about the winding cuts are made at one end of the centre piece.

The method of winding is quite unique, the turns of wire being built up into a number of air spaced sections.

Ferranti transformer type A.F.3, with a winding ratio of 1 : 3·5.

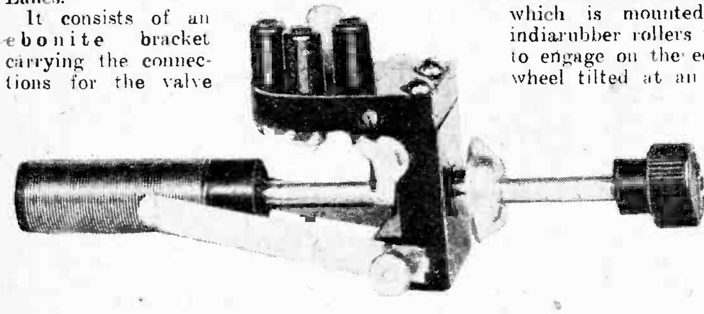
An ebonite tube which slips over the core is fitted with twelve rows of ebonite pegs, five in each row. These pegs serve as spacers between the sections and also support strips of ebonite which separate the primary and secondary windings. The sections of the secondary winding are placed centrally between the primary winding, which is divided into two main portions, and the primary is bridged with a small fixed capacity condenser consisting of copper plates and mica dielectric. The terminal strip for the primary shown at A picks up contact with the winding and the condenser B by means of clips. An iron case encloses the transformer.

It must be admitted that this component marks a step forward in intervalve transformer design, the special merit lying in the arrangement of the stampings to avoid interleaving and the method of sectioning and supporting the windings. The primary to secondary winding ratio is 1 : 3.5

COMBINED VALVE HOLDER AND FILAMENT RHEOSTAT.

The construction of receiving sets is simplified by the use of the combined filament rheostat and valve holder which is produced by the London and Provincial Radio Co., Ltd., Colne Lane, Colne, Lancs.

It consists of an ebonite bracket carrying the connections for the valve and the rheostat winding which is operated by means of a plunger between a pair of spring contacts. This component is easily attached to the instrument panel by means of one hole fixing, and the connections between valve legs and rheostat are already made. The valve holder is of low capacity type, and accidental contact between the filament pins of the valve and the anode socket of the holder is avoided by covering the contacts with insulating material, the covering for the plate connector being red.



L. & P. combined valve holder and filament rheostat.

The rheostat is obtainable in various resistance values, while it would not be a difficult matter to interchange the resistance unit when a change is made in the type of valve employed. The metal parts are nickel plated.

○○○○

ATLAS VERNIER DIAL.

Messrs. H. Clarke and Co., Ltd., Atlas Works, Old Trafford, Manchester, manufacturers of the Atlas coils, have recently produced a geared knob and dial. It is one of the first reduction geared dials of British manufacture to become available on the market and to possess an attractive appearance at least equal to any of the American products.

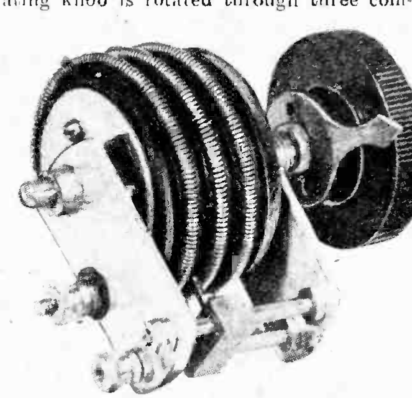
The dial is of large diameter and is controlled by two concentric knobs, one giving a quick adjustment and the other operating through gearing. The smaller knob rotates a small milled pinion which is mounted between two indiarubber rollers which are made to engage on the edge of a milled wheel tilted at an angle of about 45° to the main condenser spindle and terminating on a small rubber wheel which makes friction contact with the face of the instrument panel. The drive thus obtained does not possess the slightest degree of backlash as is usually produced when the reduction gearing consists of a train of toothed pinions.

The Atlas "Vernianob" is of large diameter and cleanly moulded in Bakelite. Critical adjustment is provided by operating through a reduction gear with entire absence of backlash.

○○○○

THE EFESCA VERNISTAT.

The need for obtaining a critical control of filament current has led to the production by Falk, Stadelmann and Co., Ltd., 83, Farringdon Rd., London, E.C.1, of a filament rheostat in which the operating knob is rotated through three complete turns in moving from maximum to the off position. The resistance wire, wound in the form of a spiral, is wrapped three times round an ebonite drum which is rotated by means of the operating knob. Contact is picked up by means of a spring carried on a metal block and supported by a pair of guides. As the drum is rotated the spring contact is caused to traverse the face of the drum.

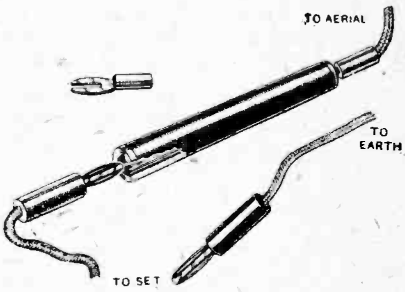


The Vernistat filament rheostat is rotated three times in moving from maximum to minimum and thus provides an exceedingly critical control of filament current.

This component has a high-grade finish, the end plates being of polished aluminium and other parts of nickel plated brass. One hole fixing is provided for attaching the rheostat to the instrument panel.

THE "RUSHTON" LEAD-IN TUBE.

This component is marketed by Messrs. J. Nicklin and Co., Ltd., Great Charles Street, Birmingham, the principal feature of the design being the provision of good spring plug connectors for the aerial wire and the lead to the aerial terminal of the set. A third plug is supplied, so that the aerial may be connected direct to earth when the set is not in use, and a spade terminal attachment enables connection to be made between any of the spring plugs and terminals on the set.



Rushton lead-in tube and earthing plug.

The lead-in tube itself is very well designed. The central conductor passing through the insulating tube consists of a metal tube riveted at each end into pressed metal caps, which space it away from the inner walls of the ebonite tube. The conductor is therefore surrounded by air dielectric where the electrostatic field strength is greatest, thus considerably reducing dielectric losses. Insulation losses are guarded against by employing ebonite tube of the highest grade.

The spring plug-in connectors are well made and give firm self-cleaning contact.

Catalogues Received.

"Star Wireless Supplies" (101, Hitchin Street, Biggleswade). Wholesale price list of Star wireless products.

○○○○

"Butterfields, Ltd." (Wireless Department, Levis Works, Stechford, Birmingham). Four-page folder dealing with Levis 1926 wireless sets.

○○○○

"H. C. Tofield, Ltd." (30, Church Street, Birmingham). Catalogue of Siren wireless receivers; also leaflet describing Siren filament rheostats.

○○○○

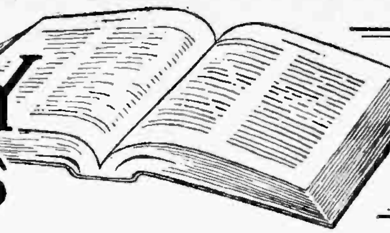
"R. Roberts, Ltd." (53, Newton Street, Birmingham). Trade price list of wireless components.

○○○○

"Gent and Co., Ltd." (Faraday Works, Leicester). Book 5, Sections 1 and 5, illustrating and describing "Pul-synetic" electric impulse clocks as used in the reception of Greenwich time by wireless.

○○○○

"Grafton Electric Co." (54, Grafton Street, Tottenham Court Road, London, W.1). 104-page illustrated catalogue of wireless and electrical accessories and components.



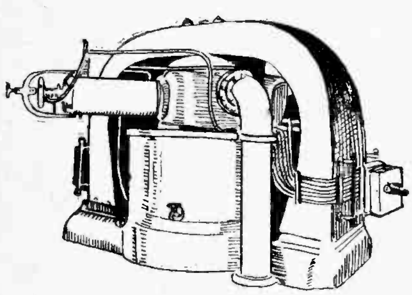
DICTIONARY OF TECHNICAL TERMS

Definitions of Terms and Expressions commonly used in Wireless Telegraphy and Telephony.

This section is being continued week by week and will form an authoritative work of reference.

Potentiometer Control (of grid voltage). A method of varying the voltage applied to the grid of a *three-electrode thermionic valve* by means of a *potentiometer* which is connected either across the filament heating battery or across a separate battery. The end of the grid circuit is connected to the *slider* of the potentiometer so that the *grid potential* may be varied at will. See GRID POTENTIOMETER.

Poulsen Arc. A special form of arc struck between carbon and copper electrodes in an atmosphere of hydrogen, used for producing high-frequency *continuous wave* oscillations for wireless purposes. The oscillations are produced in a *tuned circuit* connected across the arc, being due to the unstable nature of the arc.



Federal–Poulsen arc at the Bordeaux station.

Power. Power is the rate of doing *work*, *i.e.*, the amount of work done per unit of time. The electrical unit of power is the *watt* or *kilowatt* (1,000 watts). One watt is the rate at which work is being done, or at which *energy* is being dissipated in a circuit carrying a steady current of one *ampere* under a pressure of one *volt*. Thus the power in a circuit is given in watts by the product of amps. and volts, provided the current and voltage have steady values (cf. POWER IN A.C. CIRCUITS). In a pure resistance the whole of the electrical energy is converted into heat, and if I is the current flowing through a resistance R ohms the power is given by I^2R watts. 1 watt $=10^7$ ergs per second and 1 horse-power $=746$ watts.

Power Amplifier. A *low-frequency amplifier* specially designed to amplify speech signals up to great strength for use with powerful *loud-speakers*.

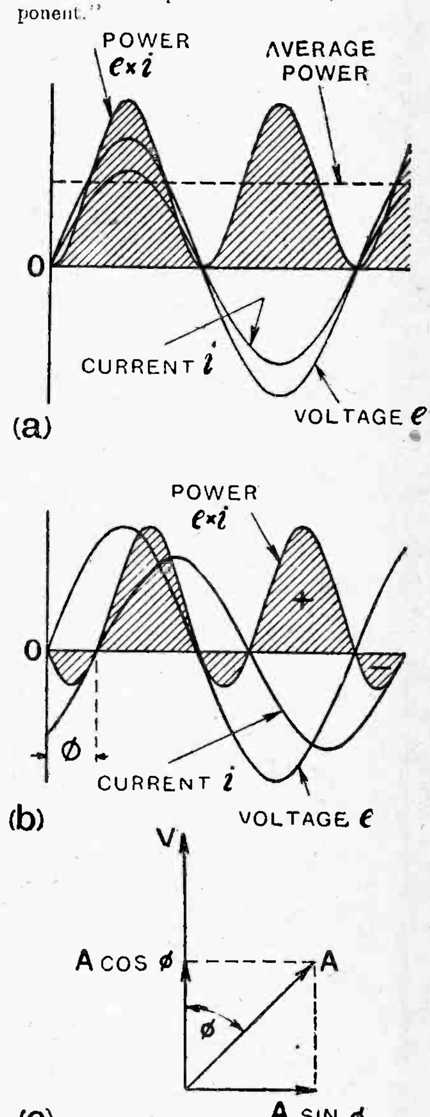
Power Component. That component of an alternating current which is *in phase* with the voltage and which, when multiplied by the voltage, gives the *true power* in the circuit. Sometimes called the "wattful component," or "wattful current" or "energy component." See POWER IN A.C. CIRCUITS.

Power Factor. A number less than unity by which the product of amps and volts (apparent power) in an A.C. circuit must be multiplied in order to give the *true power*. For sine waves it is equal to the cosine of the angle of *phase difference* between the current and voltage. See POWER IN A.C. CIRCUITS.

Power in A.C. Circuits. The average *power* in an *alternating current circuit* depends not only upon the *effective values* of current and voltage, but also upon the *phase* relation between these quantities. In a circuit where the current and voltage are *in phase* (*e.g.* in a pure resistance or a circuit tuned to *resonance*), the power at every instant is positive and it can be shown that the power in *watts* is given by the product of the effective values of amperes and volts, *i.e.*, power $=$ VA watts where A and V are the effective values of current and voltage respectively. This is the same as for a D.C. circuit, and only applies to the particular case where the current and voltage are in phase.

Where the current and voltage are not in phase (*e.g.* in an inductive circuit), the instantaneous values of the power are not all positive, and the average value of the power in the circuit is less than that given by the product of amps and volts. In this case the product of current and voltage is called the "apparent power," and in order to obtain the true power it must be multiplied by a factor whose value is less than unity. This is called the "power factor" of the circuit. When the current and voltage waves are *sine waves* the power factor is equal to the cosine of the angle of *phase difference* between the current and voltage. Thus if ϕ is the angle of phase difference, the true power is equal to VA $\cos \phi$ watts, so that for sine waves the power factor is equal to $\cos \phi$.

In terms of *rotating vectors*, A $\cos \phi$ is that component of the current which is *in phase* with the voltage and is called the "power component" of the current. The other component, which is 90° out of phase, does not represent any power, and is therefore called the "wattless component" or "idle component."



Power in A.C. circuits. (a) current and voltage in phase—power factor = 1; (b) current lagging by a phase angle ϕ—power factor = $\cos \phi$; (c) vector diagram of an inductive circuit.

Dictionary of Technical Terms.—

In a circuit where the voltage and current are out of phase by 90°, the power factor is cos 90°=0, and therefore the average power is zero, the positive energy taken over a complete cycle being exactly equal to the negative energy. Thus a perfect condenser or a pure inductance, where the voltage and current differ in phase by 90°, does not absorb any power. For this reason a current which is out of phase with the voltage by 90° is called a "wattless current."

Power can only be dissipated as heat in a circuit containing resistance, and even in an inductive circuit containing resistance the power dissipated in heat is given in watts by I^2R, where R is the resistance in ohms and I the current in amperes flowing through that part of the circuit in which the resistance is situated.

Power Valve. A *three-electrode valve* specially designed to give a large output for use in connection with a *power amplifier*. The special features are large *emission* or plate current at moderate plate voltages and a grid voltage—plate current characteristic having the straight portion as long as possible to ensure distortionless amplification. Not to be confused with *transmitting valve*.

Presspahn. An insulating material made from wood pulp and usually in the form of thin sheets which are glazed on the surfaces. It is of a fibrous nature and fairly non-hygroscopic, *i.e.*, it does not hold moisture to any great extent.

Pressure. A term very commonly used to signify electrical *difference of potential* or voltage. See POTENTIAL and POTENTIAL DIFFERENCE.

Primary. Short for *primary winding*.

Primary Battery. A battery of *primary cells*.

Primary Cell. A cell made up of suitable electrodes and chemicals so that an electromotive force is produced capable of driving a current through a suitable external circuit connected between the electrodes. A primary cell is one in which the chemicals undergo changes when current flows but which cannot be charged again electrically when all the chemicals are used up, as in the case of a *secondary cell*. In some types of primary cell the chemicals can be replaced when the cell has been fully discharged, such, for instance, as the wet *Leclanché cell*.

Primary Electrons or Primary Emission. The main emission of electrons from the filament of a thermionic valve as opposed to the emission of *secondary electrons* from the plate due to bombardment at sufficiently high velocity by the primary electrons. See DYNATRON and KENOTRON.

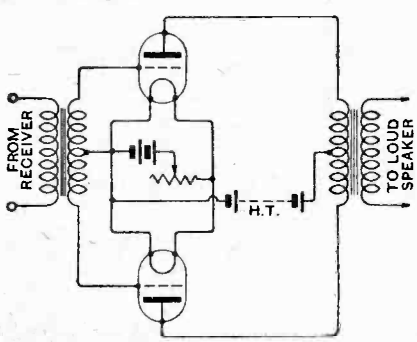
Primary Winding. That winding of a *transformer* to which electrical power is supplied, *i.e.*, the one which absorbs electrical energy from the source of supply. This is quite independent of whether the voltage across it is greater or less than that of the *secondary winding*.

Projector. A term sometimes used for "loud-speaking telephone" or *loud-speaker*.

Proton. The name given to the smallest "particle" of positive electricty which is supposed to be able to exist in a free state, just as the electron is the smallest "particle" or quantity of negative electricity.

Pulsating Current. A current varying its magnitude in a regular manner at regular time intervals, but not reversing its direction. Such a condition is met with in the plate circuit of a valve receiving a signal; the plate current varies in accordance with the received signals, but it never reverses. It really consists of an alternating current superimposed on a direct current. See OSCILLATING COMPONENT.

Push-Pull System. A system of *low-frequency amplification* applied to the last stage of an amplifier used for operating a loud-speaker. The last stage consists of two similar valves whose grid circuits are fed from a single *intervalve transformer* with a tapping taken from the centre of the secondary winding. The centre tapping is connected to the common filament circuit and the two ends to the respective grids, so that when the potential of one of the grids has its maximum positive value the other has its maximum negative value. The result is that the two plate currents vary in such a manner that their sum is always constant, but each is fed through separate halves of the primary winding of another special transformer with the primary tapped at the centre. The loud-speaker is connected to the secondary in the ordinary way.



Push-pull amplifier connections.

Pyron Detector. A *crystal detector* consisting of a contact between a crystal of iron pyrites and a metallic point, usually copper.

Q

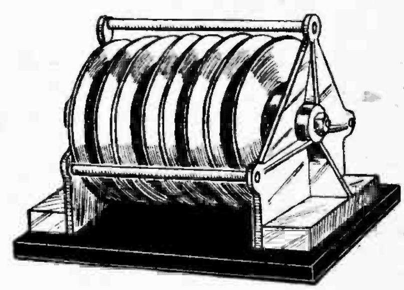
"Q" The symbol commonly used for *quantity of electricity*.

Quadrature. Two *alternating quantities* are said to be "in quadrature" when they are 90° out of *phase*, *i.e.*, when the *phase difference* between them is a quarter of a *cycle*.

Quantity of Electricity. In current electricity the "quantity of electricity" which passes a given point in a circuit is given by the strength of the current multiplied by the time for which the current flows, assuming, of course, that the current has a steady value. The unit of quantity of electricity in the practical system is the *coulomb*, and is defined as the quantity represented by a steady current of one ampere flowing for one second.

In electrostatics unit quantity of electricity or unit *charge* is defined as that charge which will exert a force of one *dyne* on an equal charge at a distance of one centimetre.

Quenched Spark. A spark passed between points in a special discharger which prevents an arc forming after the spark proper has passed. The passage of the spark is made to excite oscillations in an aerial system for spark transmission of wireless signals. The quenching of the spark is necessary in order that sharply tuned signals may be obtained.



Quenched spark gap.

Quiescent Aerial. A system of wireless telephony where the *carrier wave* is suppressed when speech is not actually taking place.

R

"R." The usual symbol for *resistance*.

Radian. The angle subtended at the centre of a circle by an arc equal in length to the radius, being equal to 57.5 degrees.

Radiating Circuit. An *oscillating circuit* of such a nature, such as an *aerial* system, that energy is radiated into space in the form of *electric waves* when an *oscillating current* flows.

Radiation. The transference of energy into space from a *radiating circuit* in the form of electric *waves* through the *ether*. The ether waves set up by an oscillating aerial are made up of two separate components, namely, the electromagnetic component and the electrostatic component respectively. The magnetic component comprises a purely magnetic disturbance in the ether, being detached loops of magnetic force propagated through space, and similarly the electrostatic component is made up of loops of electrostatic *lines of force* propagated through space. When a *frame aerial* is used for reception only the magnetic component is picked up, the signals being of maximum strength when the plane of the frame aerial is parallel to the direction in which the waves are propagated.

RADIO SOCIETY OF GREAT BRITAIN.

Survey of a Successful Year's Work.

"A BUSY and successful year" sums up the activities of the Radio Society of Great Britain during the last twelve months. The Report of the Council for 1925 was read at the Society's annual general meeting held on December 16th at the Institution of Electrical Engineers.

Early in 1925 the Society was called upon to render valuable service in connection with the "Wireless Telegraphy and Signalling Bill, 1925," which then came before Parliament. The ultimate withdrawal of the Bill was, it is considered, largely due to the Society's efforts.

The prestige of the Society has undoubtedly increased. Linked up with affiliated organisations throughout the country, it continues to be recognised as the most important national organisation for amateurs.

In December, 1924, "Experimental Wireless and the Wireless Engineer" became the official organ of the Society instead of "The Wireless World," owing to the change of proprietorship of the latter.

Standardisation of Ebonite.

The fact that a standard specification of ebonite is now available is consequent upon the efforts of the Society in co-operation with the British Engineering Standards Association. This important achievement, from which all amateurs will benefit, is being followed up by proposals for the standardisation of wireless components and apparatus.

The decision to adopt a distinctive emblem has been put into effect and badges are now available to members.

With the formation of the International Amateur Radio Union, the Society has received further distinction, three of its members being appointed officers in the Union. In April the Society once again had the pleasure of entertaining Mr. Hiram P. Maxim, president of the American Radio Relay League, and several other American colleagues.

On the social side the Society organised an annual dinner in London and a summer excursion to the Marconi Transmitting Centre at Ongar, in Essex.

Lectures of the Year.

During the session six important lectures were delivered, the speakers being Sir Oliver Lodge, D.Sc., F.R.S., Prof. C. L. Fortescue, Mr. P. K. Turner, Mr. G. G. Blake, and Mr. F. M. Colebrook, B.Sc. In addition a number of profitable informal meetings were held A Technical Advisory Committee has been formed to give assistance to all members desirous of taking advantage of its services.

The advantages accruing from the consolidated opinion of all the affiliated societies have been shown at the meetings of the General Committee of the affiliated societies. As a testimony to the value of the considered opinion of the Society, it is interesting to note that when the Imperial Communications Committee proposed the drafting of technical wireless regulations, the Society was invited to send a representative.

Thanks to the courtesy of the B.B.C., fortnightly talks have been given regularly from the London Broadcasting Station

A scheme for the registration and certification of wireless dealers and repairers is at present under consideration, but the Society recognises the inherent difficulties in working such a scheme, and very careful investigations are being made.

Membership in all branches has shown a decided growth during the year, notably in the Transmitter and Relay Section.

Transmitter and Relay Section.

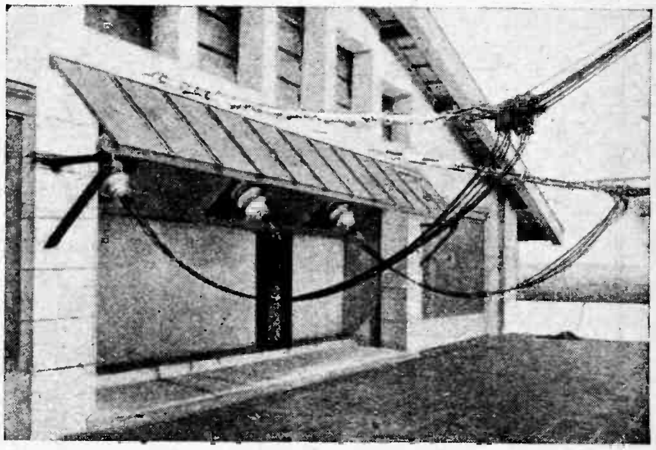
The extension of the "T. and R. Section" has been remarkable. There are now members in Africa, Spain, France, Italy, America, Canada, and India, with the result that much useful co-operation has been possible in the direction of experimental tests. Informal meetings held at regular intervals have proved a steady attraction, and while the lectures have been mainly devoted to transmission questions, the receiving side has not been entirely neglected.

In July the important decision was made to issue a monthly publication known as "The T. and R. Bulletin," devoted entirely to the interests of transmitting amateurs. This publication, which is circulated only among members of the Section, has been well received, and is responsible for a large influx of members.

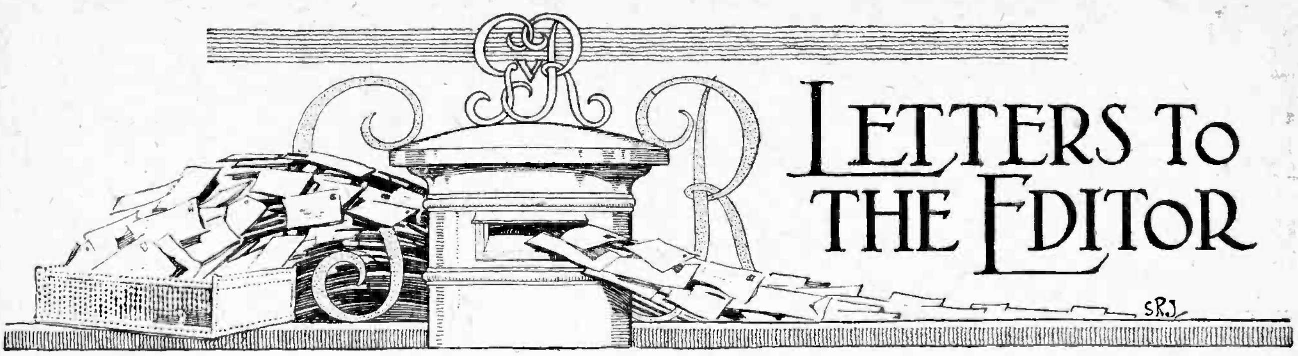
The Society's report concludes with a reference to the Schools Radio Section, which has also shown good work in the past year, notably in the organisation of a Schools Radio Exhibition in the summer, and in collaborating with the Education Department of the British Broadcasting Company.

The treasurer's report for the year ended September 30th, 1925, shows a satisfactory state of affairs, a substantial balance being carried forward.

In the coming months the "R.S.G.B." should have ample scope for a still greater extension of its activities, and amateurs will wish it well in its journeyings through the mists and uncertainties of 1926.



NO LEAKAGE HERE! The aerial lead-in at the high power station (PCG) at Kootwijk, Holland, which maintains communication on 9,000 metres with the Java station PKX. Owing to the terrific atmospherics in Java transmission has frequently to be made as slowly as ten words per minute.



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.

INADEQUATE "QSL'S."

Sir,—I feel that I must say a few words regarding the habit of asking for "wall paper" (QSL cards), which seems to be largely indulged in by a few people who possess a receiver which will go down to the 45-metre band.

During the last few weeks I have been conducting some telephony transmissions on that wavelength, and in response to each series of tests I receive literally "showers" of "ordinary" postcards (not fit for wallpaper), most of which read like this :—"You will be interested to learn that I heard you calling 'test d.c. QXV' last week-end; please QSL by card." What a useful report to receive! No date, no time, strength, modulation, or any detail whatever, and yet these people expect a QSL card in reply to their so-called "report" and do not even send a stamp for reply in most cases (I must admit some have done so), and only last week my expenditure on stamps to "QSL" people whose reports were useless amounted to 2s. 1d.

I sincerely hope that this letter will not stop people from sending in reports which contain some data, as these are always very welcome, but I sincerely hope also that unless they can "deliver the goods" in the form of reports on modulation, strength, time, date, steadiness of wave, etc., that they send a stamp for their acknowledgment.

Meanwhile I am continuing my tests on 45 metres, both C.W. and telephony, and shall gladly welcome reports of a useful nature.

GERALD A. JEAPES, G2XV.

"Chandos,"
Gt. Shelford, Cambs.

MICA COUPLING CONDENSERS.

Sir,—The increasing popularity of resistance and choke coupling prompts one to ask when are British manufacturers going to produce a mica dielectric coupling condenser of 0.15 mfd. or thereabouts, at a reasonable price? Presumably not until forced to do so by the influx of American goods, as in the case of low loss variable condensers, etc.

London. W. D. BRAID.

S.B. FROM LONDON.

Sir,—I have recently completed the construction of the two-range receiver described in your pages, and I may say that I am somewhat disappointed.

The performance of the set is all that can be desired; it is easy to tune, and brings in the 2LO and 5XX transmissions at good strength and with excellence of quality, but my complaint is that I have not by the adoption of this dual-equipped set a choice of two programmes. I find that Daventry for four-fifths of the time is relaying London's programme.

Surely the purpose of the high-power station is to provide an alternative programme, yet to the listeners in the most densely populated areas in and around London the station might not exist. Here is a station which London listeners can so easily tune in sending out a programme which is already available from the local station.

Does the fact that the London programme is invariably chosen for relay imply an inferiority of the provincial programmes?

Let us have an independent programme from 5XX to which we can tune when the London transmission exasperates us. The question of cost does not enter into it, as the B.B.C. pays, as we saw recently, stupendous fees for brief items by really first class artists.

J. T. H.

Acton.

"A TALK TO THE HOME MAKERS."

Sir,—Captain Eckersley's recent article in *The Radio Times* on the subject of home construction must have left most of his readers gasping.

A point which amateurs would like Capt. Eckersley to answer is why should he take up the cudgels for the manufacturer and deplore the effects of competition with the home constructor when, as far as I can see, Captain Eckersley is more responsible than any other man in England for any disappointment which the wireless industry may feel in the amount of business which broadcasting has produced. Let Captain Eckersley first of all put his own house in order and give up his constant advocation of the crystal set policy. A little less of that and the manufacturer would to-day be selling valve sets and apparatus on a scale which would leave the question of competition by home constructors a negligible factor.

London, N.W. C. H. S.

HIDDEN ADVERTISEMENTS COMPETITION.

"The Wireless World" Hidden Advertisements Competition, which is maintaining its popularity among our readers, will be continued from week to week until further notice.

The correct solution of the Fourth Competition (23/12/25) is as follows :—

Clue No.	Name of Advertiser.	Page.
1.	General Electric Co., Ltd.	11
2.	S. A. Lamplugh, Ltd.	4
3.	Metro-Vick Supplies, Ltd.	14
4.	H.T.C. Electrical Co., Ltd.	2
5.	J. and W. Barton	19
6.	British Insulated and Helsby Cables, Ltd.	17

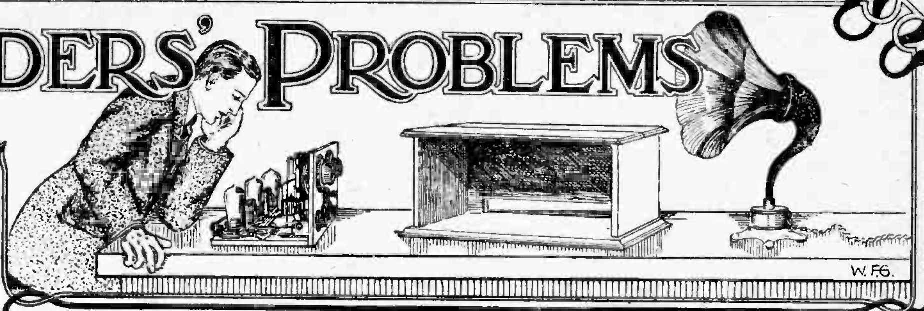
The following were the prizewinners :—

B. P. Wilner, Eltham, £5.
F. Disher, London, N.22, £2.
A. L. Rimer, Warkworth, Northumberland, £1.

Ten shillings each to the following :—

Alec Forbes, London, N.19.
John Thynne, Ilford.
M. R. Scoble, Truro.
G. W. T. Bond, Wimbledon.

READERS' PROBLEMS



"The Wireless World" Information Department Conducts a Free Service of Replies to Readers' Queries.

Questions should be concisely worded, and headed "Information Department." Each separate question must be accompanied by a stamped addressed envelope for postal reply.

A Sensitive Four-electrode Valve Receiver.

I was very interested in the four-electrode valve reflex circuit published recently in your journal, but wish to construct a straight regenerative detector receiver using a four-electrode valve, my object being the headphone reception of distant stations rather than volume on near-by stations, and I shall be glad if you could indicate to me a suitable circuit using plug-in coils. J.C.R.

The circuit which we illustrate in Fig. 1 will be found to meet your needs. Plug-in coils of the ordinary values such as would be used on a conventional single-valve receiver should be used.

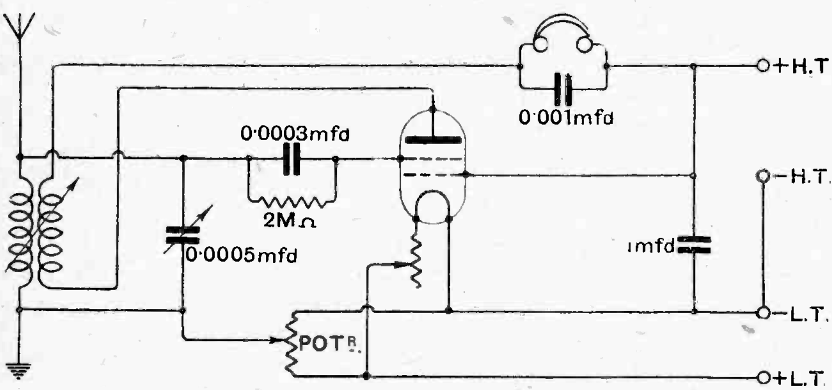


Fig. 1.—Four-electrode valve circuit for distant reception with headphones.

The instrument will be found eminently suitable for long-distance headphone reception, reaction control being specially smooth. Since four-electrode valves can now be obtained with a filament consumption of 0.06 amp., and the H.T. required is only a few volts, it is obvious that this receiver is exceptionally suitable for use where the battery problem is serious, as in country districts. The circuit also lends itself admirably to the construction of a portable receiver, since it is possible to use four flash-lamp batteries for H.T. supply, and for operating over a short period of time a similar battery may be used for L.T. supply. The reduction in H.T. voltages is obtained by connecting the inner grid to +H.T., thus diminishing the effect of space charge.

Charging Accumulators from A.C. Mains.

I have a mains supply of 240 volts 50 cycles A.C. in my house. Please inform me of the best way in which I can charge my accumulator. S.E.J.

There are four principal methods of charging accumulators from A.C. mains. First by means of a step-down transformer and a vibrator rectifier, second by means of a chemical rectifier, third by means of a valve rectifier, and finally by means of a rotary rectifier. The first two of these methods may be said to be inefficient and not to be generally recommended, whilst the reverse is true of the two latter methods. The difficulty with vibrator rectifiers of even an expensive type is to keep them in phase, they being apt to be put out of phase by any sudden mechanical "jar" with disastrous results to the accumulator, whilst even when working more or less satisfactorily the accumulator does not thrive greatly on this method of charging. Chemical rectifiers have the disadvantage of being "messy," troublesome and malodorous. Most of them rectify far from perfectly, and the reason why accumulators are charged at all by them is that they pass a somewhat greater current in one direction than they do in the reverse direction, and so there is a cumulative effect in one direction which charges the accumulator. Their efficiency is extremely poor, and except for charging very small accumulators where only a small charging current is needed, they are not to be recommended. Valve rectifiers are efficient, silent, odourless and trouble-free, but they possess one serious disadvantage, and that is that the cost of renewing the rectifying valve forms a large overhead charge which must of course be added to the cost of charging the accumulator. With regard to rotary converters, it may be said at once that they are undoubtedly the most efficient, and in the long run the cheapest, method of charging accumulators from A.C. mains. In the case of large accumulators there is no alternative method that is really practicable, and in the case of small accumulators this method is the most efficient. Unfortunately, however, the initial cost of a reliable machine is in the neighbourhood of seven guineas, but this outlay will undoubtedly be returned with compound interest during the course of a relatively short period. A good machine will run quite silently and need no attention.

○○○○

An Unusual Cause of Interference.

I have installed at my residence a system of electric clocks impulsed at every half minute by a master clock in the usual manner. Every time that an impulse is transmitted by the master clock the broadcasting programmes are spoiled by an objectionable click emitted by the loud-speaker. Can you inform me how to abate this nuisance? P.H.R.

It is evident that the impulse transmitted in the clock circuit is being picked up inductively by some lead or leads associated with the receiver. In the first place it is necessary to make sure that any leads such as loud-speaker leads are kept well away from the other leads under discussion. After making sure on this point, the usual remedies recommended in the case of interference from electric lighting mains may be carried out. Should this fail to bring about the desired result, it may be necessary to arrange that all wiring to clocks is carried out by means of lead-sheathed wire suitably earthed, if, indeed, this has not already been done. In many cases the desperate remedy of stopping the clock system during the time that reception is being carried out may have to be resorted to. Readers having electric light installations in their houses will almost invariably notice that a click is emitted by the loud-speaker when switching the light on or off, which is, of course, a phenomenon similar to that produced by the clock system, but since this does not occur periodically every half-minute, its effect usually passes unnoticed.

oooo

Advantages of a Low Resistance Loud-speaker.

I recently connected very long extension leads, consisting of about 30 yards of electric lighting "flex," to the output terminals of my receiver in order to operate my loud-speaker in a very remote part of the house. Quality, which is excellent normally, was very poor when the loud-speaker was used on the extension leads, the tone being very "woolly." Thinking it due to the fact that the capacity between the two wires of the long extension "flex" caused a large capacity to exist across the loud-speaker terminals, I unravelled the leads and ran one wire along the picture rail, the other being tacked to the skirting-board, but results were not improved. Can you assist me in finding the trouble? J.B.R.

The trouble is undoubtedly due to an excessive capacity across the loud-speaker terminals as you suggest, but a moment's thought will reveal the reason why it is not sufficient to separate the two wires. It is obvious that one wire is connected to the plate of the final valve, *i.e.*, to that side of the telephones which are at high potential, and the remaining wire to the positive of the H.T. battery; *i.e.*, to that side of the telephones which is at earth potential *with respect to audio-frequency currents.* Now, although the positive of the H.T. battery is at high D.C. potential with respect to the earth, it is at earth potential with respect to all oscillating currents, whether H.F. or L.F., since the large fixed condenser with which it is customary to shunt the H.T. battery acts as a virtual short-circuit to all radio- and audio-frequency impulses, although of course, not to D.C. Therefore, since the high potential wire is tacked to the wall, which is in intimate relationship with the earth, it is obvious that a capacity exists between the high potential wire and the earth, with the result that the higher musical frequencies are short-circuited to earth by this capacity, and distortion sets in. Exactly the same effect could be produced by shunting the loud-speaker with a large fixed condenser. Many people try to avoid the difficulty by employing a choke filter circuit or a 1-1 ratio output transformer; but, although these devices serve a very excellent purpose in eliminating the possibility of D.C. leakage by keeping the steady anode current out of the extension leads, the deleterious effect of the capacity remains unaltered. The only real safeguard in cases where a loud-speaker is to be used on very long extension leads is to employ a low-resistance loud-speaker in conjunction with the usual 10-1 step-down transformer. The low-frequency transformer possesses, also, the additional advantage shared by the equal ratio transformer of keeping the H.T. away from the loud-speaker windings. It is, perhaps, somewhat to be deplored that the modern tendency among amateurs is to look askance at the low-resistance loud-speaker, on the grounds that it introduces extra distortion. Of course, many readers find that the reverse is true, and that their loud-speakers give better results on long extension leads. The reason for this is usually that their instrument is of inferior design and actually requires a large capacity across its windings in order to make it tolerable to listen to. The remedy in your case would be to stretch the high potential wire across the various rooms through which it passes well away from walls, ceiling and floor. The remaining wire, which is at earth potential, may lead round picture rail or skirting board, or may even be placed under the carpet. In this case, then, you will be reducing the actual capacity across the loud-speaker, and thereby the effect of it, whereas the step-down transformer does not reduce the capacity, but does very greatly reduce the effect, and is much more convenient, in that it permits of double flex being led round the picture rail or under the carpet out of sight. Incidentally the low-resistance instrument is also far more robust than its high-resistance brother, and, being relieved of the steady anode current which would otherwise pass through the windings, is far less likely to burn out.

oooo

Using a Transformer as an L.F. Choke

I wish to construct a L.F. amplifier, the first stage to be choke coupled, the second stage being transformer coupled, and shall be glad if you could give me the circuit, together with any other details which you think necessary. D.B.D.

In Fig. 2 you will find the circuit which you require. Since you will in all probability be employing a general purpose valve as detector, it is important that the choke be of high inductance value, about 100 henries being a good value to aim at. There are many types of chokes upon the market which have an inductance of only 20 henries or so. Whilst quite suitable for following a low-impedance power valve, a higher inductance value is necessary after a general purpose detector valve, which usually has a fairly high impedance. An excellent L.F. choke of high inductance value can be had by connecting the windings of an ordinary intervalve transformer in series with each other. In this manner not only do we obtain the sum of the individual inductance of primary and secondary, but obtain a great increase in inductance owing to the mutual inductance present between the two windings of the transformer. It is important, however, that these windings be correctly connected in series in such a manner that the mutual inductance increases instead of decreases the total inductance. We cannot say, however, whether to join OP to IS or OS, since it differs in various makes. The correct connections are, however, quickly found by experiment, since when wrongly connected, a very low total inductance value is obtained, and both quality and volume leave much to be desired. When correctly connected it will be found that results are distinctly superior to those obtained with many types of chokes that are upon the market.

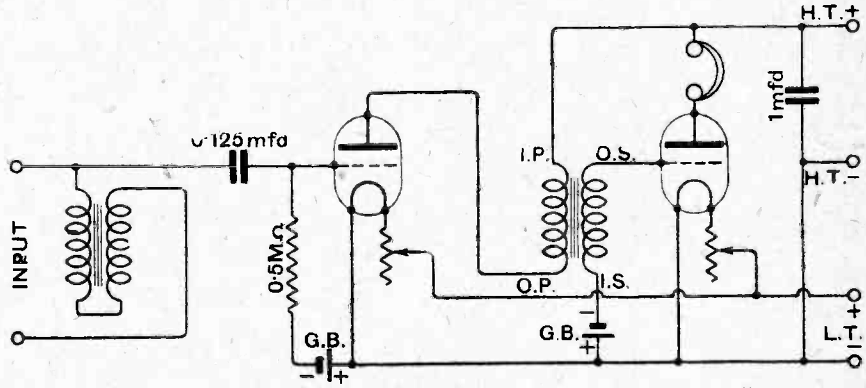


Fig. 2.—Low-frequency amplifier with choke and transformer coupling.

The Wireless World AND RADIO REVIEW

(13th Year of Publication)

No. 335. WEDNESDAY, JANUARY 13TH, 1926. VOL. XVIII. No. 2.

Assistant Editor: F. H. HAYNES. Editor: HUGH S. POCOCK. Assistant Editor: W. JAMES.

Editorial Offices: 139-40, FLEET STREET, LONDON, E.C.4 - Telephone: City 4011 (3 lines).

Advertising and Publishing Offices: DORSET HOUSE, TUDOR STREET, LONDON, E.C.4. - Telephone: City 2847 (13 lines).

Telegrams: "Ethaworld, Fleet, London."

COVENTRY: Hertford Street. Telegrams: "Cyclist Coventry." Telephone: 10 Coventry.

BIRMINGHAM: Guildhall Buildings, Navigation Street. Telegrams: "Autopress, Birmingham." Telephone: 2970 and 2971 Midland.

MANCHESTER: 199, Deansgate. Telegrams: "Iliffe, Manchester." Telephone: 8970 and 8971 City.

Subscription Rates: Home, £1 1s. 8d.; Canada, £1 1s. 8d.; other countries abroad, £1 3s. 10d. per annum.

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.

RUGBY AND THE BEAM STATIONS.

COMMENTS and correspondence appearing in the Press recently might well be taken as an excuse for conjecture as to whether the Post Office and those responsible for the erection of Rugby are not anticipating an unfavourable comparison between that station and the Beam stations for which a contract has now been placed by the Post Office. There seems to be, in our opinion, no possible reason why the Post Office should feel under any obligation to make an apology for Rugby or to seek to justify their action in erecting this station in preference to the apparently more economical but efficient Beam system which has been so much talked of during recent months.

Rugby Fully Justified.

It should be realised that Rugby has already proved itself to be an ultra-efficient station of its class, and it was, of course, designed and actually under construction before the possibilities of high efficiency from short-wave transmissions were recognised. If the Post Office had hesitated in the early stages of construction of Rugby because of the possible superiority of short waves, we venture to think that criticism would have been far more justified on account of the protracted delay in the establishment of an efficient Empire link than can possibly be the case now, even if it is proved that the short-wave system is far superior to the long-wave and more costly equipment.

Undoubtedly the Government did the right thing in going ahead as rapidly as possible with the construction and completion of Rugby, but, on the other hand, in our opinion it is regrettable to see that short-wave Beam stations are not being given their proper place of relative importance. On the one hand, claims are made for the stations which have not yet been publicly justified, but are based entirely on statements of experimental results, and, on the other hand, some persons who support the Rugby policy have endeavoured to belittle the importance of Beam stations and to imply that the Government contracts for these have only been placed so that the stations may act in a purely subsidiary *rôle* to Rugby.

CONTENTS.

The Real Position.

We should be glad to see a more honest statement of the case from both sides. The public should be allowed to understand that Rugby is a most efficient station, perhaps the most efficient of its class ever constructed, but that it was projected, designed, and partly built before the importance of short waves was realised; as for short waves and Beam stations, let us accept the possibility that, when established, these stations may prove their complete superiority over stations of the Rugby class, and, if such superiority should be proved, let us not be grudging in our appreciation of a new step in advancement whilst recognising the achievement in design and efficiency of which Rugby has already given definite evidence.

Our concern is that efficient Empire wireless communication, so long overdue, should be established, and that the system adopted should be as economical as possible without sacrificing reliability of service.

COMPOSITE REFLEX RECEIVER

Three Valve and Crystal Set

Three Stable H.F. Stages with Dual Amplification.

By H. F. SMITH.

IT is often stated that a set consisting of a detector valve with one or two stages of L.F. amplification is capable of receiving practically "everything that one needs," and adherents to this type of receiver are apt to question the advisability of going to the trouble of constructing high-frequency amplifiers. Although admittedly the detector valve with reaction, under favourable conditions, can, and in skilled hands often does, give wonderful results, the assertion that H.F. amplification is not worth while is, like most dogmatic statements concerning wireless matters, far too sweeping to pass unchallenged. The simple set may "get" the stations, but the writer ventures to think that those who have only listened on this type of receiver would be agreeably surprised to hear the comparative freedom from interference, and to experience the ease with which distant transmissions may be received at good strength on a set with two or three effective stages of high-frequency. There is a difference between merely "getting" a station and being able to appreciate the transmission.

Not the least of the advantages resulting from the adoption of tuned H.F. amplification is that the overall selectivity of the receiver increases with the number of tuned stages, which act as filter circuits. It is, in practice, hardly possible to use these filters, except as couplings between valves, due to the reduction of signal strength which is caused by their resistance. Again, if an H.F. amplifier is to be used, the coupling between the aerial and the grid circuit of the first valve may be reduced sufficiently to prevent "shock-excitation" of this circuit by signals from a powerful near-by station. Without amplification, it might well be necessary to use such a loose aerial coupling to obtain the necessary degree of selectivity that signals from the distant station would be too weak to operate the detector.

In the receiver which it is proposed to describe here, three H.F. stages are used, with a crystal detector, the output of which is passed back to the last valve; this, therefore, acts as a dual or reflex amplifier. It was considered that the difficulties inherent in the construction of a set with three tuned couplings were sufficient to warrant the inclusion of one aperiodic stage, particularly as this helps to ensure stability. It is possible so to arrange the untuned coupling that two of the valves are automatically stabilised, as in neither case need *both* their grid and plate circuits be tuned to the wavelength of the desired signal. A number of untuned or semi-aperiodic coupling devices are available; in this case the

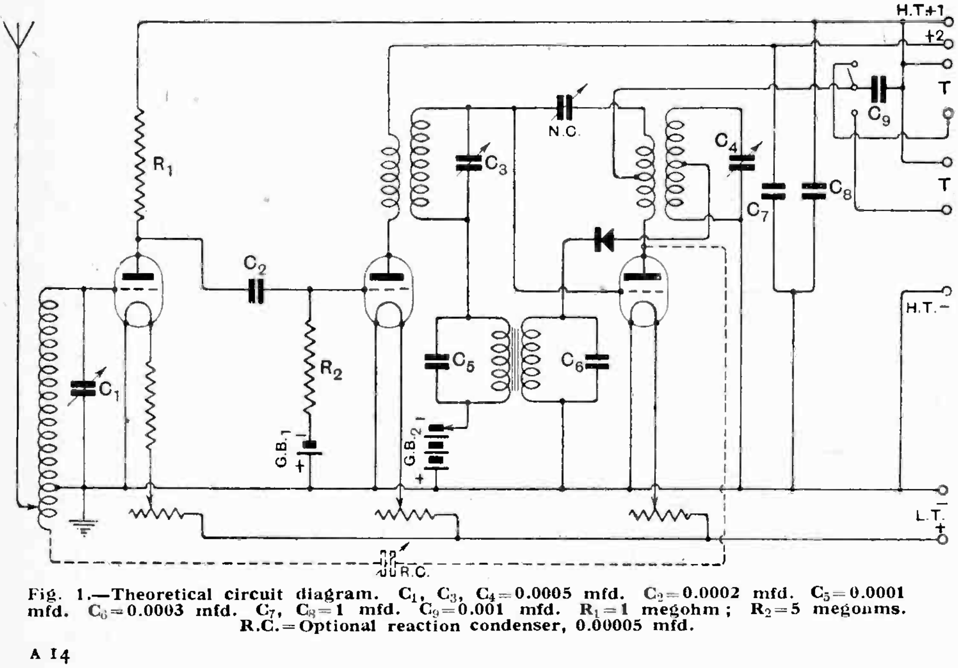


Fig. 1.—Theoretical circuit diagram. C_1, C_3, C_4 = 0.0005 mfd. C_2 = 0.0002 mfd. C_5 = 0.0001 mfd. C_6 = 0.0003 mfd. C_7, C_8 = 1 mfd. C_9 = 0.001 mfd. R_1 = 1 megohm; R_2 = 5 megohms. R.C. = Optional reaction condenser, 0.00005 mfd.

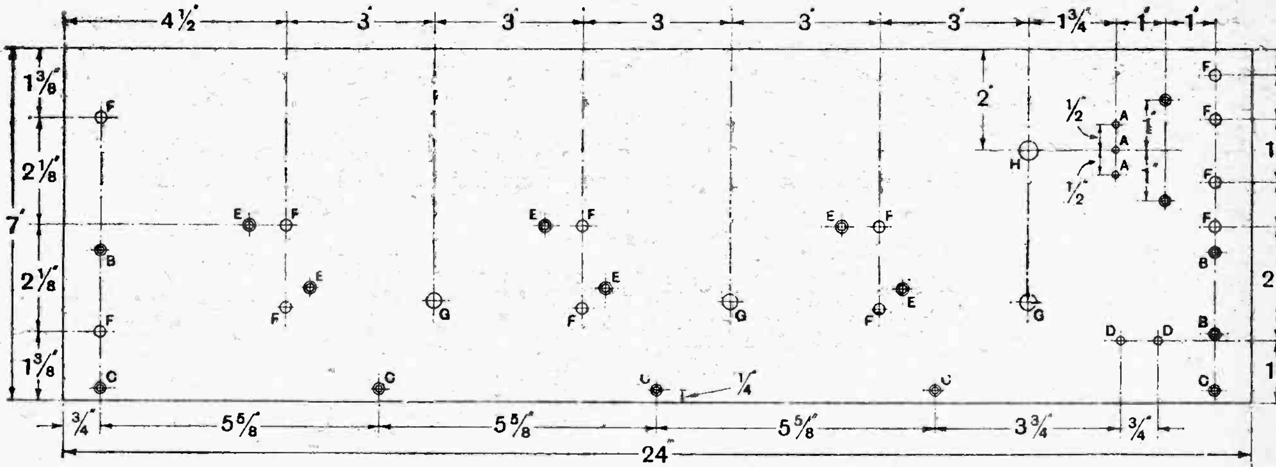


Fig. 2.—Drilling details of the front panel. Sizes of holes are as follow :—A, 1/8in. dia.; B, 1/8in. dia., countersunk for No. 6 B.A. screws; C, 1/8in. dia., countersunk for No. 4 wood screws; D, 5/32in. dia.; E, 5/32in. dia., countersunk for No. 4 B.A. screws; F, 7/32in. dia.; G, 5/16in. dia.; H, 3/8in. dia.

resistance-capacity method due to von Ardenne, and described in the issue of this journal dated September 23rd, 1925, has been adopted. Its novelty lies in the use of an exceptionally high value of anode resistance. Although no very high degree of amplification is obtainable (certainly not more than threefold at 400 metres), the method has several advantages, not the least important being that, due to the low emission required, the valve may be run at about half its rated filament voltage, and will consequently have an extremely long life. At the same time, the anode current consumed is almost negligible. To sum up, it may be said that, in spite of the small H.F. amplification obtainable from this resistance-coupled stage, its use is justified by the fact that it serves, by breaking the chain of tuned circuits, to stabilise the whole set, and that, in view of the fact that its maintenance cost is so low, the small degree of amplification obtained is by no means to be disregarded.

Referring to the theoretical circuit diagram (Fig. 1), it will be seen that the aerial circuit is not separately tuned, and is coupled to the lower end of the grid coil of the first valve, which has connected in its anode circuit the high resistance (of 1 megohm) already mentioned. Amplified voltages set up across the resistance are applied to the succeeding valve through the customary grid condenser, the leak for which should have a value of at least 5 megohms. The second valve is coupled to the third through a step-up H.F. transformer having a tuned secondary winding. As the grid and plate circuits of the third valve are both tuned, artificial stabilising becomes necessary, so a "neutrodyne" valve-to-crystal transformer has been used. The crystal detector is connected across only a part of the secondary of this transformer, and its output is passed through the primary winding of an L.F. transformer, the secondary of which is inserted in the grid return lead of the last valve, a negative bias being applied through the secondaries of both transformers, which are in series.

Resistance-coupled H.F. Valve.

Two pairs of output terminals are provided, with a change-over switch. It will generally be found convenient to keep the loud-speaker and a pair of 'phones permanently connected and to change from one to the other, depending on which form of reception is desired.

It is practically essential that the first valve should be of the low-capacity high-magnification type, so our choice is limited to the D.E.Q., or its bright-emitter counter-

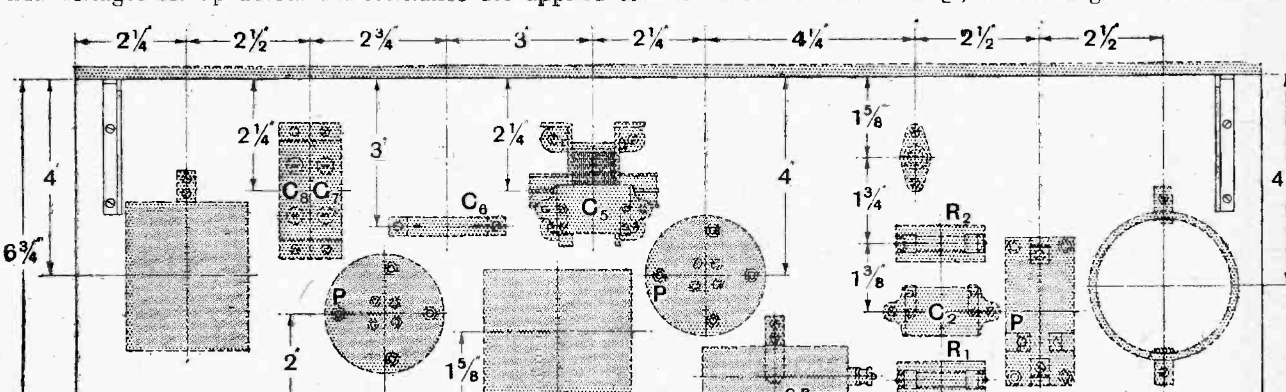


Fig. 3.—Layout of the baseboard. The neutralised H.F. transformer is fitted with a single brass bracket.

Composite Reflex Receiver.—
part; the former was used with highly satisfactory results. A special holder must therefore be provided; those on the market are, unfortunately, not designed for baseboard mounting, and so four short distance pieces of ebonite tube, $\frac{3}{8}$in. diameter and $\frac{3}{4}$in. long, must be used to give a clearance. The holding-down screws pass through these tubes.

H.F. Transformer Construction.

The L.F. transformer must be of good design, and have a high step-up ratio—either 6 : 1 or 8 : 1. Unless attention is paid to this point, loud-speaker volume cannot be expected, even from a near-by station. The last valve must be of low impedance, and it is recommended that one of the same type be used in the second position.

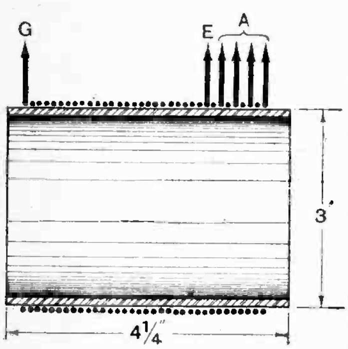


Fig. 4.—Constructional details of the aerial-grid coil.

With the exception of the three tuning coils, all the components are standard ready-made articles. The aerial-grid coil has 78 turns of No. 20 D.C.C. wire, with tappings at the 5th, 10th, 12th, and 15th turns from the bottom end. To this latter tapping point the earth connection is made, so there are actually 63 turns in the grid winding proper, with optionally 3, 5, 10, or 15 turns of aerial coil, depending on which tapping point is used. The fewer the number of turns included, the greater will be the selectivity. The former for this coil is of ebonite tube, measuring $4\frac{1}{4}$in. long by 3in. diameter, and it is secured to the baseboard by two small brass angle brackets.

The first H.F. transformer is wound on an ebonite tube measuring 3in. long by $2\frac{1}{2}$in. diameter, and has 65 turns of No. 24 D.S.C. wire as secondary winding. Over the low-potential end (remote from the grid) is wound the primary winding, spaced from it by 12 wooden strips in the manner already described in this journal. The four ends of the windings are taken to soldering tags held in position by screws passing through the tube. The primary winding has 20 turns of No. 30 D.S.C. wire, slightly spaced; but if it is desired to use a high-impedance valve the number of turns should be increased to about 35, using

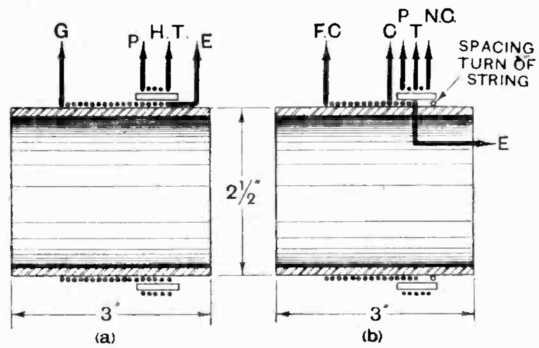
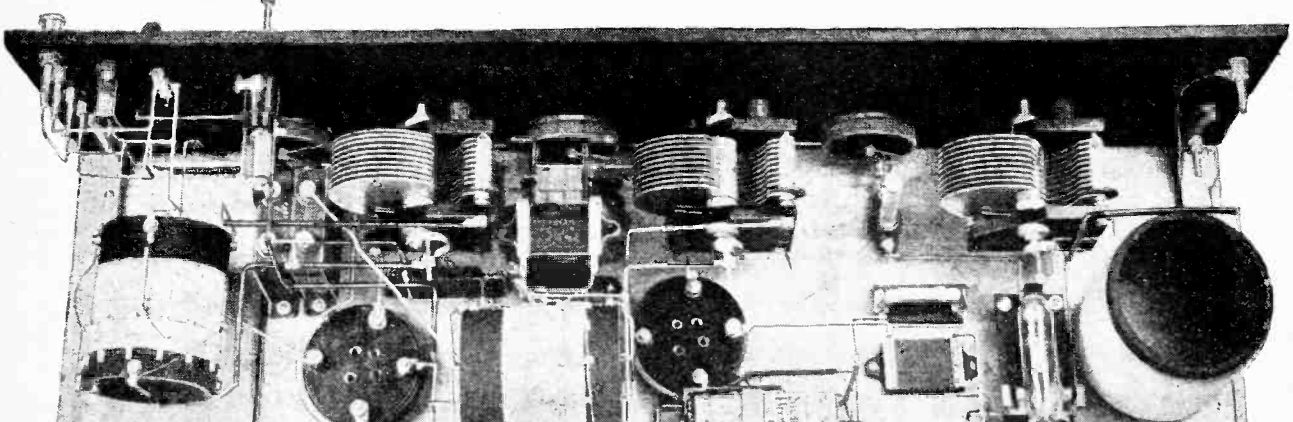


Fig. 5.—Constructional details of the H.F. transformers.

No. 36 wire. The coil is screwed to the baseboard by two $1\frac{1}{4}$in. brass screws passing through tubular ebonite distance pieces $\frac{3}{4}$in. long. The method of connecting is made clear in Fig. 5 (a).

The Valve–Crystal Transformer.

The neutralised valve-to-crystal transformer is similar to that used in the "Single Valve Loud-speaker Set" described in *The Wireless World* of December 2nd, 1925, and has 65 turns of secondary on a former of the same dimensions as that used for the first H.F. transformer. A tapping for connection to the crystal is made at the 20th turn from the end connecting to −L.T. The combined primary and neutralising windings are spaced from the secondary in the manner described above (match sticks were actually used as spacers). There are in all 40 turns of No. 30 D.S.C. wire, tapped at the 20th turn for the H.T. + connection. Consideration of Fig. 5 (b) will show the method of construction and connecting up. In



View from above. Note that the condenser C_5 is resting on the L.F. transformer, supported by its own wiring.

Composite Reflex Receiver.—
this case, again, the lettering of the connections corresponds to that of the practical wiring plan.

The main panel and the small terminal panel should be drilled in accordance with the dimensions given in Figs. 2 and 7. The various components may now be mounted both on the panel and baseboard; the positions for those attached to the latter being as shown in Fig. 3.

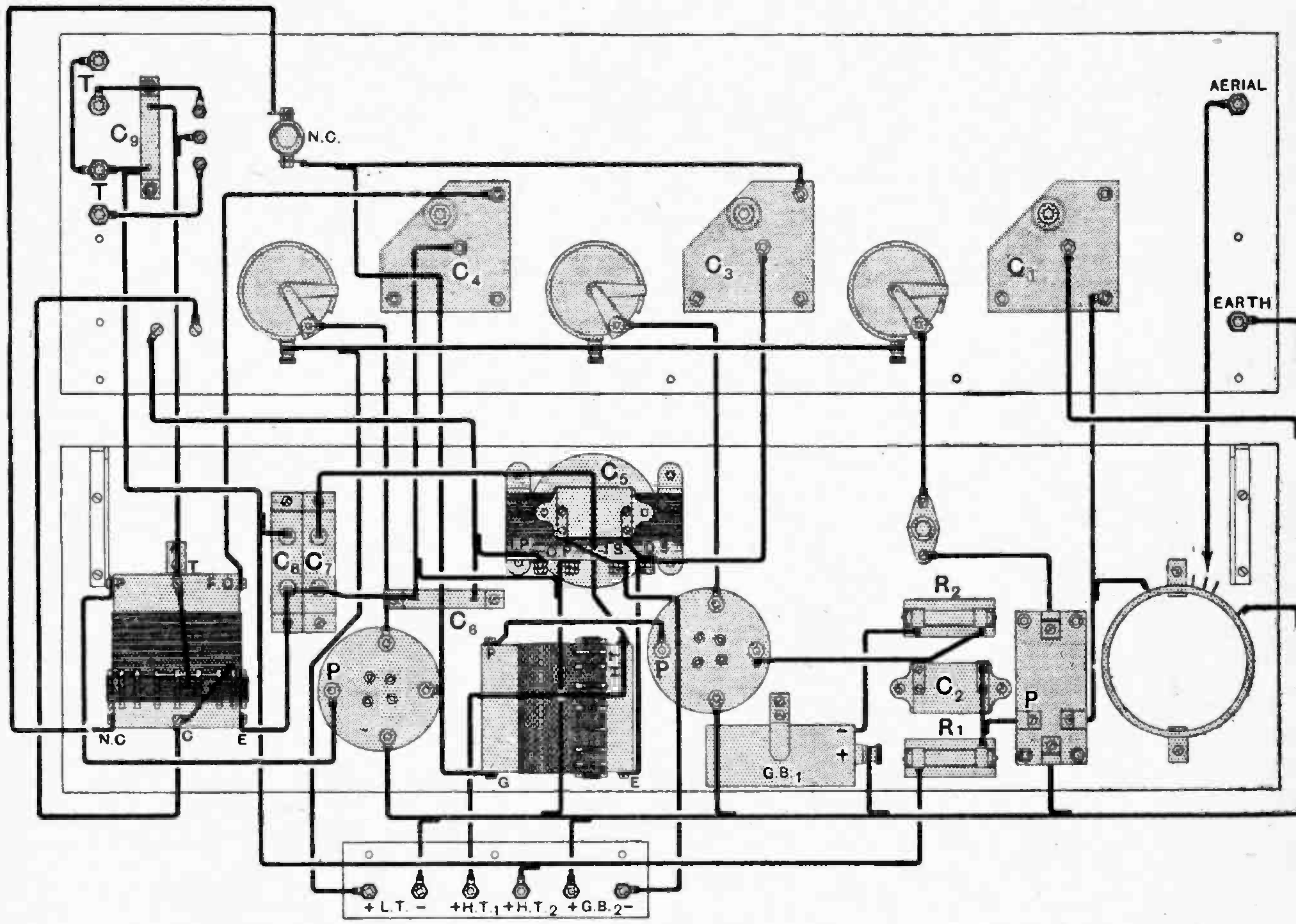


Fig. 6.—The practical wiring diagram. The lettering on the transformers corresponds to that shown in Fig. 5.

Particular care should be taken to allow the full amount of spacing between the high-frequency coils, and to mount them in the relative positions as shown.

Before screwing together the panel and baseboard, it will be as well to put on some of the wiring in the less accessible positions, particularly on the filament rheostats. Where necessary, insulating sleeving is used to prevent risk of short-circuiting. Following the usual practice, wires at low H.F. potential are carried low down on the panel and baseboard, while plate and grid leads are well spaced, and kept as short as possible.

Use of Reaction.

It was found, on test, that the set as described was so perfectly stable that a certain amount of reaction could with advantage be applied. Its use detracts to a certain extent from the simplicity of operation, so it was decided to leave the question of its adoption to the discretion of the constructor. Reaction may most conveniently be applied by joining the plate of the third valve to the lower end of the aerial winding through a small vernier condenser with a maximum capacity of about 0.00005 mfd. This condenser may be mounted on the panel immediately above the first filament rheostat. As the voltage of the H.T. battery will be applied across it, there must be no risk of a short-circuit between its fixed and moving vanes. Wiring to this condenser must be well spaced from the other leads, as the connections are unavoidably rather long. They are shown in dotted lines in Fig. 1.

Resistances of the grid leak type, of the particular make specified, were used, as the manufacturers state that they are capable of carrying the small current, amounting to about 0.1 milliampere, flowing in the anode circuit, without undue change of resistance value.

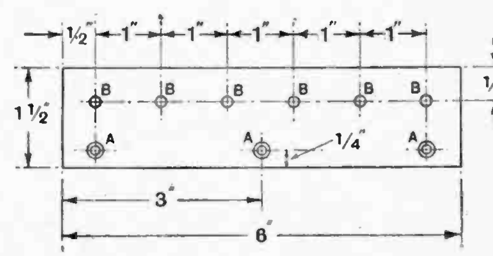
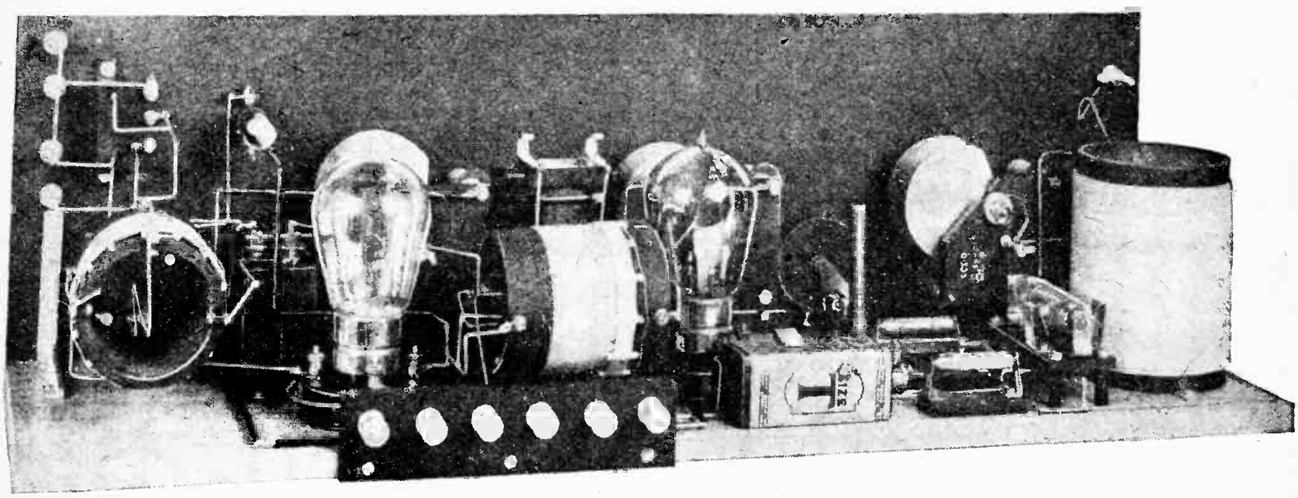


Fig. 7.—The terminal panel. A, 1/8in. dia., countersunk for No. 4 wood screws; B, 5/32in. dia.

LIST OF PARTS.

1 Cabinet (Carrington Manufacturing Co.).
1 Ebonite panel, 24in. × 7in. × ¼in.
1 Ebonite panel, 6in. × 1½in. × ¼in.
3 Variable condensers, slow motion, 0·0005 mfd. (A.J.S.).
1 Baseboard, 24in. × 6⅝in. × ⅜in.
1 L.F. Transformer, 6 : 1 ratio (Pye).
2 Valve-holders, base mounting (Igranic).
1 Valve-holder, V.24 type (G.E.C.).
3 Rheostats, wire-wound (Lissen).
1 Fixed condenser, 0·001 mfd., type 600A (Dubilier).
1 Fixed condenser, 0·0003 mfd., type 600A (Dubilier).
1 Fixed condenser, 0·0002 mfd., type 600 (Dubilier).
1 Fixed condenser, 0·0001 mfd., type 600 (Dubilier).
2 1 mfd. condensers (T.C.C.).
1 Pair panel brackets (Dew).
1 Resistor socket, with resistor (Burndept).
1 Dry cell, "T" size (Siemens).
2 Grid leak bases.
1 Crystal detector (G.E.C.).
1 Grid leak, 1 megohm (Ediswan).
1 Grid leak, 5 megohms (Ediswan).
1 Switch, S.P.D.T. (Radio Components, Ltd.).
1 Neutralising condenser (Polar).
1 Ebonite tube, 3in. diameter, 4½in. long.
2 Ebonite tubes, 2½in. diameter, 3in. long.
Terminals, screws, connecting wire, small quantity No. 20 D.C.C., and No. 30 and 24 D.S.C. wire, etc.

Assuming that a D.E.Q. valve is to be used in the first position, the fixed resistor in series with the filament rheostat should have a value high enough to drop the actual voltage on the valve to about 2 volts, which can, if necessary, be still further reduced by turning back the rheostat. A fixed resistor will of course be unnecessary if a 2-volt accumulator is used, and in any case it may be omitted if a 30-ohm variable resistance is used. From the point of view of safety its use is, however, desirable. As explained above, a low impedance or general purpose valve may be used in the second position, while a small power valve is essential in the reflex stage.



Rear view of the receiver. The method of fitting the low-capacity valve-holder is clearly shown

Supply Battery Voltages.

Two positive high-tension terminals are provided, one for the first and last valves, which require from 100 to 120 volts, while about 60 volts is applied to the second high-frequency amplifier. The grid bias of this valve is supplied by the single cell mounted in the receiver (it is secured to the base by a spring clip), while the reflex valve is biased by an external battery connected to the terminals as shown in Fig. 6. The voltage in this case will, of course, depend on the value of high-tension applied, and will generally be about 4.5 to 6 volts.

The three condensers are turned until the local transmission is heard, when the crystal should be carefully adjusted for best signals. As the H.F. circuits are brought into tune the set will normally oscillate; this tendency is corrected by adjustment of the neutralising condenser. If reaction is used, the small controlling condenser (R.C. in Fig. 1) should be set at zero when making these preliminary adjustments.

Tuning Adjustments.

To search for distant stations, the three tuning condensers must be simultaneously adjusted. This, at the first attempt, will be found rather difficult, as unless all circuits are in tune the set will seem "dead," and reaction will have no effect. As soon, however, as a few stations have been picked up, this difficulty will disappear, and the operation of the set will be found quite simple and straightforward. It must be realised that *simultaneous* adjustment is necessary, and this is best effected by turning each dial a degree or two at a time. Even if there are no signals or even atmospherics coming in on the wavelength to which the receiver is tuned, a slight breathing sound will indicate the fact that all circuits are in resonance. Careful records should be kept of the adjustments corresponding to the various stations; this will greatly facilitate the process of searching for other transmissions on neighbouring wavelengths. A station once "logged" may easily be tuned in on subsequent occasions.

Composite Reflex Receiver.—

The set as described will cover a wavelength range of from approximately 200 to 550 metres, thus including in its scope practically all the broadcasting stations operating on the normal band. It was not considered worth while to introduce the complications necessary to provide for interchangeable coils for longer wavelengths.

As was to be expected, it was found that the efficiency of the set was at its greatest on the upper half of the broadcast band. At the higher frequencies, however, its performance was extremely good; the speech transmissions from the Goodwin lightships, on about 220 metres, were received at very good strength. These stations always provide an excellent test of sensitivity on the shorter wavelengths.

Loud-speaker reception must not be expected, except from a comparatively near-by station, as there is only one reflex stage of low-frequency magnification. If extra volume is desired, a single-valve power amplifier may be added as a separate unit, or included in the set.

As already indicated, selectivity may be increased by reducing the number of turns in the aerial circuit. The best position should be found by trial; the flexible lead from the aerial terminal may then be permanently soldered to the tapping point which is found to give best results.

It is recommended, when adjusting the crystal, that the second H.F. circuit be slightly distuned; otherwise one is apt to get a false idea as to whether the best setting has been found. The tapping point for the crystal on the neutralised transformer may also be varied, but this is hardly likely to be necessary if ordinary treated galena is used.

MEASURING SMALL CHANGES OF CURRENT.

Methods of Increasing Accuracy and Sensitivity.

By E. H. W. BANNER, M.Sc., A.Inst.P.

NO indicating measuring instrument will read accurately a change of current of less than 0.1 per cent., and the usual laboratory or test-room instruments are only good for changes not less than about 0.5 to 1 per cent.

Some time ago it was required to ascertain if the current in a circuit remained constant when other conditions were altered, and it was required also to read to much closer than 0.1 per cent (or 1 in 1,000) in order to be able to state that no change occurred.

The best indicating instrument obtainable was a sub-standard guaranteed to be within ± 0.2 per cent., but this was far too insensitive for the purpose. It was finally accomplished in this manner. A reflecting galvanometer of high resistance and sensitivity was obtained, the calibration being about 300 millimetres per microampere at one metre scale distance. The sensitivity was increased directly by removing the galvanometer to a position about two metres from the scale; the spot of light was out of focus on the scale, but as the test was a null one this did not matter.

In order to take the current—in this case about 0.7 ampere—the galvanometer was short-circuited by a thick piece of copper wire, the actual length being adjusted until the galvanometer gave about full-scale deflection. All alterations had to be made with the current off.

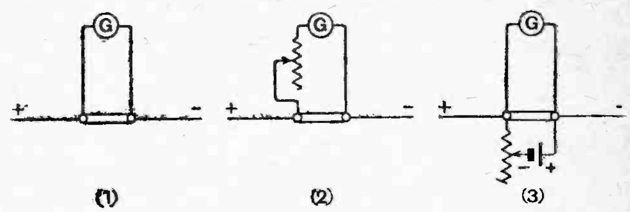
This was taken as a datum, or displaced zero, and any movement of the spot from this position showed a change of current, the absolute value being unknown from this reading. The sensitivity was far better than 0.1 per cent., and for any case it can be calculated.

It is $\frac{d}{l}$ where d is the smallest change of the position of the spot that can be read, and l the length of the scale. With a good spot d is about 0.1 mm. for a good observer, and should not be greater than 0.5 mm. in any case. The scale length, l, can usually be about two metres, and so a change of deflection of 0.1 mm. in two metres corresponds to a sensitivity of $\frac{0.1}{2,000}$ or 5 in 10,000, or 0.005 per cent.

There are two means of increasing the sensitivity still further. When the shunt is adjusted to give about full scale deflection the zero adjustment of the galvanometer may be set to bring the spot back towards the true zero (*i.e.*, with no current passing). The shunt may then again be decreased until the spot is at the full scale deflection. It will be seen that if the zero adjustment has been sufficient to bring the spot right back to the true zero and then the spot brought back to its full-scale position, the effective length of scale is twice the measured length, and the sensitivity is also twice the previous value.

The other method is to bring the galvanometer to true zero by balancing its current against a current from a local battery passed through the instrument in the reverse way. The sensitivity is again increased.

With either of these last two methods it is necessary to vary the current to be measured gradually, as a sudden switching on or off is likely to give the instrument a bad kick which might easily break the suspension.



(1) Plain galvanometer circuit with low resistance shunt. (2) High-resistance rheostat connected in series with galvanometer for fine adjustment of sensitivity. (3) Local battery and rheostat for balancing out the main current.

In the diagram (1) shows the plain circuit, and if a high resistance rheostat is included in series with the galvanometer, as in (2), fine adjustments of deflection may be obtained directly. The diagram (3) shows the "balanced" method, where the measured current is balanced out or neutralised by the local battery and rheostat. An accumulator is preferable to a dry cell on account of the unsteadiness of the latter when on load.

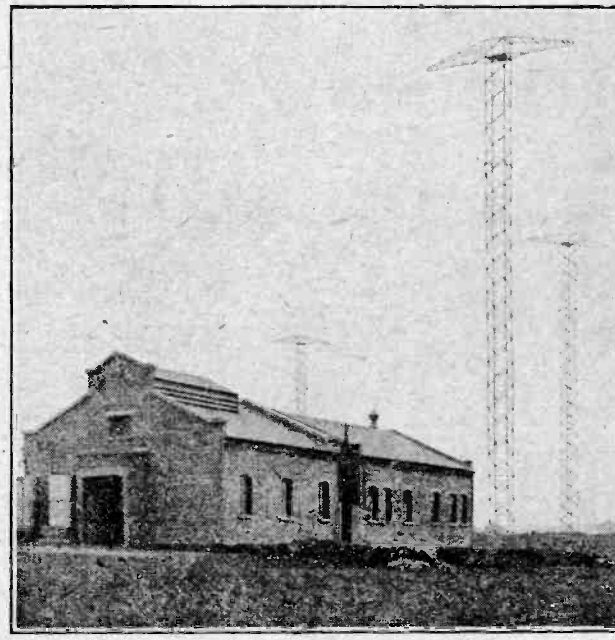
IMPERIAL WIRELESS DEVELOPMENTS.

Progress with the British Beam Stations.

THE year just begun bids fair to be one of the most important in the history of commercial wireless telegraphy. Before many months have passed, the first of the new Marconi beam stations will be brought into operation, and in the course of the year direct high-speed wireless services on the beam system will be established with all the principal Dominions.

The first of these beam stations—for communication with Canada and South Africa—are in an advanced state of construction.

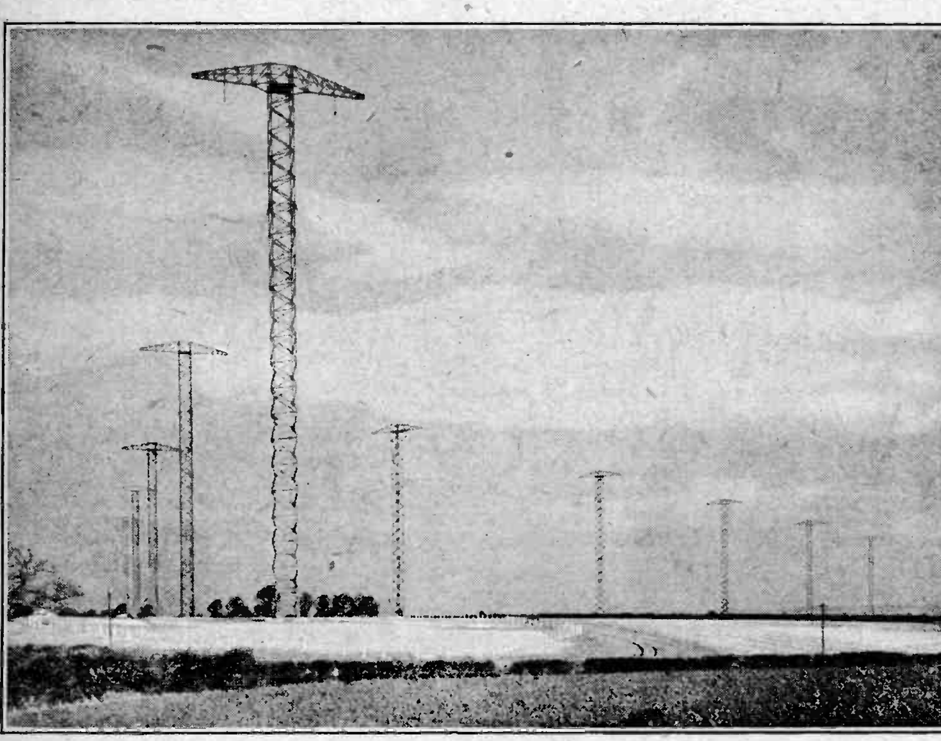
The stations now nearing completion are at Bodmin, in Cornwall, and at Bridgwater, in Somerset. That at Bodmin will be the transmitting station used for communication with Canada and South Africa, the Bridgwater station being the receiver for these services. At each station there are ten masts—five for communication with each Dominion. The design of the masts is identical for the transmitting and receiving stations.



The newly-completed station building at Bridgwater, with three of the masts. Bridgwater is the beam receiving station, Bodmin constituting the transmitter.

The Aerials and Reflectors.

The five masts for each Dominion are erected in a straight line at right angles to the direction in which communication is to be established. These masts are 277ft. high, each having a cross-arm at the top measuring 90ft. from end to end. The aerial and reflector will consist of a number of vertical wires suspended from triatics attached to the cross-arms of the masts. There will thus be two parallel steel cables, separated by a distance dependent on the wavelength used, running on each side of the masts from the first to the last. From these cables the vertical aerial and reflector wires will be suspended, the lower ends of the wires being kept in position by balance weights. The distance between the masts is 650ft. from centre to centre, and the length of the whole system of five masts for each transmitter about 3,200ft. from tail anchor block to tail anchor block.



Another view at Bridgwater. The five masts on the right will support the aerials for reception from Canada, those on the left from South Africa.

At Bodmin transmitting station all the power required will be generated on the site. The various voltages required for the operation of the valves will be supplied by motor generators and alternators. The valves themselves will be of the oil-cooled type, and the complete valve transmitters will

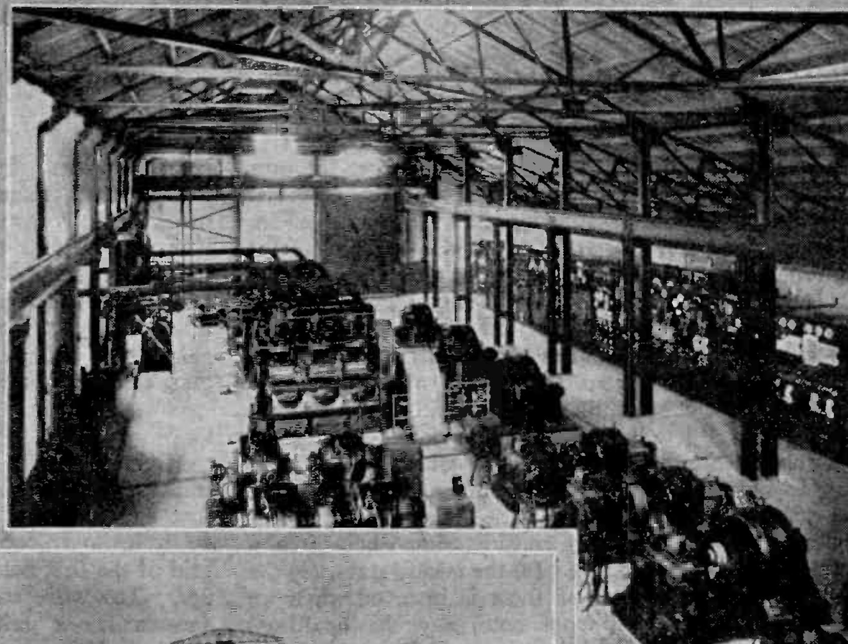
Imperial Wireless Developments.—be housed in a separate room adjacent to the power-house. The generating plant has been mounted on a concrete raft supported on cork to prevent vibration being communicated to the transmitting set, and the valve oscillators themselves are mounted on a similar raft. From the transmitting room, feeders are led to the aerials by means of copper tubes fixed above the ground.

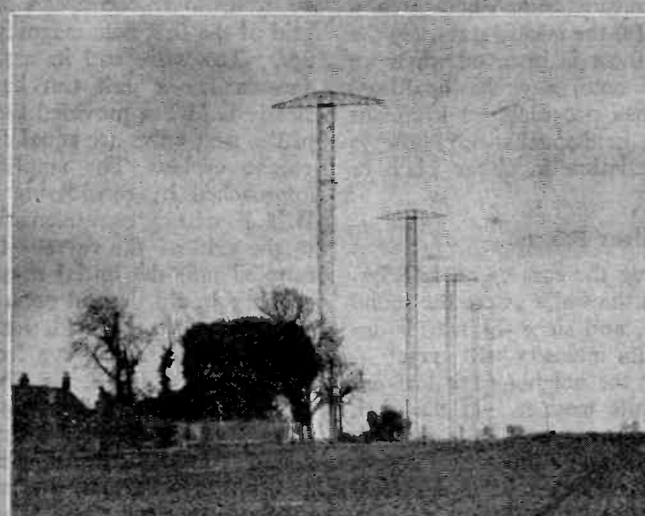
At the Bridgwater receiving station power is supplied by 18 h.p. two-cylinder Aster engines driving the D.C. generators which supply the station with light and run the motors for charging the receiver batteries.

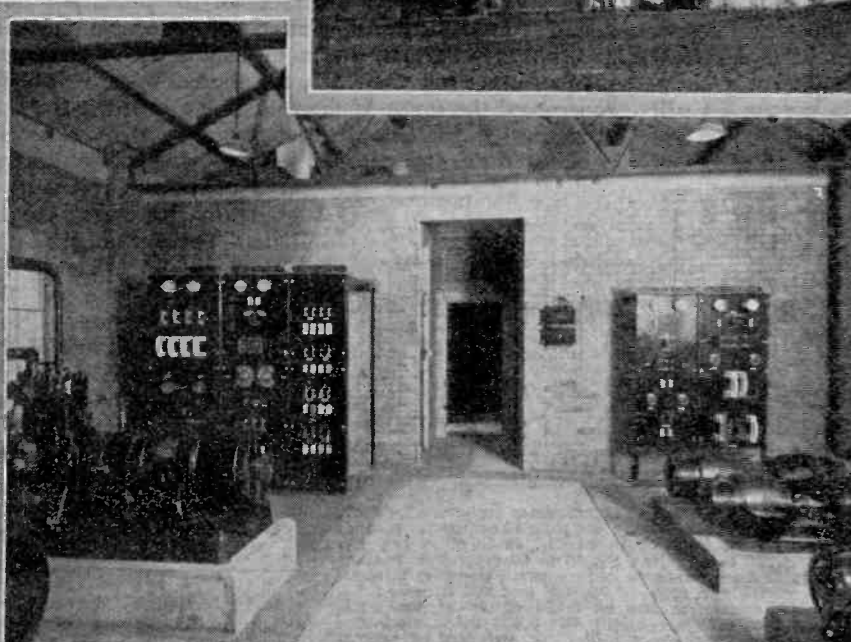
Both transmitting and receiving stations will be connected by direct land lines with the Central Telegraph Office, G.P.O., London, and the transmitting station will be operated from London by distant control.

In addition to the advantage possessed by the beam system of concentrating energy in one direction, the speed of working and freedom from interference have been greatly increased. These stations thus open up possibilities with regard to Imperial communications which have never before been available and which have been the ambition of the Dominions for many years past.

The corresponding stations in Canada, near Montreal, and South Africa, near Cape Town, are in practically the same state of advancement as the English stations, and similar stations of the Imperial system are being erected at Grimsby and Skegness, in England, for communication with other stations at Poona, in India, and Melbourne, in Australia.







Photos. Courtesy of Marconi's Wireless Telegraph Co., Ltd.

(Top) The machinery hall at the Bodmin beam transmitting station. The alternators and generators are seen in the foreground.

(Centre) The "Canadian" masts at the Bridgwater station.

(Bottom) Switchboard and generators at the Bridgwater receiving station, for supplying light and charging the batteries.

SPEECH AMPLIFIER DESIGN.

Reducing Distortion in L.F. Chokes and Transformers.

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

IN comparing various types of loud-speaker, it does not always occur to the listener that the amplifier plays an important function in the acoustic effect. The room also plays its part, but we will omit this in the meantime, because it is much easier to alter the amplifier characteristics and note the effect than it is to do likewise with the acoustic properties of the room. We hear a good deal about distortionless amplification. Taken in a relative sense, the term distortionless may be regarded as meaning that one amplifier or a certain class of transformer yields "less" distortion than another. But in the absolute sense there is no amplifier which is distortionless. In fact, the majority of amplifiers distort probably more than their owners are aware. There are two salient physical states which require consideration when discussing the problem of distortion : (*a*) the steady state, (*b*) the transient state. The first of these is involved when we listen to a steady continuous note, say the broadcast tuning-in note. The conditions—provided we keep our heads still when listening to a loud-speaker—are always the same, and there is no variation in either pitch or intensity.

Nature of Transient Effects.

Motion of the head may bring the ears to an interference zone due to reflection from the walls where the sound is of greater or lesser intensity, and since the note is impure, its character as well as its intensity will vary.[1]

Moreover, the air pressure in the neighbourhood of our ears varies in a perfectly definite manner. If the pitch of the note is 1,500 vibrations per second, the air will go on expanding and contracting 1,500 times per second, each separate expansion and contraction being identical with its successor and its predecessor. In other words, the physical conditions under which the note is sounded will remain unaltered throughout its occurrence. The second and more important physical state to which allusion was made occurs at the beginning and at the end of any sound whatsoever. In playing a note on any instrument, say the violoncello, there is always a transition or intermediate stage between the first application of the bow and the fully sustained note. This is clearly due to the mechanical inertia of the moving parts. Similarly, when the bow ceases to move, the motion of the string has to be damped out, and this takes time, even if it is of short duration. Again, when the pitch or the intensity of a note alters, there is always a transition stage. Moreover, music in general consists of a series of transients. The severity of a transient may broadly be measured by its rate of change. Thus a transient is severe if the rate of change of air pressure—either increase or decrease—is rapid, *e.g.*, pianoforte playing, ordinary speech, the chiming of bells, the beating of drums, the firing of a gun, rattling of coins, or turning over a sheet of paper.

Transients in Electrical Circuits.

We come now to the reproduction of steady sounds and transients by electrical means. Assume for simplicity that equal steady E.M.F.s, varying in frequency from 20 cycles to 10,000 cycles per second, are applied to the grid of the first note magnifying valve of a speech amplifier. The valve and its associated transformer or resistance-condenser unit can be considered distortionless to steady E.M.F.s provided the voltages applied to the grid of the next valve are equal for all frequencies from 20 to 10,000 cycles. The amplification of transients can be approached by considering what occurs when a steady E.M.F. of any convenient frequency is suddenly applied to the grid of the valve. In the case of a transformer coupled unit the initial shape of the current through the primary would depend upon the initial phase of the voltage applied to the grid, *i.e.*, the application may occur at any point of the wave from 0° to 360°, and upon the ratio L/R, where L is the primary inductance under actual conditions and R is the internal resistance of the valve *plus* the effective resistance of the primary. Both L and R are actually differential values concomitant with a variation in current, due to the unidirectional nature of the feed current to the valve, the alternating current being superposed thereon. If the voltage is applied to the grid at zero value, the amplitude of the first current wave will be greater than succeeding waves,[2] whereas application at a phase of 90° entails a gradually increasing amplitude. These phenomena are due chiefly to electrical inertia in the form of the primary inductance. Now the secondary voltage of the transformer which is applied to the grid and filament of the next valve is proportional to the rate of change of primary current. It is—owing to the impedance of the valve—initially depen-

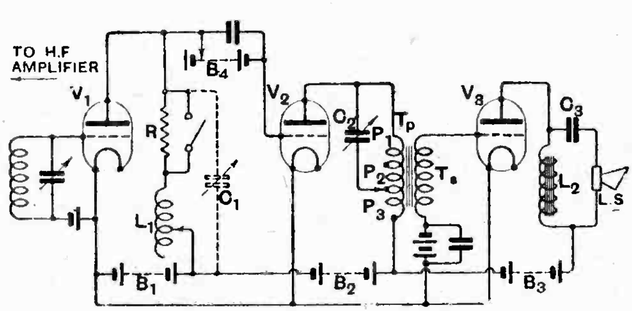


Fig. 1.—Combined resistance and transformer coupled amplifier, designed to have a cut-off frequency less than 50 cycles per second. Values of components are as follow : B_1, 40 to 60 volts ; B_2, 60 to 80 volts ; B_3, 20 to 60 volts ; B_4, 40 to 60 volts (this battery should be of small dimensions to reduce earth capacity effects). L_1, inductance variable in steps of 25, 100 and 900 henries ; L_2, 25 henries, D.C. resistance 500 to 1,000 ohms—of low self-capacity ; R, 0.1 to 0.25 megohm ; C_1, 0.002 mfd., variable ; C_2, 0.007 mfd., variable ; C_3, 4 mfd. ; T_P, primary of special transformer with variable ratios of 2 : 1 or 3 : 1 ; T_S, transformer secondary

[1] See *The Wireless World*, November 4th, 1925.

[2] The "double" current rush when switching on a power transformer (50 cycles) at zero voltage phase is well known.

Speech Amplifier Design.—
dent upon the phase at which the voltage is applied to the preceding grid. If the various resistances of the circuit and the self-capacity were zero, the phase of the voltage applied to the first grid would be immaterial, for that on the second grid would always be a replica thereof.[3] Thus, where transformers are concerned, the initial portion of a transient is generally altered in shape. Its rate of rise may be less or greater than the original, according to the resistances and capacities in the circuits and the frequency and initial phase of the wave. With a complex transient where the ultimate steady state consists of waves of many different frequencies, each wave is initially altered in shape, thereby causing distortion

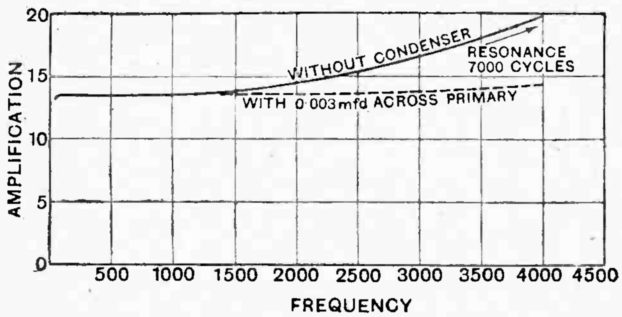


Fig. 2.—Characteristic curve of 2 : 1 ratio transformer and D.E.5 valve. Anode volts, 160; grid volts, 9. Primary inductance (15,000 turns) at 1,000 cycles, 225 henries; secondary inductance (30,000 turns) 900 henries. Secondary self-capacity 100 micro-mfd.

of the transient. Moreover, throughout a broadcasting system, *i.e.*, from microphone to loud-speaker, the phases and amplitudes of the components of a transient are so altered that in certain cases, *e.g.*, the report of a gun, the reproduction fails to convey any meaning. There is no intention to pursue this complex problem any further at present. The point to be enforced is merely that in amplifiers having transformers and condensers the amplification curve for constant voltages after a steady condition has been attained is no criterion of what may occur with transients, especially those with a deep wave front (air pressure), although a good steady voltage characteristic is usually associated with all-round pleasing quality: but the latter is not synonymous with faithful reproduction.

Uniform Amplification of Steady Voltages over a Wide Frequency Range.

The most facile mode of accomplishing the above result is by the use of a resistance capacity amplifier having good mica condensers of the order of 0.2 mfd. The characteristics of such an amplifier are extremely well known. Owing to the increase in impedance of the condenser with decrease in frequency the amplification falls off in the lower ranges. In fact, the chief difficulty when amplifying at audio-frequency—without the aid of

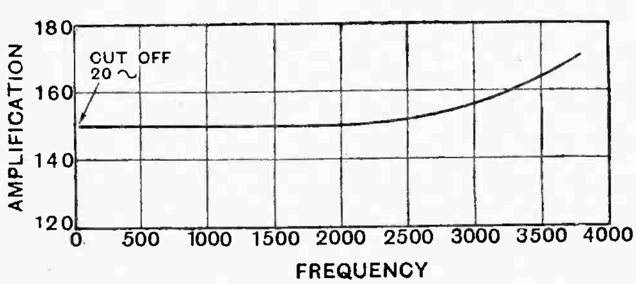


Fig. 3.—Characteristic of amplifier of Fig. 1, from grid of V_1 (D.E.Q.) to grid of V_3; resistance coupling between V_1 and V_2.

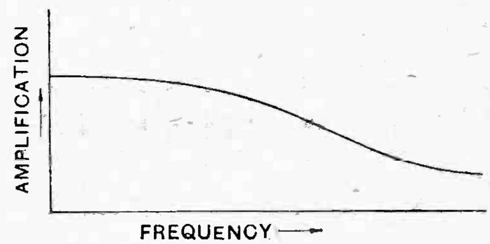


Fig. 4.— Form of characteristic curve obtained with condenser across anode resistance.

H.F. reaction—is to get a reasonable volume from the low tones. By suitable choice of condensers and resistances the desired result can be attained. It is highly desirable in order to reproduce the lower tones of the pianoforte (lowest frequency about 20 per second), 'cello, double bass, drums, etc., that the cut-off point (where the amplification begins to fall off rapidly) should not occur above 50 cycles per second. In this section it is proposed to describe a combined resistance-transformer combination which, although not *always* yielding a maximum of magnification, gives uniformity over a relatively wide range. The diagram of connections is indicated in Fig. 1. Valve V_1 is for rectification, which is secured either by grid leak or on the bend of the anode characteristic. The latter is to be preferred. In the anode circuit of V_1, which may be of the D.E.3B., D.E.5B., or D.E.Q. type, is inserted a resistance of from 0.1 to 0.25 megohm (according to the type of rectifier used), which serves to couple V_1 to V_2. Battery B_4 is adjusted to give the necessary grid bias to V_2, which may

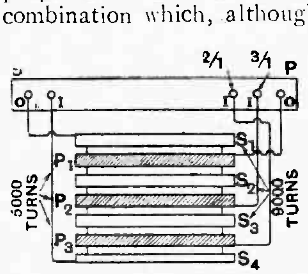


Fig. 4 (a).—Distribution of sections in high inductance tapped transformer. S_4 is used to give the correct turn ratio, the other sections being standard. A better arrangement would be to have 4,500 turns on the primaries, giving an inductance of 182 henries. A 3 : 1 ratio can be obtained by connecting P_2 P_3 in parallel.

be a D.E.5, D.E.5B., or L.S.5 valve. If the bias for V_2 is e_2, then $B_1 - B_3 - ir = e_2$. The current i is the steady anode current during reception of signals, and r is the resistance of R and the choke L_1; e_2 is less when there are no signals, since there is then no carrier wave to rectify. In the anode circuit of V_2 is inserted a special transformer having a high primary inductance. Its actual value is 225 henries[4] at 500 cycles, which is at least ten times the inductance of the majority of transformers used in amplifier design. The ratio of transformation is 2 : 1 or 3 : 1. The steady voltage characteristic with a

[3] Zero capacity and infinite resistance would yield a like result.

[4] Measured on bridge at 500 cycles. Even with a current of 3 to 4 mA. in the primary there is experimental evidence to show that the value does not fall below this at low frequencies. With pure A.C. the maximum inductance at 50 cycles exceeds 3,000 henries.

Speech Amplifier Design.—

D.E.5 valve is shown in Fig. 2, from which it will be seen that the cut-off point is about 35 cycles per second. From a frequency of 1,000 cycles, the amplification increases gradually to 7,000 cycles (not shown on diagram), beyond which it decreases. This gradual increase in amplification is due to leakage, and will be treated in a subsequent section. By putting a 0.003 mfd. condenser on the primary of the transformer, the characteristic be-

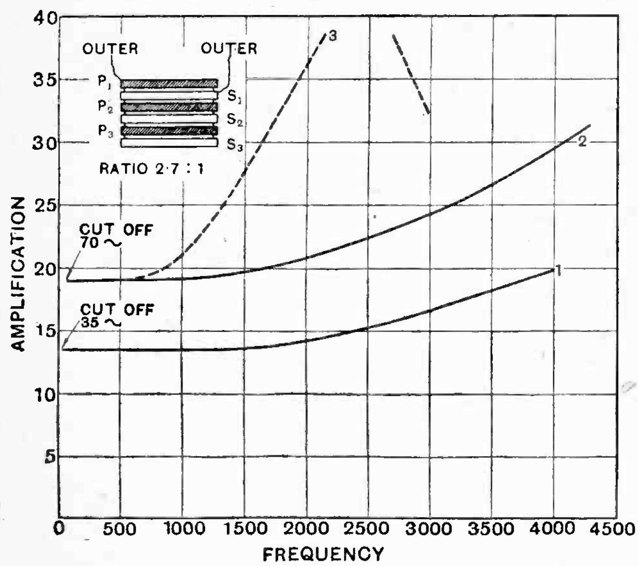


Fig. 5.—Curves of D.E.5 valve (anode volts 160, grid bias, −7.5 volts) and tapped transformer with idle primary section in different relative positions. (1) 2 : 1 ratio transformer without primary condenser. (2) Special 2.7 : 1 transformer (primary 100 henries) with P_1 as the idle section. (3) Special 2.7 : 1 transformer with idle section P_3 between S_2 and S_3.

comes almost horizontal from 35 to 4,000 cycles. Beyond the latter point the actual curve was not measured, but at some higher frequency it dips slowly downward (see dotted curve, Fig. 2).

The curve from the grid of the detector to the grid of the valve V_3, which is a power valve of the D.E.5A. or L.S.5A. type, with resistance coupling between V_1 and V_2, is sketched in Fig. 3. The curve does not rise quite so rapidly as that shown in Fig. 2, owing to the high impedance of the detector valve (D.E.Q.) at its rectification point and the capacity to earth of B_3. With

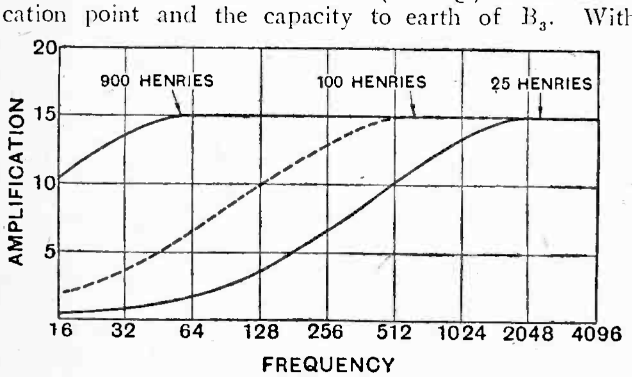


Fig. 6.—Calculated amplification curves plotted to a logarithmic scale of D.E.3B. valve (impedance under operating conditions 80,000 ohms) with 25, 100 and 900-henry chokes connected in anode circuit. The self-capacity of the choke winding has been neglected.

strong signals at the grid of the detector the quality from a good loud-speaker is remarkably pleasing, even though the intensity is great.

Variable Amplification of Steady Voltages.

Having secured an amplifier of uniform steady voltage characteristics over a wide range of frequencies, it is now

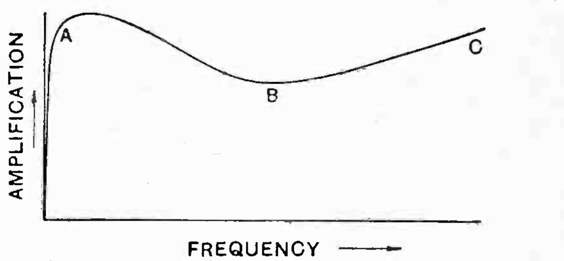


Fig. 7.—Overall amplification curve with dip in middle register. The correct shape depends upon the characteristic of the loud-speaker; with certain types the portion B C should be horizontal, while with others it should rise from about 3,000 cycles upwards.

possible by rapid switching to hear the effect of varying the amplification curve. The variation can be accomplished in several ways, and the most salient are about to be described.

(1) Referring to Fig. 1, if a 0.005 mfd. variable condenser is connected across the resistance in the anode circuit of V_1 the impedance of the resistance condenser unit will decrease with increase in frequency and the characteristic will have a downward slope, as shown in Fig 4. The result is to attenuate the higher tones relative to the lower and intermediate tones, which remain much as they were. At a certain value of capacity the music or speech will sound muffled.

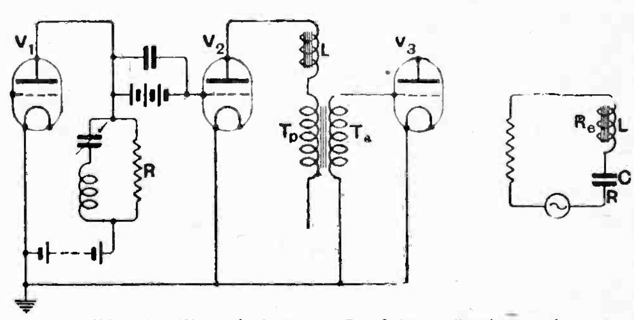


Fig. 7 (b).—Auxiliary inductance L of low effective resistance and low self-capacity for obtaining resonance at the upper audio-frequencies. The amplification at resonance depends upon $\rho+R_e+R$ and upon the reactance $\frac{1}{\omega C}$. The resonance frequency can be varied by varying L and by connecting a variable condenser across the secondary winding. The purpose of the choke and condenser in parallel with R is to produce a dip in the characteristic.

(2) If a tapping is taken on the primary of the transformer the ratio can be made 3 : 1 instead of 2 : 1. Owing to the disposition of the primary and secondary coils the leakage is different in the two cases. Since the primary turns have been reduced in the ratio 3 : 2, the inductance has been reduced in the ratio 9 : 4, *i.e.*, it is now 100 henries. The curve is shown in Fig. 5. The cut-off point of the lower frequencies is now 70 cycles instead of 35, and the upper frequencies are more prominent than before. The effect of changing the ratio

Speech Amplifier Design.—

of transformation from 2 to 3 is to give the speech or music a higher pitch (so far as our auditory organs perceive it), and at the same time to increase the intensity, since the energy is augmented due to the greater transformation ratio. There are three primary sections on the transformer which are interleaved with the secondaries as shown in Fig. 4 (*a*). There are three ways of obtaining a 3 : 1 ratio, viz., P_1 P_2, P_2 P_3, or P_1 P_3. In each case there is an "idle" primary section. Moreover, the resulting amplification curve is different in the three cases owing to the different relative position of the section and the variation in leakage (coupling). For example, with P_2 P_3 the system is symmetrical and the idle section is at the H.T. battery end, where the potential variation is zero. The effect of the idle section is least here and leakage resonance occurs at a frequency of the same order as that for the 2 : 1, *i.e.*, the untapped transformer. Using sections P_2 P_3, the idle section P_1 now being situated at the anode end, where the greatest variation in P. D. occurs, the result is rather interesting. (See Fig. 5.) The resonance frequency of the idle section occurs in the region 2,000 cycles to 2,500 cycles, and this amongst other things is responsible for the summit-like aspect of the amplification curve. Whilst the curve would give an overpowering high tone

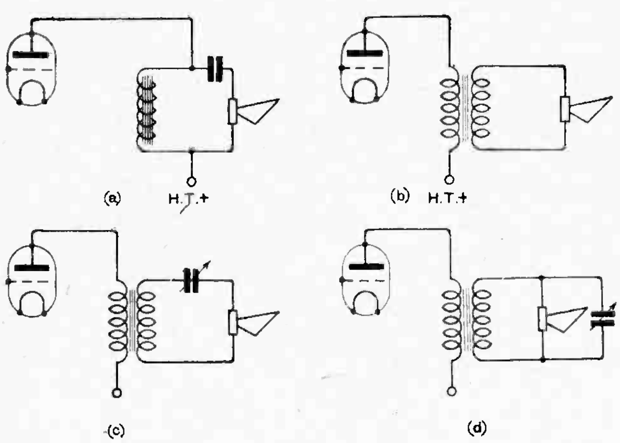


Fig. 8.—Methods of diverting direct anode current from the loud-speaker. By reducing the condensers in (a), (b) and (c) the low tones are decreased ; a reduc. on of the value of condenser in (d) decreases the high tones.

scale, the P_1 P_2 combination is good and is useful for certain classes of loud-speaker. To obviate the influence of the idle or free section, it can be joined in parallel with one of the active units. The primary inductance is then the same as the tapped transformer, but the leakage will be a little different. The curves of Fig. 5 are for one of the high inductance transformers, but a section of 3,000 turns was omitted from the secondary. The ratio of the untapped transformer was therefore 1.8 : 1 (225 henries), and when tapped 2.7 : 1 (100 henries). It should not be confused, however, with the standard 2.7 : 1 "Ideal" transformer, the inductance of which is 50 henries.

(3) Suppose we substitute an iron-cored choke for the resistance R of Fig. 1 and let the choke be variable, say, in three steps of 25, 100, and 900 henries. This can readily be accomplished by putting the primary and secondary of a transformer in series and tapping off. The inductances will, of course, depend on the type of transformer. Taking valve V_1 alone, the calculated characteristics with the three inductances are shown in Fig. 6. Thus, with 25 henries the loud-speaker will sound high pitched, with 100 henries it will sound more normal. With 900 henries will be more pronounced than before. The results will depend on the self-capacity of the choke and the impedance of the rectifier. By putting a (variable) condenser across the choke, the characteristic of the detector and choke can be made to droop, as in Fig. 4, so that with the 3 : 1 transformer the overall characteristic is akin to that illustrated in Fig. 7. This

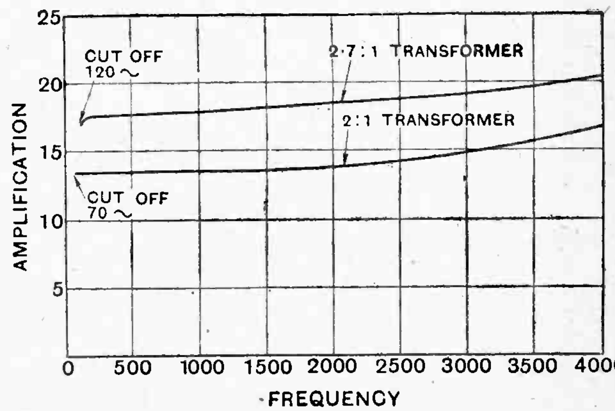


Fig. 9.—Frequency characteristics of 2.7 : 1 (50-henry primary) and 2 : 1 (100-henry primary) transformers. D.E.5 valve (anode volts, 160, grid bias, −7.5 volts).

has a dip in the middle. A somewhat similar result can be secured by using the resistance coupling and condenser in place of the choke. To get an appreciable dip in the curve it is essential that the upward slope due to leakage shall be much greater than the downward slope due to the condenser on the choke or the resistance. So far as quality is concerned, the resistance coupling between V_1 and V_2 is to be preferred, but the choke yields increased magnification. In fact, with a choke of 900 henries, with or without the resistance, and a D.E.3B., D.E.5B., or other valve of moderate impedance, practically the whole magnification factor of the valve is secured. If the choke is sectionised on one core, care must be exercised to avoid resonance effects due to the idle sections, as shown above in the case of the transformer. The idle part can be paralleled with the active part. It must be remembered, however, that there will be additional self capacity due to this process. A high resistance alone, *e.g.*, 0.2 megohm, detracts somewhat from the efficiency of the rectifier and only about half the "*m*" value is secured. There is, of course, for any valve, an optimum value of resistance which can be found by trial. To secure the requisite steep slope due to leakage resonance, it is usually necessary to have a low impedance valve (D.E.5, L.S.5, or D.E.5A.), and it may be necessary to insert an auxiliary inductance in series with the primary of the transformer as shown in Fig. 7 (*b*).

With certain types of loud-speaker, particularly those devoid of high and low tones, an amplifier with

Speech Amplifier Design.—
a characteristic of this nature yields very pleasing results.

(4) The best mode of coupling the loud-speaker in the anode circuit of the power valve is sometimes a moot point. It is preferable to have merely an alternating current in the loud-speaker windings, as this reduces the possibility of breakdowns, which seem to be due to prolonged electrolytic action caused by D.C., although there are cases in which the winding has succumbed under A.C. Of course, this argument is fallacious in one respect: for the choke, the transformer, or the resistance may break down, so that we are merely shifting the onus from the loud-speaker elsewhere. In general, it will be conceded, however, that the policy of avoiding D.C. in the loud-speaker is a wise one, for a breakdown of the coupling unit is very easily rectified, and the loud-speaker can always be used direct in the valve circuit as a temporary expedient pending the replacement of the faulty component. There are two practical methods of preventing the D.C. feed from passing through the loud-speaker: (*a*) transformer coupling, (*b*) condenser-choke coupling. The two arrangements are depicted in Fig. 8.

With condenser coupling—choke feed—the tone can be varied by using a variable condenser. When C of Fig. 8(a) is large, say 4 mfds., its impedance to all frequencies from 30 to 4,000 cycles is negligible compared with that of valve *plus* loud-speaker, but for smaller values of C, say 0.05 mfd., the impedance at the lower frequencies is comparatively high. Thus with a 0.05 mfd. condenser, the lower tones are reduced in intensity, and the effect is to make the loud-speaker appear high-pitched. By varying the condenser (in steps), the depth of tone can be altered, but the lower tones cannot be enhanced at the expense of the higher. The acoustic characteristics can be varied in like manner with transformer coupling by putting the condenser in series with the loud-speaker across the secondary terminals, as in Fig. 8(c). The design of the transformer has a profound effect on the quality. In general, there are three salient points to be borne in mind whilst designing transformers: (*a*) The primary inductance must be comparatively high, (*b*) the self and mutual capacities must be low, (*c*) the leakage must be low—unless a rising characteristic is required. The core of the special high inductance transformer is identical with the Marconiphone "Ideal" type, but the primary and secondary windings have more turns than the standard types. A first approximation to its performance can be made by using a 2.7 : 1 with a D.E.5, and a second approximation by putting two 2.7 : 1 in series. The primary inductance would then be 100 henries. The characteristic of a 2.7 : 1 with D.E.5 valve is given in Fig. 9, whilst that of a special 2 : 1 with 100-henry primary is also shown.

(*To be continued.*)

TRANSMITTING NOTES AND QUERIES.

General Notes.

Mr. S. K. Lewer (G 6LJ), 32, Gascony Avenue, West Hampstead, N.W.6, reports two-way communication at 7.30 p.m. on December 27th with FI 8QQ in Saigon, French Indo China; his signals were stated to be R5. This is believed to be the first communication between England and French Indo China, though, as reported in our issue of December 30th, an amateur in Northern Ireland has forestalled 6LJ. FI 8QQ listens for European stations at 11 p.m. G.M.T. every night. Mr. Lewer also informs us that his signals are received regularly at good strength in U.S.A. every morning until about 1 p.m., when daylight covers the whole of the Atlantic.

oooo

Mr. L. Bland Flagg (G 2GO) was heard in India by Corporal Coates on December 13th at 2252 Indian Standard Time (about 6 p.m. G.M.T.), the strength of his signals were reported as R5.

oooo

2GO was working with an input of 12 watts derived from a M.L. converter and an output of 500 volts 25 milliamps with an Osram DET1 valve.

oooo

The lack of any official regulation of the International prefixes and intermediates is the cause of a good deal of confusion. There are at present three different countries, India, Uruguay and Yugo-Slavia, using the letter Y, while the Irish Free State appears to use both IR and GW. It is to be hoped that some fixed agreement will soon be effected between the various countries and a definite and official system of prefixes adopted.

New Call Signs Allotted.

5JW.—P. Cox, 101, Birchfield Road, Longsight, Manchester, transmits on 45, 90, and 150-200 metres.

5CJ.—O. Carpenter, 35, Sunnyside Road, Weston-super-Mare, transmits on 90 and 440 metres.

2NH.—E. A. Dedman, 65, Kingston Road, New Malden, Surrey, transmits on 2.5, 5, 8 and 23 metres.

5WV.—D. Woods, Station House, Braintree, Essex (in place of 2AXZ), transmits on 23 and 45 metres.

2FV.—W. Scott Hay, "Ivycraig," Newton Mearns, Renfrewshire, transmits on 23, 90 and 170 metres.

2BNN.—T. H. F. Wagstaff, 24, Earl Howe Street, Leicester (artificial aerial).

oooo

Stations Identified.

Z 1AR.—R. J. Orbell, Box 69, Te Aroha, New Zealand. (Mr. Orbell's station was formerly Z 3AA Christchurch.)

CH 1ER, CH 1EG.—E. Guevana, Casilla 69, Vilcun, Chile, and 646 Av. Libertad, Viña del Mar; the latter being the address of both stations during the summer months. Mr. Guevana, who works on 100 watts from Vilcun and on 32 watts from Viña del Mar, will welcome reports, especially on transmissions from 1ER.

PI 3AA.—F. Johnson, Elser, Baquio, Philippine Islands.

KUDG.—U.S. s/s. "West Jester," c/o Messrs. Struthers and Berry, S. Francisco, Calif.

NCGI.—U.S. Coast Guard Radio Repair Base, Navy Yard, Philadelphia.

NOSN.—U.S. Submarine Base (F. A. Emrick), Coco Solo, Panama (uses the intermediate Ü (. . — —) and works on 40 metres.

NWQ.—U.S. s/s "Wyoming," Guantanamo Bay, Cuba.

Y CKM.—Americo Mantegani, Vazquez 1427 Montevideo, Uruguay.

Y RCS.—Carlos Stefani Canclones, 874, Montevideo, Uruguay.

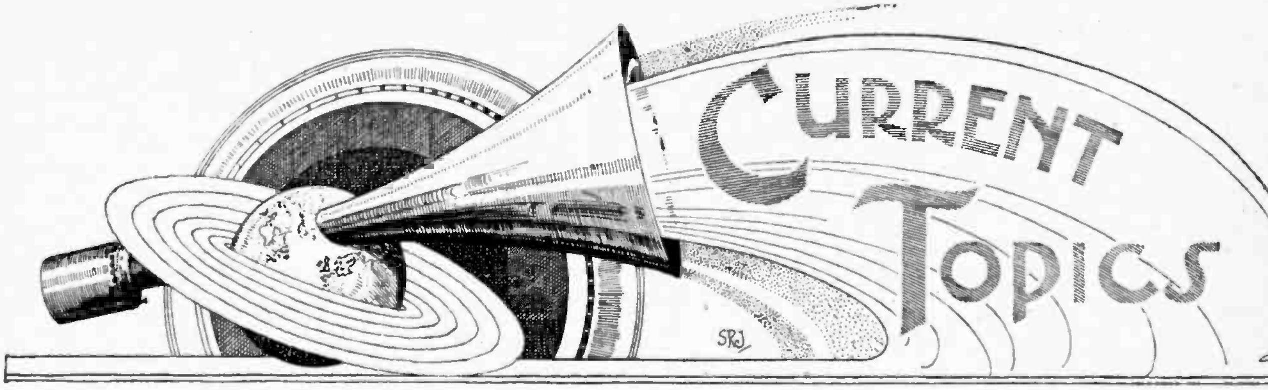
oooo

Mis-use of Call Signs.

The poaching of call signs has long been prevalent in Great Britain, but hitherto few complaints have been received from Ireland. Mr. F. R. Neill (G5NJ), of Chesterfield, Whitehead, Co. Antrim, now reports that there are definite indications of the illicit use of his call letters by some unknown person or persons. He would be glad of any information likely to assist in the detection of the offender.

oooo

Mr. E. C. Miller, the hon. secretary of the Sunderland Wireless and Scientific Association, suggests that indistinct pronunciation by the operator of the transmitter may, in some cases, be the cause of complaints of the mis-use of call signs. He advocates the practice of giving the call sign slowly, in Morse, on a buzzer after each transmission, or, alternatively, of repeating it in either the Army or Post Office letter codes.



News of the Week in Brief Review.

WHERE AERIALS ABOUND.

The P.M.G. should reap a rich harvest from Rhosywain, near Chirk, where the number of wireless masts has evoked a District Councillor's remark that the suburb looks like a harbour full of old ships.

oooo

A POWERFUL BROADCASTING STATION.

WJZ, the new high power station of the Radio Corporation of America at Bound Brook, New Jersey, was officially opened on New Year's Day. Transmitting on 450 metres, WJZ employs a power of 50 kilowatts.

oooo

NO MORE LICENCE WARNINGS.

The last licence warning has sped upon its unwelcome flight. There are to be no more, according to a statement made by an official of the General Post Office. Since August last, when the first tactful reminder was issued, more than 150,000 additional licences have been taken out. It is calculated that 600,000 listeners are still unlicensed.

oooo

CADETS WIRELESS KNOWLEDGE.

Public school cadets are not at present in a position to make practical use of wireless, according to Captain F. A. Mason, who spoke at the annual general meeting of the Public Secondary School Cadet Association on January 4th.

Captain Mason, who is a signalling officer, said that cadets had a long way to go before they could reach the state of efficiency and the speed required by Post Office examiners.

oooo

IRISH CRYSTAL USERS' COMPLAINT.

Replying to a request for the reduction of the wireless licence fee of £1 in the case of crystal users in the Irish Free State, Mr. Walsh (Minister of Posts and Telegraphs) said the fee was nominal in England, but the country gained in the manufacture of sets. There was no corresponding benefit in the Irish Free State. Taxpayers would be obliged to meet a heavy deficit on the wireless, which would be more expensive than anticipated.

RADIO TELEPHONY IN CHINA.

A Shanghai message states that the Ministry of Communications is taking steps to establish a wireless telephone service between Tientsin and Shanghai.

oooo

COURSE FOR FRENCH CONSTRUCTORS.

A Paris wireless school announces a special course, lasting two months, for instruction in the art of building and installing private wireless telephony installations. A "Constructor's Diploma" is issued.

oooo

SAFEGUARDING THE PUBLIC.

Sir Charles Bright has accepted the presidency and Sir William S. Glyn-Jones the vice-presidency of the Wireless Retailers' Association.

One of the objects of the Association is to safeguard the public from unreliable dealers, a certificate of membership being issued for this purpose.

WIRELESS WITHOUT TEARS.

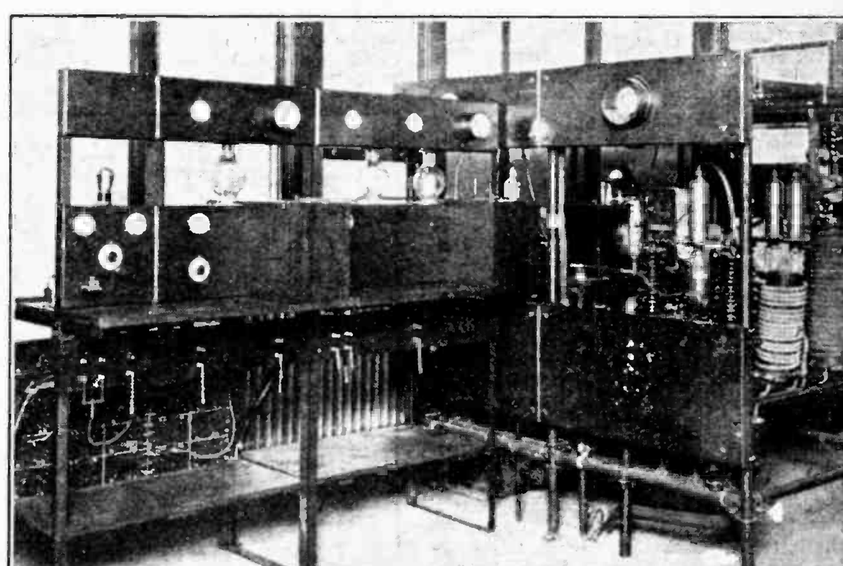
A wireless workshop has been opened by Messrs. Selfridge & Co., Ltd., at their Oxford Street store. Daily demonstrations are given of "Wireless Without Tears."

oooo

A MISREAD DISTRESS CALL.

The mystery regarding the supposed distress call on December 29th from the steamship *Coronado* when off the coast of Spain was partially cleared up when the Spanish steamer *Maria Victoria*, which reported the distress call, arrived in the Clyde.

It appears that the operator heard the *Coronado* transmit "CQ," which he interpreted as meaning "want assistance." Considering that the original distress call, before "SOS" was standardised, was "CQD," it is quite possible that the fears entertained for the *Coronado's* safety were simply due to some freak of memory on the part of the Spanish vessel's operator.



FAMOUS SHORT-WAVE TRANSMITTER. A new photograph of the transmitting apparatus at KDKA, Pittsburg, Pa. On the extreme left is the quartz crystal oscillator which serves to maintain transmission at a constant frequency.

ANNUAL DINNER OF THE I.E.E.

Members of the Institution of Electrical Engineers will hold their Annual Dinner and Reunion at the Hotel Cecil, Strand, W.C., on Thursday, February 11th, under the presidency of Mr. R. A. Chattock, supported by the Council. Application forms for tickets are obtainable from the Secretary, Mr. P. F. Rowell, at the Institution, Savoy Place, W.C.2.

oooo

WIRELESS PATENT CONFUSION.

Inventors were particularly busy during 1925, wireless inventions being well to the forefront. Owing to Patent Office procedure, however, it is not possible to bring searches right up to date, and inventors are often more or less in the dark when they file their patent applications. As a result (writes Mr. H. T. P. Gee, A.M.I.R.E., a London patent agent), some of the applications conflict with one another, and often the trouble can only be rectified when publication of the patent specification takes place.

oooo

RESIGNATIONS FROM THE N.A.R.M.A.T.

A trade event of considerable interest to the general public is revealed by the news that the Sterling Telephone and Electric Co., Ltd., have resigned from the Manufacturers' Section of the National Association of Radio Manufacturers and Traders. The Marconiphone Company's resignation from the same organisation is to take place on March 1st.

The Marconiphone Company, who are the sole selling agents for the Sterling Telephone and Electric Company, have been instructed to market the entire range of "Sterling" products at more advantageous discounts to the trade.

oooo

AN OPTIMIST.

Evidently realising that attack is the best form of defence, a defendant in the West Ham Police Court put forward a novel claim against the Post Office when he was charged with operating a receiver without a licence.

A supervisor pointed out that Jarvis (the defendant) argued that, in return for the 10s. licence fee, the Post Office should erect his aerial in the same way that a telephone is installed for an inclusive charge. Disregarding this optimistic plea, the magistrate fined the defendant £1, with £1 1s. costs.

oooo

B.S.A. IN THE WIRELESS FIELD.

Those familiar initials, "B.S.A.," which have so long been associated with cycles, motor cycles, and rifles, are entering upon a new phase of existence.

It is officially announced that the Birmingham Small Arms Co., Ltd., of Birmingham, have entered into an agreement with the Standard Telephones and Cables, Ltd. (formerly Western Electric Co., Ltd.), whereby the developments of the latter company with broadcast receiving apparatus will operate for both companies. A new company has been formed under the name of B.S.A. Radio, Ltd., with offices at Small Heath, Birmingham, to market the new B.S.A. products.

FORTHCOMING EVENTS.

WEDNESDAY, JANUARY 13th.

Radio Society of Great Britain.—Informal meeting. At 6 p.m. At the Institution of Electrical Engineers, Savoy Place, W.C.2. Talk on "The Development and use of Valves for Broadcast Reception," by Mr. F. E. Henderson.

Barnsley and District Wireless Association.—Electricity and Magnetism as Applied to Wireless.

Muswell Hill and District Radio Society.—At 8 p.m. At St. James's Schools, Fortis Green. Lecture and Demonstration: "Liquid Air," by Mr. Allen J. Bremner, B.Sc.

THURSDAY, JANUARY 14th.

Liverpool Wireless Society.—At 7.30 p.m. At the Royal Institution. Lecture: "Fading," by Prof. E. W. Marchant, D.Sc., M.I.E.E. (President).

FRIDAY, JANUARY 15th.

Radio Experimental Society of Manchester.—At 7.30 p.m. At the Athenæum, Princess Street. Lecture: "High-frequency Amplification," by Mr. B. L. Stephenson.

Sheffield and District Wireless Society.—At 7.30 p.m. At the Department of Applied Science, St. George's Square. Lecture: "Superheterodyne Receivers," by Mr. Forbes-Boyd.

MONDAY, JANUARY 18th.

Swansea Radio Society.—Lecture and Demonstration: "Short Wave Reception," by Mr. F. H. Haynes (Assistant Editor, "Wireless World").

TUESDAY, JANUARY 19th.

Bolton and District Radio Society.—Lecture: "Radio Television," by Mr. I. E. Kemp, M.R.D.S.

SHORT-WAVE TRANSMISSIONS.

We have received from the Société Française Radio-Electrique a letter correcting some of the information regarding their short-wave stations which was published on page 895 of our issue of December 23rd, 1925. The correct particulars and wavelengths are as follow:—

Sainte-Assise FW (Cie Radio-France) transmits on 42 and 23 metres commercial traffic with Buenos Aires.

Sainte-Assise 8GB transmits on 75 metres, tests by S.F.R.

Clichy 8GA transmits on 30 metres, tests by S.F.R. This station is installed on the premises of the Cie Française de Radiophonie, which controls the "Radio-Paris" broadcasting station.

THE HIDDEN ADVERTISEMENTS COMPETITION.

Below are given the solution and prizewinners in the Fifth Competition (30.12.25). "The Wireless World" Hidden Advertisements Competition will be continued until further notice.

Clue No.	Name of Advertiser.	Page
1	Cleartron Radio Ltd.	14
2	Reflex Radio Co., Ltd.	7
3	Telegraph Condenser Co., Ltd.	4
4	London and Provincial Radio Co., Ltd.	24
5	General Electric Co., Ltd.	11
6	Stratton & Co., Ltd.	19

The following were the prizewinners:

Dennis, S. Deakin, Portsmouth	£5
A. G. Bailey, Maida Hill, W.9	£2
G. E. F. Lodge, Huddersfield	£1

Ten shillings each to the following four:

Wm. T. Clark, London, W.C.1.
S. P. Whitefield, Ealing.
P. G. Boxall, Sanderstead, Surrey.
C. E. White, Bournemouth.

LECTURES ON "A.C."

A course of ten lectures on "Alternating Currents and Electrical Oscillations" is being given by Dr. D. Owen, B.A., F.Inst.P., at the Sir John Cass Technical Institute, Jewry Street, Aldgate, E.C.3, on Tuesday evenings from 7-8.30 p.m. The first lecture was given last evening (Tuesday) and the remaining nine are to be given weekly throughout the present term. Full particulars of the course are obtainable from the Institute.

oooo

WIRELESS AT SOUTH KENSINGTON.

The laboratories and lecture rooms of the Imperial College of Science, South Kensington, wore a lively air on January 5th, 6th and 7th, when they formed the venue of the annual exhibition of the Physical Society of London and the Optical Society. Among the visitors were members of the Radio Society of Great Britain, for whom the wireless exhibits had a special appeal. Several stands were devoted to receiving apparatus, accessories and components, and considerable interest was shown in a demonstration of high-speed telegraphy.

oooo

HOW DUBLIN WAS HEARD.

Following the official opening of the Dublin broadcasting station (2RN) on New Year's Day, a number of interesting reports have been received from various parts of the Free State.

Excellent results, it appears, were obtained in Dundalk and Londonderry; but from other towns reports were less favourable. Disappointment was felt in Galway because at least four valves were necessary for good headphone reception. Waterford appears to have been equally unfortunate; but an even sorrier tale was told in Cork, where reception from the new station was described as "a complete failure."

oooo

CAPTAIN ECKERSLEY ON "WIRELESS TELEPHONY."

Promises for the future of startling developments in regard to simultaneous broadcasting in Great Britain were suggested by Captain P. P. Eckersley in his lecture on "Past, Present and Future Development in Wireless Telephony," before the Institution of Electrical Engineers on Thursday last.

The lecturer also referred to his recent proposal to the Office Internationale de Radiophonie whereby many stations working on exactly the same wavelength but sufficiently separated would help to overcome interference. No heterodyne note would be audible. Stations working on the same wavelength could have a restricted power and be used for purposes of local interest.

oooo

A CORRECTION.

With regard to a "Trade Note" in our issue of December 23rd, we learn from Messrs. L. Ormsby and Co., the wireless manufacturers, that the Mr. C. J. Proctor referred to has not been appointed their sole agent for the Manchester district, and has no connection whatsoever with the firm.

WIRELESS IN THE LONDON HOSPITAL.

A Description of the Automatic Broadcast Receiving Installation.

WHAT is claimed to be the largest radio receiving system in the world has been installed at the London Hospital. This hospital is the largest in the United Kingdom, accommodating 1,000 in-patients and covering an area of 15 acres.

The radio plant, which has been designed and presented by the Igranic Electric Co., Ltd., is housed in an asbestos-lined hut on the roof of the institution. It employs sixteen valves, and is operated through the agency of a relay mechanism controlled by a tumbler switch in the porter's lodge. The various wards have been wired into nine distinct circuits, eight of which supply 842 pairs of headphones, whilst the ninth actuates a series of loud-speakers in the children's wards.

The installation can best be analysed under three heads :—

(1) The receiver.
(2) The power amplifier and distribution scheme.
(3) The batteries and charging mechanism.

Aerials Available.

A sheet of metal fixed to the roof of the hut serves as the aerial. It is attached to an Igranic 6-valve super-heterodyne receiver, the wiring arrangement of which is similar, in essentials, to that of the standard model.

By employing various combinations of terminals it is possible to use a variety of signal input circuits. Thus, either the recently developed twin winding frame aerial or a simple frame aerial may be used directly coupled, or else *via* the intermediary of a two-circuit tuner. Alternatively, any form of open aerial may be used, either directly coupled or variably coupled, as before. The comprehensive nature of these arrangements facilitates the treatment of any regional interference on the lines best suited to its elimination.

The initial valve (an Osram D.E.5, working at 60 volts) functions in the dual capacity of oscillator and rectifier, a capacitative balancing system permitting the signal-frequency and oscillator-frequency circuits to be worked without mutual interference. The use of this system not only dispenses with one valve, but also effectively restricts the amount of locally generated energy passed into the aerial circuit, reducing the possibility of radiation to negligible terms.

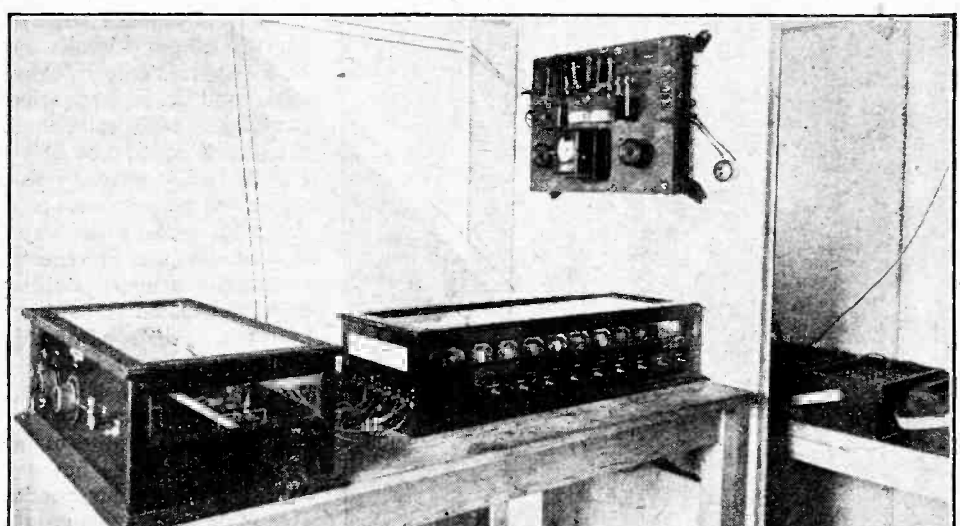
Details of the Receiver.

This valve communicates with three stages of intermediate-frequency amplification, each of which employs a form of reactance-capacity coupling adjusted to a wavelength of some 6,000 metres. This wavelength would seem to be the most satisfactory choice when it is intended as in this case, to effect reception of stations using waves up to 2,000 metres in length, for it implies a desirably substantial frequency difference between the two channels of signal acceptance, whilst the copper losses remain low and the unwanted electrostatic couplings are of high reactance.

Great importance attaches to the resonance curve of the intermediate-frequency amplifier, for in no other practical receiving system is there the same opportunity of maintaining the most satisfactory selective condition throughout the entire range of received signal wavelengths.

As the result of an extinction of limiting couplings between the intermediate-frequency stages, the designers are able to cascade three Osram D.E.5B. valves, working at 120 volts, and to employ their high *m* value to the maximum in each stage without any trace of instability and without resorting to the deliberate introduction of losses as a means of suppressing undesirable oscillation. Indeed, so stable is the amplifier that it has been possible to impart to the grids of the intermediate-frequency valves a negative bias of 1½ volts in order that no grid current shall flow and so encourage premature rectification and consequent distortion.

A novel arrangement is used to apply reaction to the amplifier when desired. The potential gradient between



General view of the superheterodyne receiver, power amplifier, and supply batteries.

Wireless in the London Hospital.—
the grids of the first and second amplifying valves is controlled by means of a variable non-inductive resistance having a maximum value of one megohm.

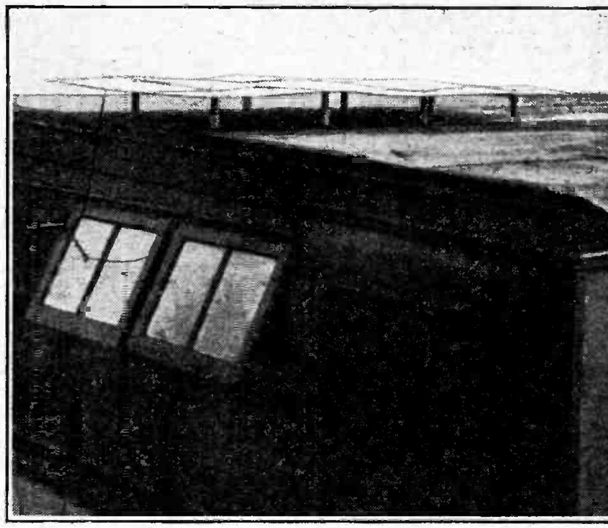
The third intermediate-frequency stage delivers to the final rectifier an Osram D.E.5B. working at 120 volts, the grid of which is maintained at a positive potential to stimulate the flow of grid current esential to cumulative rectification.

The single stage of note amplification of the standard receiver is not included in the hospital receiver, since the latter is attached to a special power amplifier.

Methods of Winding the Frame Aerial.

Although, in virtue of the very high amplification available, the plate aerial proves effective for the full-load reception of a number of stations, higher selectivity and responsiveness is exhibited when the frame aerial is employed.

This frame, which, by the way, is a collapsible and portable one, performs an interesting secondary function, for it eliminates interference set up by stations using wavelengths in or near the band to which the intermediate-frequency amplifier is responsive. It embodies two geometrically parallel windings consisting of an equal number of turns, one winding being tuned to the signal frequency by means of a condenser in the receiver, and the other winding being wound in the opposite sense, and not tuned. The two windings are so arranged in the receiver circuit that the arrival upon the frame of a widely non-resonant frequency results in the simultaneous formation of two potentials of equal voltage and opposite sign—a condition producing mutual cancellation and an obvious elimination of the long-wave interference to which superheterodynes working on direct-

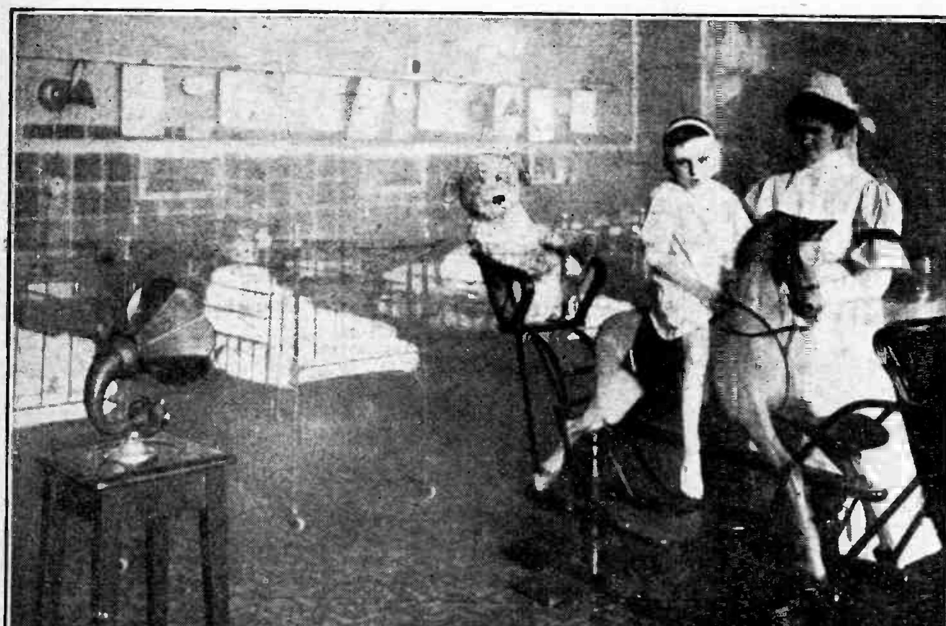


Aerial plate mounted on porcelain insulators on the roof of the receiving hut.

coupled frame aerials have always been subject. On the other hand, when dealing with resonant frequencies, the responsiveness of the tuned winding rises to a maximum, while that of the untuned winding remains at a very low figure. Hence there are no opposing effects, and reception from desired stations is, therefore, in no way effected.

Power Amplifier and Distribution Scheme.

In the power bank amplifier the secondary winding of the input transformer is common to nine valves. The anode circuit of eight of these valves contains an output transformer, the secondary winding of which is earthed at its centre point in order to maintain the output leads at balanced potentials.



A scene in one of the wards.

The impedance of the various output circuits has been approximately equalised, and it is such that, considered with relation to the anode impedance of the Osram L.S.5 valves, 7 to 1 step-down transformers were designed. Since the capacity of the line is reflected across the primary winding of its associated transformer inversely as the square of the ratio of transformation, it may be as high as 0.1 mfd., without seriously impairing the amplitude of the higher frequencies. This figure is not attained at the London Hospital, and even on the longest line there is no interference with the tonal balance.

The ninth valve delivers, *via* an appropriate trans-

Wireless in the London Hospital.—

former to an Osram L.S.5A. valve, the anode circuit of which is coupled through an output transformer to a number of Amplion loud-speakers.

An indication of the input voltage swings which are qualitatively permissible (and quantitatively desirable to ensure a reasonable safety factor) is provided by the fact that a negative bias of 45 volts is imparted to the grid of each of the L.S.5 valves, while the grid of the L.S.5A. valve is negatively biased to the extent of 120 volts. The anode current to all the valves in the power bank is supplied at a pressure of 300 volts.

The output lines are paired off and run in lead-covered cables, all the coverings being bonded and earthed to obviate induction effects. Each headphone circuit is sub-divided into four or five ward sub-circuits at appropriately placed junction boxes, and, in the event of a local fault, it is therefore possible to isolate any ward expeditiously and without detriment to the main service.

Some idea of the magnitude of the installation may be gauged by the fact that about fifteen miles of lead-covered line had to be laid to carry the current from the radio hut to the bedside headphones and loud-speakers in every part of the hospital.

Although primarily intended to provide reliable reception of London and Daventry programmes only, the plant is able to give a full-load service on a number of European broadcasting stations.

Batteries and Charging Mechanism.

The filaments of the receiver and power bank valves require a total current of 10 amperes at 6 volts, while the combined anode requirements account for 150 milliamperes at 300 volts, 3-ampere hour accumulator cells providing the latter supply.

The batteries are housed in an isolated and separately ventilated section of the instrument hut. Practical considerations dictated the provision of two motor generator sets for charging purposes, and these are also installed in the battery compartment of the hut. No. 1 set has an output of 15 amperes at 10 volts, and No. 2 set delivers 0.3 ampere at 350 volts.

Since the apparatus has been designed to provide a possible 14-hour reception programme daily, it is necessary to adopt a reliable means of expeditiously conducting the charging operation, and to this end the activities of the motor generator sets are governed by a special Igranic system of control switches.

Automatic Controls

Directly the receiver is switched off, these controllers automatically start up the generators and maintain them, the charging current driving, *inter alia*, a small mercury motor. This motor communicates with an indicator which registers the extent to which the ampere-hour capacity of the batteries is satisfied. When the indicator is driven to the position denoting a complete charge, a relay is tripped and the charging circuits are broken. If the receiver is switched on during the charging process, the generators automatically close down and resume their task when the receiver is again switched off.

The employment of this mechanical battery attendant coupled with the fact that the two essential tuning adjustments of the receiver are normally fixed for reception from Daventry, eliminates the necessity for skilled or semi-skilled attention, and, as a result, the operating function may be entrusted to anyone who is able to switch on an electric light.

The wards of the London Hospital provide convincing evidence that, by making available at 1,000 bedsides an optional supply of first-rate entertainment, radio science is materially assisting medical science in alleviating the lot of the sick.

O. J. C.

WHAT IS BEING SAID.

THE SUPPLY OF COMPONENTS.

"THE parts merchant of to-day and to-morrow is not the fellow who attempts to unload a lot of radio jimcracks on credulous but misinformed radio buyers, but he is rather the man who understands the reason for every part he sells and is able to render the home constructor the sort of service he is reasonably entitled to."—Arthur Lynch, in *Radio Broadcast*, New York.

A DOUBLE PLEASURE.

"I KNOW from experience what a pleasure it is to hear good music and speaking, and also what a pleasure it is to be able to turn it off when one has had enough." —Lord Cave.

A TELEVISION PROPHECY.

"I AM certain that before the end of 1926 an orator speaking into the microphone will have both his voice and his image transmitted simultaneously all over the globe." —M. Edouard Belin.

BEAM WIRELESS AND ITS FUTURE.

"THE New Year will determine the future place which wireless will occupy in long-distance communication. It will demonstrate whether the beam system is efficient and reliable. If it passes both tests, then wireless will have won an unassailable position, as these merits, with its cheapness, will make its application almost universal throughout the Empire. If it is only moderately successful, then wireless, both long and short wave, has a serious competitor in the new loaded cables which enable rates to be cut by more than half, while multiplying capacity and speed."—Sir Robert Donald in *The Observer*.

INTERNATIONAL BARRIERS CRUMBLING?

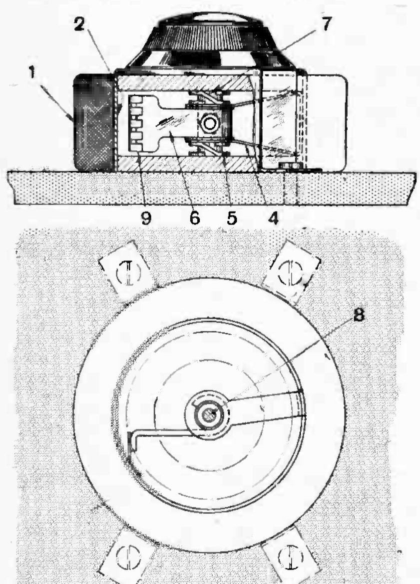
"MEN of different races are speaking to one another in a common jargon across half the circumference of the earth. Who knows but that it may be one step towards promoting a better mutual understanding between nations and towards the universal peace which we all—even we professional 'hired assassins'—desire?"—Capt. W. G. H. Miles, R.M.

Brain Waves of the Wireless Engineer.

Variometer.
(No. 240,555.)

Application date: July 4th, 1924.

Mr. N. H. Clough describes in the above patent specification a variometer provided with a detachable metallic shield preferably in the form of a split ring and with means for inter-connecting two variable points on the shield, so that a variable length may be short-circuited. By this means a closed metallic loop is provided, and its area is variable from zero to the area enclosed by the shield. In the form illustrated, the shield consists of a split ring 2 arranged on the inner periphery of the coil 1. A saddle piece 4, connected to one end of the split ring 2, is pressed by spring washers 5 against an arm 6 carried by a tube 7. The arm 6 has at its end a brush 9 making contact with the strip 2.



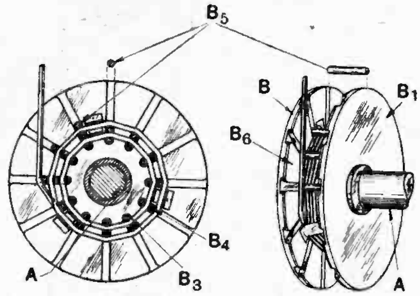
Variometer with adjustable damping plate. (No. 240,555.)

○○○○

Multilayer Coils.
(No. 240,283.)

Application dates: Sept. 8th, 1924, *and Oct. 18th*, 1924.

Messrs. L. H. Paddle and J. A. Crisp describe in the above patent specification a multilayer inductance coil in which each layer of the coil is wound upon a temporary support which determines the diameter of the layer. The convolutions of each layer are secured together by an adhesive or binding material, and further each layer is secured to a side piece or cheek or to two opposed side pieces or cheeks by an adhesive material.



Multilayer coil construction. (No. 240,283.)

One form of coil and winder is illustrated in the drawings.

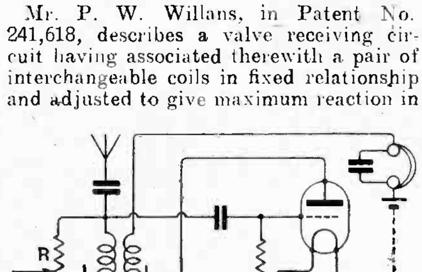
On a spindle A are assembled a pair of cheeks B, B_1 having radial series of holes. After winding, the outer cheeks and the spindle are removed, and the coil allowed to dry; the separating pins B_3, B_4, B_5, and the inner cheek B_6 then being removed. The finished coil is preferably inserted in a casing and supported by one side only.

○○○○

Receiving Circuit.
(No. 241,618.)

Application date: July 21st, 1924.

Mr. P. W. Willans, in Patent No. 241,618, describes a valve receiving circuit having associated therewith a pair of interchangeable coils in fixed relationship and adjusted to give maximum reaction in which a variable resistance is shunted across one of the coils or across a third coil coupled thereto, so that the degree of reaction may be controlled and varied.



Resistance control of reaction. (No. 241,618.)

The illustration shows a well-known receiving circuit having an aerial coil L and a reaction coil L_1 in fixed relationship and adjusted to give maximum reaction, and an adjustable resistance R connected across the aerial coil L.

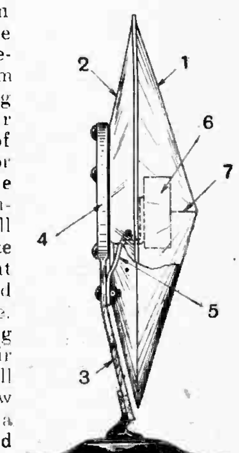
The specification states that a resistance having a maximum value of 100,000 ohms is suitable.

○○○○

Hornless Loud-speakers.
(No. 240,596.)

Application date: Aug. 9th, 1924.

The object of the Western Electric Co., Ltd.'s, patent No. 240,596 is to provide a diaphragm for a loud-speaking receiver which will cause the lower speech frequencies to be reproduced as well as the higher frequencies. This object is effected by an acoustic device comprising a cone-shaped diaphragm having an opening to the outside air in one wall thereof and means for supporting the cone at the opening so that all points of the vibrator except at the opening end are free to vibrate.



The "Kone" loud-speaker. (No. 240,596.)

With an opening to the outside air the vibratory shell functions at low frequencies as a resonator, and thus the low tones of the musical or vocal reproduction are given their full value. The illustration shows a side elevation of the loud-speaker, in which the cone 1 is united at its base to the greater edge of a frusto-conical member 2, and supported by a stand 3.

The atmosphere has access to the interior surface of the diaphragm through the space enclosed by the supporting ring 4.

Attached to this ring is a bracket 5 on which is mounted an electromagnetic actuating device 6, which transmits vibrations to the diaphragm at its apex.

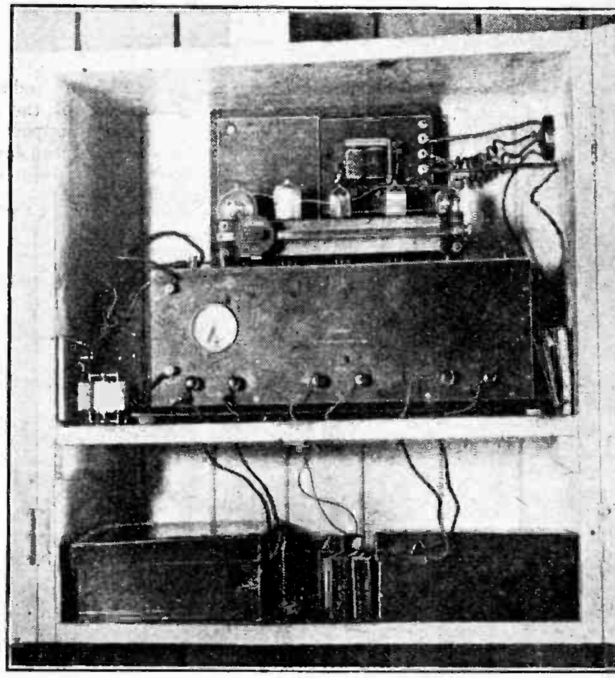
Important Application of THE LIGHT SENSITIVE CELL.

Automatic Fog Signal Apparatus Installed at Dublin.

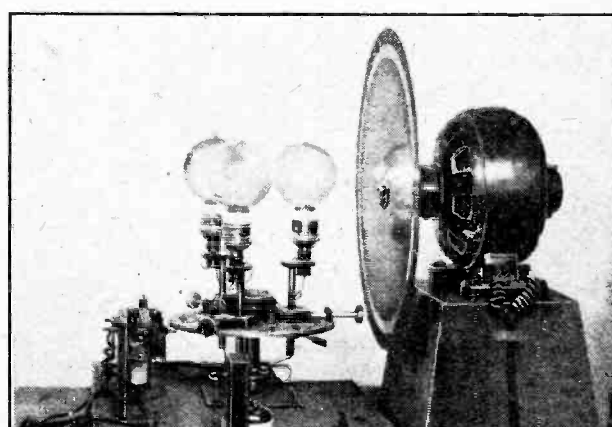
VALVE amplifiers used in combination with the photo-electric cell can be employed to register the intensity of light. The conductivity of the light sensitive cell varies with the brightness of the light to which it is exposed, and thus the current passed by the cell under changing light conditions can be caused to automatically actuate electrically controlled apparatus.

The lighthouse from which the bell is sounded, showing the lens window which receives and concentrates the beam.

In proportion to its normally high resistance, the resistance fluctuations of the photo-electric cell with variations of light intensity are exceedingly small. Valve amplifiers can be used, of course, to magnify the output, and by a chain of amplifiers and relays heavy currents may be controlled. The input valve circuit may be arranged so that the resistance of the photo-electric cell takes the place of the grid leak, thus regulating the grid potential. A highly sensitive light detector can be produced when the frequency of a valve oscillating circuit is influenced by the resistance of the cell, and is caused to set up beats with another oscillator. An ordi-



Valve amplifier and relays which amplify the fluctuating output from the photo-electric cell.



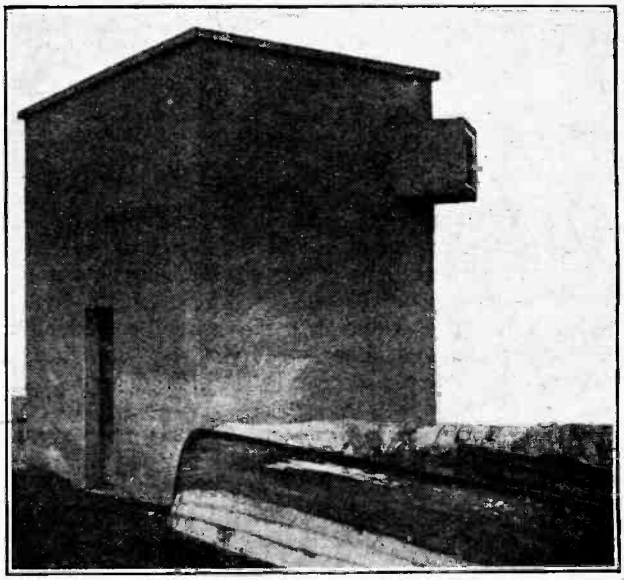
The lamps and motor-driven interruptor disc. Should the filament of the lamp burn out a new lamp is automatically brought into operation.

The Light Sensitive Cell.

nary note magnifier may be adopted, however, to amplify the output from the cell, though it is obvious that in this case the source of light must be interrupted.

The principle has been successfully applied by Professor J. J. Dowling, of the National University, Dublin, for automatically operating the fog bell on the north wall of the River Liffey in the Port of Dublin. A lamp house has been erected on the opposite side of the river, from which a beam of light is focussed on a photo-electric cell installed behind a convex lens at the lighthouse. The beam is interrupted by means of a revolving disc, with holes around its circumference, so that an audio-frequency note of about 500 per second is produced at the receiving amplifier. So long as the beam of light falls on the cell the fog bell is restrained from acting, but as soon as the light is cut off by fog the bell rings forth its warning. The equipment thus serves as an indicator of the opacity of the atmosphere, and so sensitive is it that, if the beam is briefly intercepted by one's hand at the lamp house, the warning bell sounds out across the river a quarter of a mile away. The lamps producing the beam are in operation both day and night, and an automatic device is introduced to bring a new lamp into operation should the one in use fail.

It is stated that a saving of expenditure of approximately £1,000 a year is brought about by the installation of the automatic equipment in this instance, and the extension of the scheme to other lighthouses is being considered.

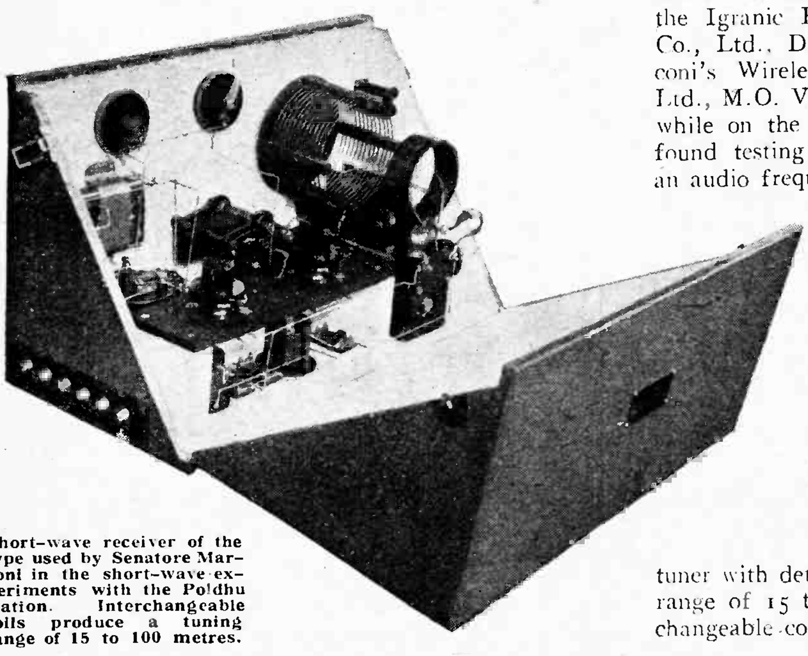


The lamp house. The light emerges from the square window on the right. Actually two lights have been installed in this building working with two independent light-detecting equipments.

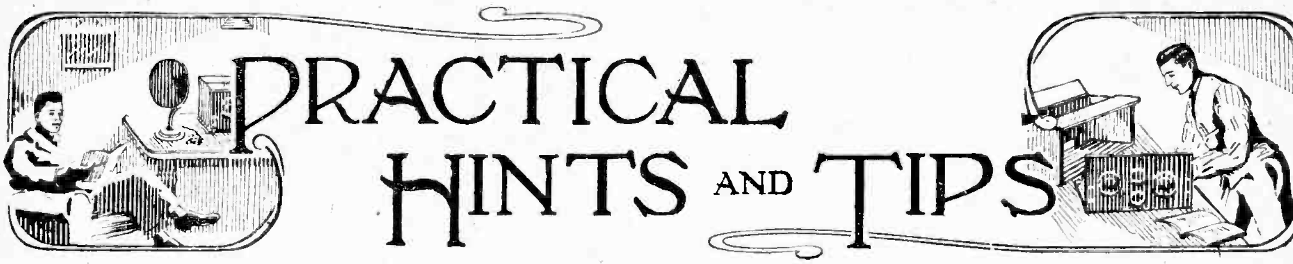
PHYSICAL SOCIETY OF LONDON.

Seventh Annual Exhibition.

WIRELESS apparatus continued to occupy a conspicuous position among the general scientific exhibits which were to be seen at the annual exhibition of the Physical Society of London and Optical Society held again this year in the laboratories of the Imperial College of Science at South Kensington. Among the manufacturers of wireless apparatus who exhibited were the Igranic Electric Co., Ltd., Mullard Radio Valve Co., Ltd., Dubilier Condenser Co. (1925), Ltd., Marconi's Wireless Telegraph Co., Ltd., Gambrell Bros., Ltd., M.O. Valve Co., Ltd., and H. W. Sullivan, Ltd., while on the stand of H. Tinsley and Co. was to be found testing equipment of wireless interest, including an audio frequency transformer test set designed by Mr. P. W. Willans, and a calibrated variable low-frequency oscillator. A standard multivibrator wavemeter designed by Mr. D. W. Dye, of the National Physical Laboratory, was shown in operation on the stand of H. W. Sullivan, together with standard heterodyne wavemeters and wavemeters with specially low wavelength ranges. The Marconi exhibits included apparatus for broadcast reception. Of special interest to readers, no doubt, is the Marconi short-wave receiver shown in the accompanying illustration, which is built on orthodox lines, consisting of low loss tuner with detector and note magnifier valve, and a wave range of 15 to 100 metres produced by means of interchangeable coils.



Short-wave receiver of the type used by Senatore Marconi in the short-wave experiments with the Poldhu station. Interchangeable coils produce a tuning range of 15 to 100 metres.



PRACTICAL HINTS AND TIPS

A Section Mainly for the New Reader.

THE CARBORUNDUM DETECTOR.

It is difficult to see why the carborundum detector is so seldom used nowadays for broadcast reception. Before the valve came into general use it was regarded as the one stable and reliable rectifier, and is certainly quite as much entitled to the name of "permanent detector" as many of the modern products. A good specimen will frequently remain in adjustment for several months, this being partly due to the fact that a heavy contact pressure may be used without seriously impairing its rectifying properties.

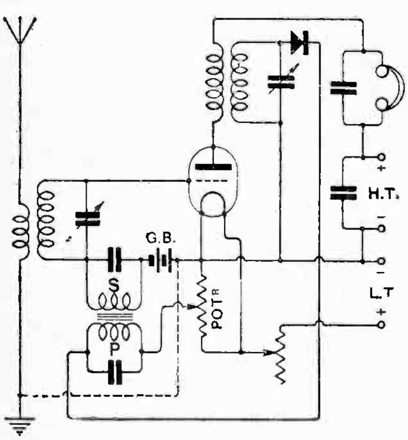


Fig. 1.—A reflex receiver with carborundum detector.

Although the efficiency of the carborundum-steel combination hardly equals that of a good treated galena crystal, assuming that both are used in the most suitable manner, the high resistance of the former is in many cases an advantage, as it may generally be connected across the whole of the tuning inductance without giving rise to an excessive degree of damping.

The need of a local battery and potentiometer, whereby a small voltage may be applied to the crystal, and without which, generally speaking, no rectification of weak signals will take place, is probably one of the reasons why this combination is not popular. However, in the case of a valve-crystal receiver, no extra battery is required, as the filament lighting cells will supply the necessary biassing voltage if the scheme of connections suggested in Fig. 1 is adopted. Here is shown a reflex receiver of conventional design, the potentiometer being connected across the filament terminals (and not the battery leads) in such a way that, when the valve is switched off, no current will flow through the potentiometer windings. Even if a two-volt accumulator is used, it will generally be possible to obtain a sufficient voltage for the crystal, as very few carborundum specimens require more than one volt. Care should be taken to ensure that the connections to the crystal are in the right direction, and the preliminary adjustment should be made on a fairly weak signal; an examination of the curve of a typical crystal will show that large amplitudes will be rectified without the necessity of applying any biasing voltage.

It should be pointed out that, in the circuit shown, the L.F. transformer should have a lower ratio than that usually recommended for use in valve-crystal circuits. This is due to the fact that, as already stated, carborundum has a considerably higher resistance than galena, or even than the perikon combination. A transformer with a ratio of certainly not greater than 4 : 1, with a high-impedance primary winding, should be used.

It is strongly recommended that, following the best commercial practice, two separate detectors should be fitted, with a switch to change over from one to the other. It will then be easy to ensure best adjustment by direct comparison of one crystal against the other.

oooo

ANODE OR CRYSTAL RECTIFICATION.

It is well known that the valve operating as an anode or "bottom bend" rectifier is unlikely to introduce any distortion when working on a strong signal, and also that the method has the disadvantage of comparatively low sensitivity. In Fig. 2 is shown a very practical circuit with alternative anode and crystal rectification for use both as a receiver for the local broadcasting, and also for long distance work. (The word

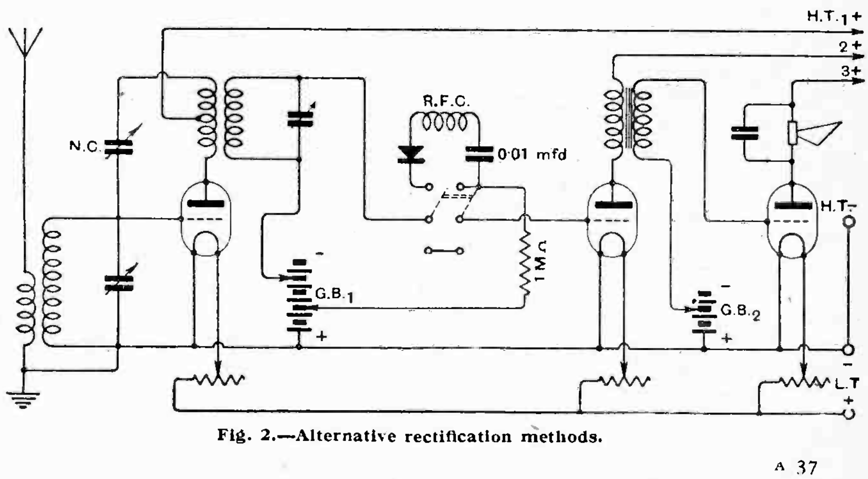


Fig. 2.—Alternative rectification methods.

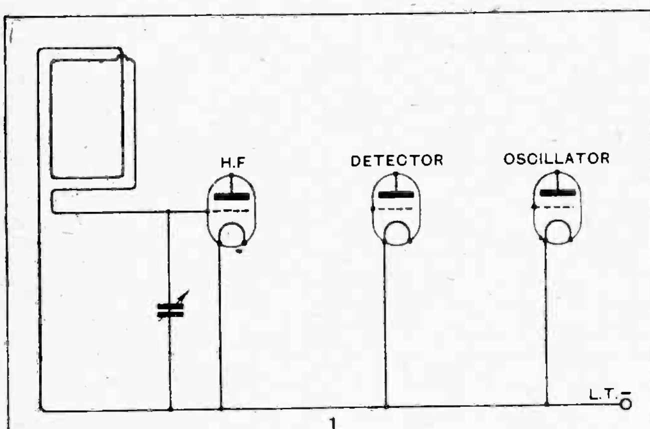
"local" is used here in the wireless sense, and the first-mentioned arrangement should be effective up to 50 miles or more.)

Referring to the diagram, it will be seen that the first valve operates as a neutralised high-frequency amplifier, although, of course, any other system of amplification could be used without interfering with the basic idea of the circuit. When the change-over switch is "down," the second valve functions as an anode rectifier, the grid battery supplying the necessary bias. Under these conditions the receiver is extremely simple in operation, and is eminently suited for use as a domestic broadcast set. When it is desired to search for distant transmissions, the switch is thrown to the "up" position, when the crystal detector comes into operation, acting as a potential rectifier with negative bias. The second valve becomes an L.F. amplifier. A grid condenser and leak are also inserted, the grid bias being automatically changed to a suitable value. It will be noticed that the grid is now insulated by the condenser as far as the voltage which was previously applied to it is concerned. The radio-frequency choke helps to keep unrectified H.F. impulses off the grid. It will hardly be necessary to say that the utmost care should be exercised when a switch is introduced into the grid circuit of a valve dealing with high-frequency voltages, and capacity effects should be reduced to a minimum. Where appearance is not of great importance, it would be as well to arrange a system of plug-in connections on the face of the instrument panel.

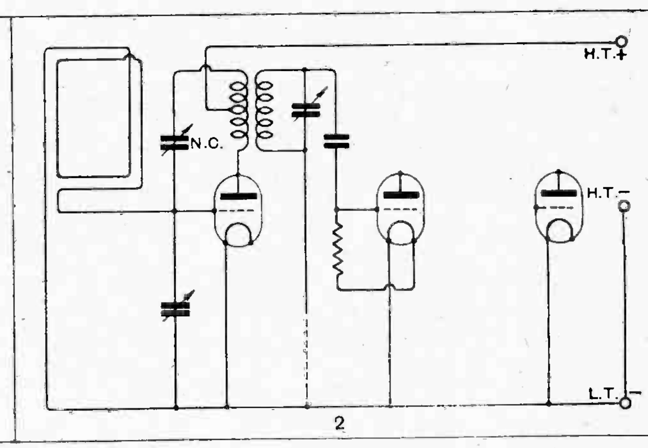
DISSECTED DIAGRAMS.

No. 14a.—A Practical Superheterodyne with One Stage of Neutralised H.F. Amplification.

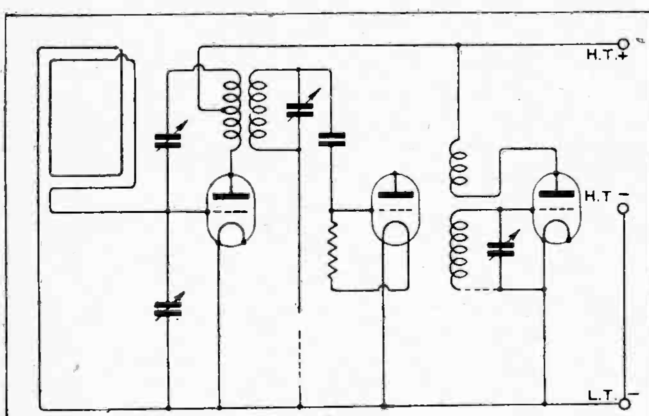
For the benefit of readers who find difficulty in reading circuit diagrams, we are giving weekly a series of sketches, showing how the complete circuits of typical receivers are built up step by step. Below are shown the connections of the first three valves of a superheterodyne; the remainder of the circuit will be completed in our next issue.



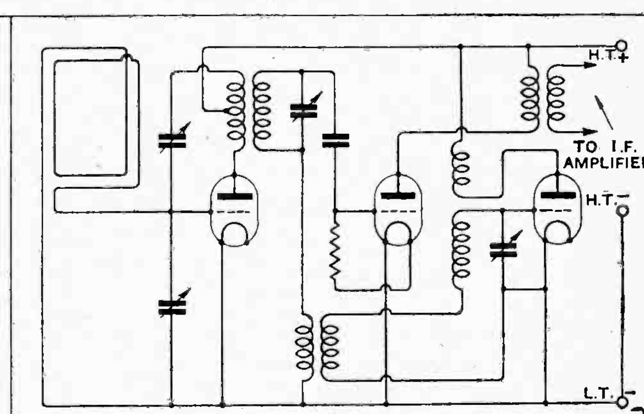
Three valves, operating respectively as H.F. (fundamental frequency), first detector, and oscillator. To avoid unnecessary complication, the filament circuits are not completed. A frame aerial and tuning condenser are connected between grid and filament of the H.F. valve.



The H.F. valve is coupled to the first detector through a "neutrodyne" transformer (See "Dissected Diagrams," *Wireless World*, Dec. 2nd, 1925). The tuned secondary is connected between grid and filament of the detector valve, a leaky grid condenser being inserted for rectification.



A tuned circuit (inductance and variable condenser) is connected between grid and filament of the oscillator valve, the plate circuit of which is completed through a reaction coil, coupled to the grid coil and the H.T. battery.



Oscillations are fed back to the grid circuit of the detector valve, the resulting beat frequency (long wave or intermediate frequency) being applied to the amplifier through a transformer, with its primary in the plate circuit of the detector valve.

PIONEERS OF WIRELESS.

By ELLISON HAWKS, F.R.A.S.

2.—Galvani and Volta.

IN our last article we dealt with Dr. Gilbert, the famous Elizabethan, and his researches in connection with magnetism. Gilbert was the first to undertake any study of magnetism, and it is strange to find that for three hundred years after his time there was no further progress in the subject. Some advances were made in the kindred subject of electricity, however, and it was subsequently shown that magnetism and electricity are intimately connected.

Up to the latter part of the eighteenth century only one form of electricity was known. This was called "static" electricity, as distinct from "current" electricity. As every schoolboy learns, static electricity may be produced by rubbing together two substances such as a glass rod and a piece of flannel. The glass then becomes charged, and in this state will attract feathers and light objects.

Luigi Galvani.

The electric current was discovered in 1780 by Luigi Galvani, an Italian doctor of medicine. Galvani has been called "the luckiest of all famous men of science," for it is stated that it was by the purest accident he discovered the principle of what is now known as the "galvanic" battery.

Born on September 9th, 1737, at Bologna, this Italian pioneer of science devoted himself to the study of theology, intending to become a monk. His father opposed his suggestion, however, with the result that Luigi determined to become a doctor. He devoted himself so assiduously to his studies that he became one of the most brilliant surgeons of his time. His treatise on the formation of bones won for him (in 1762) the chair of anatomy at the university of his native city. He was then only twenty-five years of age, but he soon became famous as a skilful teacher and exponent of comparative anatomy.

The Story of the Frogs.

It is generally stated that the experiments that made Galvani famous were brought about through his invalid wife, for whom Galvani daily prepared a broth made from frogs' legs. The story goes that one morning, in 1790, he placed some freshly killed frogs on the table in readiness to make the broth as usual, when his wife was surprised to notice convulsive movements in the limbs. She called her husband, who examined the matter and decided that the movements were caused by the current from an electrical machine in the same room, and that the current was conducted from the machine to the frogs' legs through an anatomical knife that happened to be lying on the table and that came into contact with both machine and legs.

This story seems to have first been set in circulation by Alibert, in 1802, in his book about Galvani, and it seems to have had its origin in his fertile brain! For a hundred years or more before Galvani's time numerous experiments were carried out on lines more or less similar to those indicated in the popular account, and there seems to be no reason for thinking that Galvani was ignorant of these experiments and their results. More particularly would he be aware of them, because he was an ardent student of anatomy. Gherardi, his biographer, tells us that as early as 1780 Galvani was experimenting in muscular contractions of frogs under the influence of electricity, which statement is further proved by Galvani's own writings on the subject, published even earlier in 1773 and 1774.

Alessandro Volta.

It was about 1781 that Galvani determined to see if lightning would affect the frogs' legs in a similar manner to the electrical machine, and with this object in view he ran a copper wire through the frogs' legs and hung them to an iron railing, when a thunderstorm approached. He found, however, that it was not necessary to wait for a thunderstorm to obtain movement, for whenever the copper touched the iron the convulsive movements again took place.

For several years Galvani made many experiments of this nature, and constructed what is known as his "electric arc." This consisted of two dissimilar metals, one of which was placed in contact with the frog's nerve, and the other with a muscle, causing the latter to contract.

Galvani was of opinion that these interesting phenomena were caused by the union of the internal positive electrical charge of the nerve with the external negative charge of the muscle. He was wrong in his assumption, however, and it was left to his countryman, Volta—of whom we shall read later—to show that the cause of the

Pioneers of Wireless--
convulsive movements of the frogs' legs was to be found in the fact that the two metals generated an electric current. This has since been found to be the correct explanation of the phenomenon, and now, when it is desired to illustrate Galvani's experiment, it is usual to place the nerve and muscle of the animal in series with a small battery.

Although incorrect in his explanation of his discoveries, Galvani's work opened up an entirely new field in electricity. It showed, for instance, a new method of generating electricity, which previously was only to be obtained by frictional electrical machines.

Galvani lost his professorship at Bologna when Napoleon invaded Italy, because he refused to swear allegiance to the new Republic. Later a special edict was published by the Government, reinstating him without penalty or oath. The restitution came too late, however, for the death of his wife, whom he dearly loved, together with poverty and other troubles, had broken his heart, and he died in his native town on December 4th, 1798.

Another Italian, Alessandro Volta of Como, continued the master's unfinished experiments in current electricity with such success as to be known to-day as the "father of modern electricity."

The Voltaic Cell.

Volta was eight years Galvani's junior, having been born at Como on February 18th, 1745, and was descended from a noble Milanese family. As a boy he was brilliant and versatile, and decided to become a poet. At the age of eighteen, however, he took up the study of electricity. He invented an apparatus for generating electricity by induction, and commenced an investigation of the action of the Leyden jar, at that time the only known appliance by which electricity could be stored. Through his theory of the Leyden jar he was appointed (in 1774) Professor of Physics at Como. He travelled through England and France in furtherance of his electrical studies, and on hearing of Galvani's discovery in connection with the frog's legs he made further experiments that resulted in the discovery that electricity may be generated by chemical means. For eight years he worked on the subject and evolved the "Voltaic pile," consisting of copper and zinc discs placed alternately in column form, but prevented from touching one another by pieces of moist flannel. Volta found that the pile gave feeble charges of positive and negative electricity. He found that the supply was available in a continuous current, being renewed as fast as it flowed away.

Volta's discovery was followed by a long and heated controversy as to the origin of the electricity thus produced, which—it was finally decided—was due to chemical action.

The Voltaic pile was later replaced by the Voltaic cell, a vessel containing dilute acid, in which two kinds of metal—generally copper and zinc—were placed, and positive and negative currents obtained.

That Volta's discoveries were of the greatest importance was at once recognised in the scientific world. In 1801 Bonaparte summoned him to Paris in order to see his experiments at first hand. He honoured him by making him a Count and Senator of the Kingdom of Italy. Three years later Volta resigned his professorship and died at Como, March 5th, 1827, having published nothing else of importance.

Subsequently several other types of "wet cells" were introduced, including the "Daniel" and the familiar "Leclanché" cells, which were later followed by "dry" batteries.

TRADE NOTES.

The M.E.G. Insulation Tester.

Messrs. Evershed and Vignolles have sent us an interesting brochure dealing with the M.E.G. insulation tester, an instrument which was introduced by the firm in 1922 to cater for those engineers and contractors who desired an instrument lighter and less expensive than the Megger set. A constant pressure pattern was brought out in 1924, and two new ranges recently introduced are described in the booklet.

oooo

In a Lincoln Hospital.

The Lincoln Wireless Co., Ltd., have just installed a Marconiphone Long Range V.2 Receiver with two amplifiers in the Lincoln County Hospital. The set feeds 126 telephone and 10 loud-speaker points. The latter are provided with a unique form of compensating gear whereby the balance of reproduction is not upset when the arrangement or number of loud-speakers in use is altered.

oooo

The Radio Mail.

This bright little publication of Messrs. A. C. Cossor, Ltd., includes a number of interesting contributions in its sixth issue. There are articles dealing with the moving experiences of "Korkoran and Joe," short waves, and the future of broadcasting, while an insight into manufacturing methods is given under the title "Round the Cossor Factory."

oooo

Burndept in Ireland.

A further indication of the continued development of the Burndept organisation was shown by the recent formation of a new company, Burndept Wireless (Dublin), Ltd., with offices at 17, Dawson Street, Dublin. The new company is now in a position to supply the wireless requirements of the Irish Free State.

oooo

A New Name.

On New Year's Day Messrs. Houghtons, Ltd., the well-known Holborn wireless distributors, changed their title to Houghton-Butcher (Great Britain), Ltd., in consequence of their association with Messrs. W. Butcher and Sons, Ltd., of Farringdon Avenue, E.C. The High Holborn showrooms have been re-organised to give more expeditious service.

oooo

The Osram Bulletin.

The latest number of the "Osram Bulletin" covers a wide field of activity, as represented in the manufacture and distribution of lamps and valves. An important article appears on the subject of valve distortion and its causes, and a useful table is given showing the correct combinations of valves for different receiver arrangements.

oooo

Burndept Festivities.

The social side of a modern wireless business was seen at its height recently, when five hundred members of the head office and Blackheath works staff of Burndept Wireless, Ltd., joined in a Christmas carnival at the Blackheath Concert Hall. Among those present were Sir George Hamilton, one of the directors; Mr. E. P. Shaughnessy, chief engineer of the G.P.O.; and Mr. W. W. Burnham, managing director.

A pleasant evening devoted to a fancy dress parade and dancing to the Riviera Band was concluded with the singing of "Auld Lang Syne."

SCREENING IN RECEIVING AERIALS.

Effect of Surrounding Objects on the Currents Induced in Open and Frame Aerials.

By R. L. SMITH ROSE, Ph.D., M.Sc., A.M.I.E.E., and R. H. BARFIELD, M.Sc., A.C.G.I.

THE object of a screen in wireless is invariably to prevent E.M.F.s being induced in a conductor or piece of apparatus by electric or magnetic forces due either to locally generated oscillations, or to incoming wireless waves. In other words, the object of the screen is to bring about the annihilation of a field of force which would otherwise be present in the region it is desired to screen. This annihilation of the field is brought about by the action of the screen in setting up secondary fields, which are equal and opposite to the primary fields, both in phase and magnitude. This simple statement contains the key to the whole problem, and when once it is thoroughly grasped the design and mode of operation of screens of any description may be easily understood.

Practical Considerations.

In the practical application of screens to wireless receiving apparatus, complete elimination of the forces is rarely required, it being only necessary to reduce their magnitude to a point at which they cease to be of serious consequence for the purpose in hand. In a detailed study of the problem it is desirable to discriminate between two kinds of screening, which are conveniently termed electric and magnetic screening, according to whether it is desired to reduce the electric or the magnetic field. For example, in the first case it may be necessary to eliminate the "capacity" effect between different portions of an amplifier, or to protect a condenser from the effect of the hand of the operator. This is electric screening, and can be effected by interposing a metal grid or plate between the objects to be screened and the source of disturbance. Secondly, we may wish to guard against unwanted magnetic coupling between two inductance coils in a receiver, or to prevent a coil or transformer being acted upon directly by the wireless waves, as in the intermediate stages of a supersonic heterodyne receiver. This is essentially magnetic screening, and is effected by surrounding the component or region to be screened with a number of closed loops set with their planes at right angles to the magnetic field. The mode of operation and suggestions for the design of such screens were described in a recent article[1] by one of the writers. In some cases it may be necessary to adopt both kinds of screening at once, as when it is desired to prevent a very sensitive receiver from picking up signals direct from the incoming waves. To achieve success in this direction it is necessary to adopt the "closed-box" type of screen and to attend to many details of design and construction. An explanation of the mode of overcoming the difficulties involved and details of the design of several screens suitable for this work were given in the article previously referred to. In the present article it is proposed to describe experiments which have been carried out on electric and magnetic screening separately, in relation to the use of frame coils and open aerials for receiving purposes.

Experiments with Frame Aerials.

While the action of a frame coil in receiving wireless signals can be perfectly well explained in terms of the differential effect of the electric field on its opposite sides, it is much simpler to regard it as receiving its E.M.F. by reason of its linkage with the magnetic field of the arriving waves. Viewing the matter on this basis, the two following experiments illustrate the manner in which a frame coil may be screened, or, alternatively, how to avoid such a coil being screened by surrounding objects. In the first experiment, a receiver with a frame coil 2ft. 6in. square was set up inside a number of closed loops, 6ft. square, arranged with their planes vertical and parallel to each other at a distance of a few inches apart, as shown in Fig. 1. When these loops were arranged with their planes in the direction of the transmitting station, they had a large screening effect on the coil inside them. When they were turned through 90°, either so as to be in horizontal planes or at right angles to the direction of the transmitter, the screening effect was nil. Each loop was then cut at one point and an insulator inserted in the gap, when it was found that the system had no screening effect on the coil, no matter in what position it was placed. The explanation of the

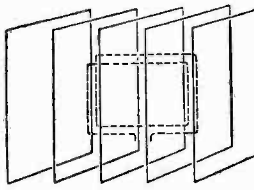


Fig. 1.—Frame aerial screened by closed vertical loops from waves approaching from a direction parallel to the plane of the loop.

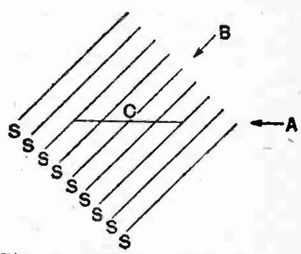


Fig. 2.—Frame aerial C receiving signals from the direction A is screened by vertical loops S from interfering waves arriving from the direction B.

above effects is based upon the fact that the magnetic lines of force in the arriving waves are at right angles to the direction of travel. Hence in the case above the screening loops can produce a counter field, parallel and in opposition to the main field, while when they are turned through 90° they have no current induced in them, and hence can produce no counter field. The last case, when the loops were broken, affords an excellent example of the necessity of having a closed conducting circuit in order to obtain screening action. A useful application of a screening system of closed loops in connection with frame coil reception may be made when it is desirable to reduce the interference effect of signals arriving from a

[1] *The Wireless World*, November 18th, 1925, page 694.

Screening in Receiving Aerials.— direction different from that of the required signals. In Fig. 2 is seen a plan view of a frame coil C set to receive the maximum signals from a transmitter in the direction A, while interfering signals or atmospherics are arriving from the direction B. If a screen of closed loops SS is arranged to be parallel to the direction B, the interfering signals will be eliminated or very considerably reduced.

The second experiment now to be described is particularly interesting as giving a result which may be rather unexpected unless the rules of screening are thoroughly understood. The limbs of a frame coil were encased in a metallic tube so as to form a complete tubular screen round the coil. The coil so enclosed was found to be completely screened. When, however, a saw cut was made through the tube at one point, as illustrated at A in Fig. 3, the screening effect almost entirely disappeared. Indeed, the frame coil functioned almost as if the tube were not present, although the gap in it was not more than a millimetre wide. This experiment was, in fact, a striking example of the necessity of completely closed loops in screening a receiving coil, and illustrates how, without this condition, the energy may get through even the smallest of cracks. From the results of these experiments it may be deduced that a frame coil receiver is very little affected by the presence of metalwork in the neighbourhood, such as electric light wiring or iron pipes, unless these form well-conducting closed loops. On the other hand, the difficulty of receiving signals inside modern steel-frame buildings may be quite well understood.

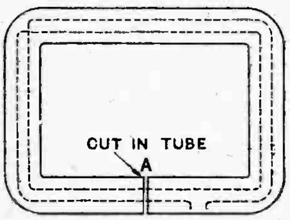


Fig. 3.—Frame aerial enclosed in metal tube.

Electrostatic Screening of Open Aerials.

Turning now to the other half of the problem, viz., the screening of the electric field, the principles upon which this is based may be understood by considering in an elementary manner the operation of a vertical aerial. In Fig. 4 is represented a vertical aerial placed in the path of arriving wireless waves which in the ordinary way have their electric force, E_1, practically vertical. This force induces an electromotive force in the aerial exactly in phase with it, and as a result a current flows up the aerial. This current causes an electric charge to build up at the top of the aerial with the result that a secondary electric field, E_2, is produced around the aerial. At points near the earth it is evident that this secondary field is vertical, and is thus parallel and opposite to the primary electric field of the arriving waves. It is thus evident that if the phases of the two fields can be made similar a reduction of the electric field of the arriving waves will take place round the base of the aerial. A consideration of the case outlined above shows that the correct phase relationship is brought about when the natural wavelength of the aerial is much less than that of the arriving waves. For aerials of moderate height and any but the shortest wavelengths, this condition is fulfilled by simply connecting the aerial to earth untuned. In this condition, of course, the current flowing may be very small, and it is to be expected that the reduction of field in the neighbourhood of a single wire aerial may be very small. It is further to be pointed out that near the upper half of the aerial the direction of the secondary electric field is materially different from that of the primary field, and thus the reduction in strength of the latter may be small in this region.

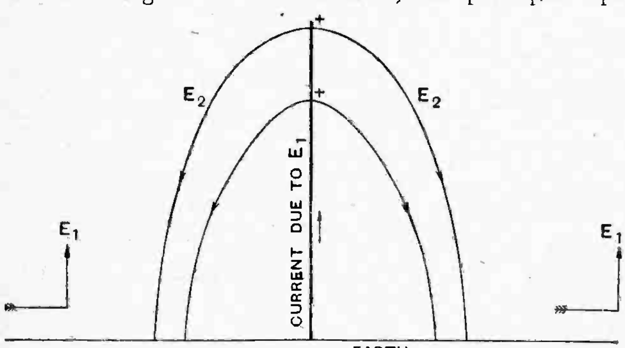


Fig. 4.—Secondary electric field E_2 due to the current charge induced in an untuned aerial by the electric field E_1 in arriving waves. The reduction of the field E_1 by E_1 is the same on both sides of the aerial.

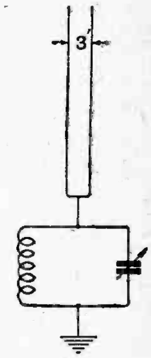


Fig. 5.—Twin-wire vertical aerial used in screening experiments.

Screening Experiments with Vertical Wires.

A description may now be given of some experiments undertaken with the object of ascertaining the effect of a screen of vertical wires used in the manner just described, in reducing the electric field in the neighbourhood. As a means of detecting the presence or absence of such a field, a simple vertical aerial receiver may be employed. A vertical aerial was therefore erected 40ft. high, consisting of two wires spaced 3ft. apart. In the first experiment the wires were insulated at the top and joined together at the bottom to form a single aerial, which was then tuned by a series inductance in parallel with a variable condenser, as shown in Fig. 5. A cage of four vertical wires fixed at the top and bottom to the corners of a wooden frame five feet square was then erected round the aerial. Both the aerial and cage were supported by pulley arrangements, so that either could be raised or lowered at will. A switch was provided so that the cage could be connected to earth when required. In the first test the cage was hauled up so that it projected about two feet above the top of the aerial. When receiving signals on a wavelength of 600 m., it was then found that :—

(1) No change in signal strength was produced when the cage was earthed, showing that the screening effect was practically negligible.

(2) When the cage was tuned in the same manner as the aerial, there was also no change in signal strength.

(3) When the cage was used as an aerial in place of the two parallel wires, it was found to give much greater signal strength.

Screening in Receiving Aerials.—

The aerial within the cage was then lowered, and tests (1) and (2) were repeated for different heights. At a height of 30ft. the earthing of the screen produced a just noticeable drop in signal strength, showing that the screen was beginning to be effective. Finally, when the aerial was only a quarter of the height of the screen, the effect of the latter was very marked when earthed in the untuned condition. When the cage was tuned at this position a very marked increase of signal strength was obtained on the aerial.

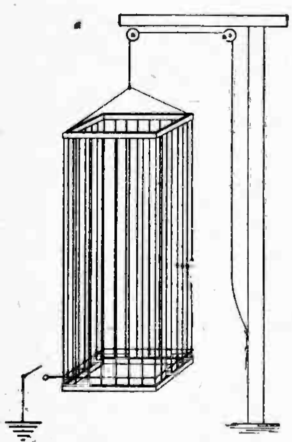


Fig. 6.—Multiple wire vertical screen for electric fields.

The number of wires in the cage was now increased to eight along each side of the five-foot square as shown in Fig. 6, and the aerial within was restored to its full height. It was then observed :—

(1) When the cage was earthed, signals previously quite loud were reduced nearly to inaudibility.

(2) When the cage was tuned, the signals on the aerial were markedly increased.

Magnetic Field Inside Electric Screens.

These results are in complete accordance with the theoretical principles of electric screening which were given above. For when the cage was connected to earth in the untuned condition, it is operative in reducing the electric field of the incoming waves. Although the effect of one or two wires is small, the combined effect of a large number of wires is so large as to make it difficult to receive signals on an aerial inside the screen. It was shown that it is important to have the screen higher than the aerial, due to the curvature of the lines of electric force near the top of the screen wires. Finally, if the screen is tuned to the wavelength being received, the phase of the secondary field is altered, so that, instead of opposing the primary field, it actually assists it with a resulting increase in the strength of signals received on the aerial. Since the unearthed wires of the cage are untuned conductors, they must also produce some screening effect in this condition. This effect is, however, small compared with that obtained on earthing the screen. By using a large number of wires at a spacing small compared with the region to be screened, a considerable screening action can be obtained without any connection to earth.

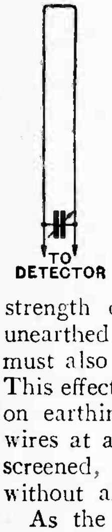


Fig. 7.—Vertical loop aerial used to demonstrate the existence of the magnetic component of arriving waves in the screen (Fig. 6).

As the reasoning given above has now been verified experimentally, it may be extended to a consideration of the state of the magnetic field. This leads to the deduction that the resultant secondary magnetic field within the screen due to all the wires will be practically zero. Hence the primary magnetic field due to the arriving waves should be received unimpaired. To test this point, the two aerial wires were joined together at the top and opened at the bottom, a series condenser being inserted to form a tuned vertical loop as shown in Fig. 7. The strength of signals received on this loop

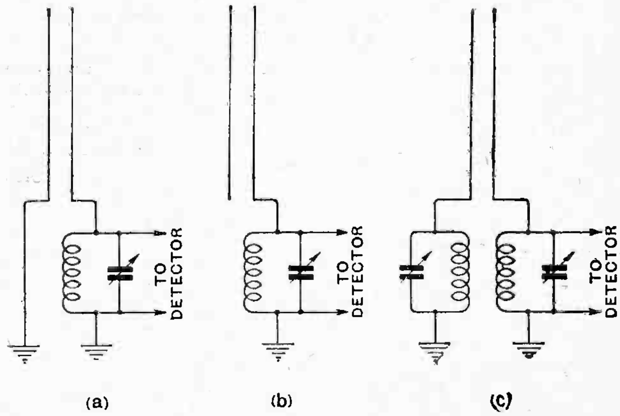


Fig. 8.—Arrangement of two vertical aerials to demonstrate mutual screening effects.

was not noticeably affected by the earthing of the cage, showing that there was no perceptible screening of the magnetic field, thus confirming the prediction made above. Subsequent tests made with a direction-finder inside such a screen showed that the direction of the magnetic field was also unaffected by the presence of the screen.

We have thus arrived experimentally at a conclusion which may sometimes have important and somewhat unexpected results. For example, it is quite possible to have a blind spot of reception of wireless signals on an open aerial, whilst reception on a frame coil remains unaltered.

As a further experiment, the cage in the above arrangement was removed, and the two aerial wires were insulated from each other. With the wires set at their maximum spacing of 3ft., the signals received on one of the wires was unaffected by the earthing or tuning of the other wire. When the wires were placed at six inches apart the earthing of one wire produced a slight decrease

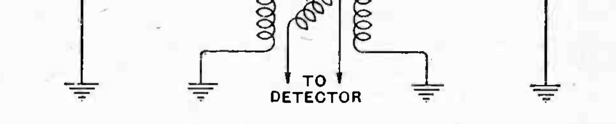


Fig. 9.—Measuring the effect of screening the vertical portions of inverted L aerials.

Screening in Receiving Aerials.—
in the signals received on the other wire. This result is important in showing that the existence of untuned earthed conductors, such as water pipes and lightning conductors, in the proximity of an aerial, produce no noticeable effect on the strength of received signals. A word of caution must be inserted here in reference to the effect of neighbouring conductors in materially altering the effective capacity of an aerial, a subject which is outside the scope of the present article.

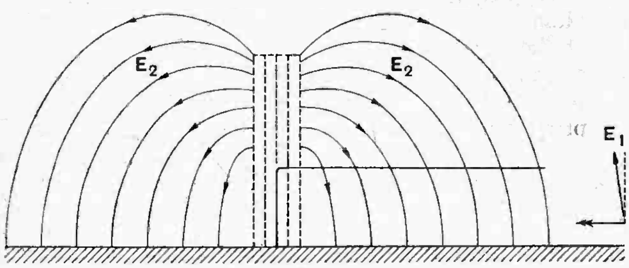


Fig. 10.—Secondary field E_2 set up by currents in the vertical screen.

Having obtained some very definite practical information on the screening of a simple vertical aerial, it will now be interesting to investigate the possibilities of screening the whole or a portion of an aerial containing both vertical and horizontal members. This matter became of very great importance in some experiments of the writers, in which it was desired to shield the vertical part of an inverted L aerial, without, if possible, affecting the horizontal portion. The difficulties in the way of realising this were well illustrated in the experiments about to be described.

Screening Inverted L Aerials.

Two exactly similar inverted L aerials, with a horizontal length equal to several times the height, were erected at a distance apart sufficient to avoid any coupling between them. As shown in Fig. 9, a vertical electric screen, of the type described above, was then placed round the vertical member of each aerial, the height of the screen being twice that of the aerial. The aerials were oriented so that one of them pointed directly towards, and the other away, from the transmitting station as depicted in Fig. 9. Leads from the two aerials were connected to earth through the field coils of a radiogoniometer. This instrument, which is used in the Bellini-Tosi system of direction-finding, is really a mutual inductance with two primary or field coils fixed together at right angles, and a secondary or search coil rotating inside them. The construction of the coils is such that the mutual inductance is proportional to the cosine of the angle between their axes. By connecting this goniometer in the manner described, it was possible to measure the ratio of the currents received in the two aerials to an accuracy of about 5 per cent.

Now, as is well known, the inverted L aerial is a partly directional receiver, due to the E.M.F.s induced by the incoming waves in the horizontal and vertical portions. Although in the ordinary way this directional effect is extremely small on medium and long wavelengths, it is easily measurable on the wavelengths from the broadcast band downwards. For two aerials arranged as in Fig. 9, the aerial pointing away from the transmitter receives more current than the one pointing towards the transmitter, the difference being proportional to the ratio of the E.M.F. induced in the horizontal portion to the E.M.F. induced in the vertical portion. Hence, by measuring the directional effect of the aerials before and after screening, the extent to which the vertical E.M.F. is reduced by the cage can be accurately measured. When this was carried out there was found to be no change whatever in the directional properties of the two aerials. This demonstrates that, by merely screening the vertical part of a bent-top aerial, a negligible effect may be produced on the aerial as a whole.

Secondary Field Produced by the Screen.

This result appears a little surprising at first sight, but a little consideration will show that it has a fairly simple explanation. In the first place, as was definitely shown in the previous section of this article, the screen must actually have reduced the electric field inside it to a very small value. The screen must therefore have prevented the incoming waves from inducing any E.M.F. in the vertical limb of the aerial. At the same time, however, it is evident that the currents in the screen will set up a secondary field outside it, and that this field can have an appreciable horizontal component in the neighbourhood, as depicted in Fig. 10. In the above experiment this secondary field acted on the horizontal portion of the aerial in such a manner as to replace the screened vertical field. A study of the directions of the fields operating shows that such an action is reasonable, but it was somewhat extraordinary to find that the compensation of the secondary field for the screened vertical component

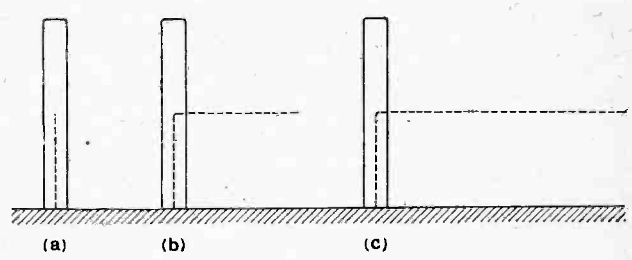


Fig. 11 —Experiments to determine the effect of a vertical screen on inverted L aerials of equal height and varying horizontal length.

of the primary field should be so exact. An inspection of Fig. 10 shows that a shorter horizontal limb should have less E.M.F. induced in it, and the aerial should then show some screening action of the cage. The following experiment was accordingly carried out to test this deduction.

A straight vertical aerial about 15ft. high was first erected inside a vertical cage, 40ft. high, as depicted in Fig. 11 (*a*). This was found to be completely screened for all practical purposes. A horizontal portion was now added to the aerial in successive stages, as shown in Fig. 11 (*b*) and (*c*), and the test repeated for each stage. It was found that, with even a length of only 10ft. protruding, the effective screening action was considerably

Screening in Receiving Aerials.—
reduced, and that it diminished steadily as each successive stage was added. In general it was found that the screening of the vertical lead was only effective when the horizontal length was less than the height of the screening cage.

General Conclusions.

These last-described experiments, beside being of scientific interest, have some bearing on practical radio reception, for it appears that there is no need to try to prevent a down lead from being screened, provided that there is a sufficient horizontal portion attached to it. For example, it would appear that a down lead taken in through an attic window and then down inside a house would be just as effective as a lead taken down outside the house, provided that the horizontal part of the aerial was greater than the height of the house. In the same way, the down lead of such an aerial would not be appreciably screened by the presence of a metallic supporting mast, even if the lead were inside the mast. The authors wish it to be clearly understood that they are not advocating experimenters to be careless in the arrangement of their aerials. What may be very serious in the above cases is the shunt capacity effect of neighbouring objects in diverting the aerial current to earth away from the receiving instrument. Another point of importance also is that serious eddy current and dielectric losses may be introduced into the aerial circuit if the down lead is very close to other objects, whether earthed or not. Both of these disadvantages can be overcome, however, by allowing as great a spacing as possible between the aerial lead and the surrounding objects.

A Common Fallacy.

Finally, the writers would like to dispose of a fallacy not uncommon among experimenters, to the effect that the screening action of neighbouring objects on an aerial has a directional property. One often reads and hears the complaint that an aerial is badly screened "in the direction of the transmitter." The principles of electric screening as explained in this article should make it clear that the secondary electric field which is operative in opposing the primary field of the wave is, in general, symmetrical about the screening object, such as a group of trees or a building. Thus the screening of the latter is independent of the direction of arrival of the wireless waves, and it is immaterial whether the obstacle is between the transmitter and receiver or not (compare Fig. 4). It is only in the cases where the dimensions of the obstacle are large compared with the wavelength that anything approaching a definite shadow effect is thrown by the obstacle in the direction of transmission. In most ordinary cases of aerials erected in residential districts, this will occur only with short waves of length 50 metres or less.

Calls Heard.

Extracts from Readers' Logs.

Harborne.

(December 1st to 22nd.)
South Africa: OA4L, OA4Z, OA3E, OA6N. Phillipine Is.; 1FN, 1CW, 1HR, NA5D. China: GFVP, NEQQ. Honolulu: HU6BUC. Australia: 3AO, 3BO, 3BM, 3LM, 3LZ, 3EF, 6AG. New Zealand: 2AC, 2XA, 4AC, 4AV, 4AR. French Indo-China: FI8QQ. Chile: 2LD. Argentine: CB8, BG8, AF1, BA1, DD7. Brazil: 1IC, 1AL, 2AF, 1BF, 1BD, 1AE, SQ1. U.S.A.: 5ALZ, 5FC, 5MS, 5ATT, 5YD, 5ZAI, 6BAV, 6HM, 7UZ, 9DMI, 9ADO, 9EGU, 9BOW, 9DS, 9ZT, 9DKA, 9VO, 9DPX, 9DNG, 9EK, 9BVS, 9BVH, 9XAX, 9ADK, 9EBA, 9DOL, 9BXS, 9CIP, 9DBH, 9EHS. Various: E1BH, E1ES, E1EH, 8AG, 85N, NISP, NISR, NIST, NGY, NFV, GDVB, C4GT, Y5CP.
(0-v-1.)
T. S. Calder.

Funchal, Madeira.

France: 8TOK, 8DI, 8GM, 8WW, 8XP, 8QQ, 8JN, 8FW, F3CA, Maroc. America: 2LU, 1BQI, 8ALY, 2BBX, 4JS, 2BEE, 1AOU, 1ER, 3APY, 1AF, 1ATV, 1UW, 2CX, 3JW, 1BQK, 1CKP, 2AK, 1GR, 1AOF, 3AUV, 9BNA, 2LD, 2APV, 3LW, 3BNU, 8DA, 8DON, 1JR, 2JW, 1AAO, 2CLG, 1AZD, 3BHA, 1CNP, 2AKY, RLU, 2MC, 2UF, 1CMF, 1GA, 2BG, 8AJ, 8XE, 1AXA, 2ANM, 2AGY, 1HI. Great Britain: 2NM, 2NB, 2KF, 2DX, 5MO, 2RB, 2OJ, 2CC, 6TD, 5DA. Holland: NPB3, PCLL, PCUU, PCMM. Brazil: 1AV, 2AF, 1IC, 2UF, 4YZ. Canada: 1AR, 1AM. Italy: 1AS. Spain: EAR2. South Africa: A4Z.
A. C. de Oliveira (P3CO).

Ashton-under-Lyne.

Great Britain: 2IA, 2QB, 2KW, 2LZ, 2VS, 2QV, 2PZ, 2NB, 2SZ, 2PO, 2OD, 2VQ, 5VL, 5RB, 5MQ, 5PM, 5WQ, 5XY, 5PD, 5YM, 5DH, 6FA, 6UZ, 6BD, 6YC, 6OG, 6KU. France: 8LZ, 8MH, 8DKV, 8LGC, 8IL, 8RIC, 8IX, 8RKX, 8HMIN, 8RIT, 8EK, 8RZ, 8JN, 8NA. America: 2QB, 2FO, KDKA, WQO, 2XAF. Belgium: B-O8, 4RS, 4YZ, S4. Holland: N-OKV, OWB, PB3, PCLL, OVB, 2PZ, OPX, OFP, OWC. Germany: KL4, KK7, KK1, K5BB, K1W, K2HR, KY5. Italy: I-1BW, 1CO, 1AY, 1MD, 1MT. Spain: EAR20. Scandinavia: S-2CO. Sweden: SMXT, SMWS. Various: BB-A22, 1ZA, BB-C22, LAB-BU3, 1BDI, 3BWT, F7VX, KPL, SS7, 8ACK, FOIGI (F8GI?).
(0-v-1.) 40 to 150 metres.
K. Gooding (G-2ARI).

Lowestoft.

(November 2nd to December 31st.)
Great Britain: 2BZ, 2IT, 2OF, 5PM, 6CL, 6LC, 6OX, 6YW, BYC. France: 8BOR, 8EA, 8JE, 8JN, 8PEP, 8RZ, 8USE, 8VX, 8WW. Holland: NOQX, PCLL. Sweden: SGC, SGT. Belgium: H6, J9, 67. Italy: 1AF, 1GN, 1MV. Ireland: 7VX. Germany: POF. Porto Rico: PR4JE. Africa: MAROC. U.S.A.: 1AAP, 2AMJ, 2AGQ, 3PB, 3BHV, USS "Seattle." Miscellaneous: Y8, PEH.
(0-v-1.)
P. L. Savage (G2MA).

London, S.E.27.

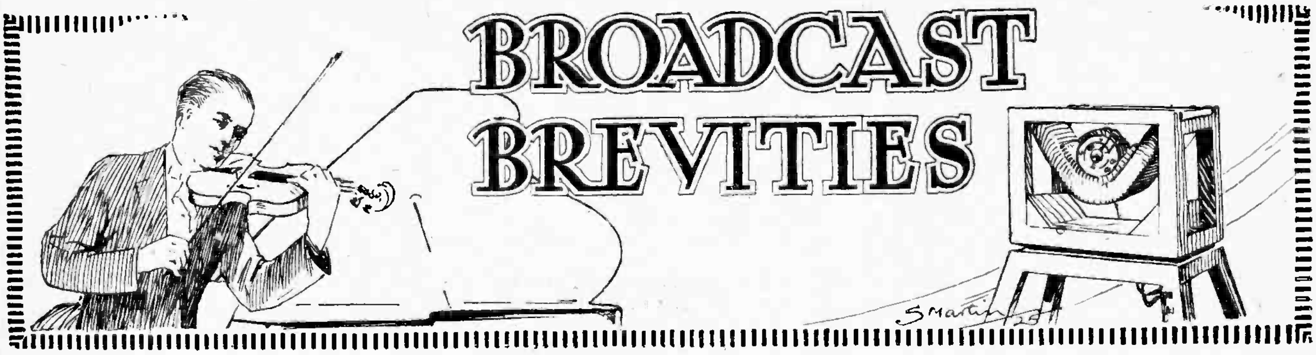
Great Britain: 2BER, 2BGO, 2EB, 2FK, 2IA, 2IT, 2OF, 2QB, 2QV, 2UD, 5GS, 5KO, 5MB, 5WV, 6AH, 6GF, 6JH, 6JJ, 6RW, 6UZ, GI6MU, GI6TB. France: 8DK, 8IK, 8PEP. Holland: OCZ, OKS, OMS. Various: BB2, BH6, BL9, F7VX, I1BB, KK4, SMU1, S2CO, S2NX, LA1A, LA4X, E1BH, FI8QQ, YHBK, HU6BUC, OA4Z, OA6N, PI1HR, PR4SA, Q2BY, RAA8, RCB8, Z3AF, Z4AV, Z7UZ, Z4AN.
L. F. Aldous (2ZB).

London, W.1.

(During December.)
Great Britain: 2BAO, 2JJ, 2UV, 2GY, 2VL, 6IV, 6YC. France: 8DP, 8GC. Italy: 1AS, 1AF. Germany: POF, K2W. Holland: PCLL. Switzerland: 9ES. Scandinavia: 2CO, 8ND. U.S.A.: 1RR, 1AXA, 1II, 1BW, 2XAF, 2XG, KDKA, WIZ, WQO, WIR. Brazil: 1IA. Miscellaneous: FW, AFP1, 1JS, 1LA, 1PF, RRP.
(0-v-1.) All below 90 metres.
M. Williams.

Halifax.

(December 22nd and 23rd.)
South Africa: A3E, A4Z, A6N. Russia: RCRL. Unknown: X2BG (to A3E), NRDM. U.S.A.: 1RD, 1CMP, 1AAC, 2AHK, 2EK, 2BBB, 2CK, 2GPK, 3BS. Australia: 3BD, 3KB. Philippines: NEQQ. French Indo-China: 8QQ. South Africa: A4Z. Unknown: CRP (to G2CC), N.G.Y.
H. Whitaker.



SAVOY HILL TOPICALITIES.

By OUR SPECIAL CORRESPONDENT.

Broadcasting to America.

2LO, Daventry and Bournemouth will transmit separate programmes to America from 4 to 5 p.m. on January 25th. Daventry, Aberdeen and Cardiff are each to transmit special programmes to America on January 27th.

oooo

Thrilling Experiences.

The broadcast engineers who have been conducting experiments for the past year or two in receiving from and transmitting to America have a wonderful story to tell, made up mostly of discomforts and disappointments; but certainly also some thrills, and these have compensated for all the trials and troubles.

oooo

Early Efforts.

The attempts at reception at Biggin Hill, in December, 1923, were made during blizzards. A twelve-valve high-frequency receiver was used, and the American programmes were received at full strength; but the set also recorded all the Morse stations in Europe, practically every storm that was raging in the world, and the harmonics of most of the high-power stations.

The First Relay.

All kinds of circuits were used, and, finally, a seven-valve high-frequency amplifier, followed by two stages of low-frequency amplification, was found to give the best results. The East Pittsburg station of the Westinghouse Electric Company was picked up very successfully on several nights, but it was not until December 28th, 1923, that the first relay through 2LO could be carried out. On that date the music was distributed through London to all stations.

oooo

Subsequent Relays.

A large number of relays took place in February, March and April, 1924, both from New York and Philadelphia. The February transmissions from KDKA and WGY in February, 1925, were picked up by numerous listeners in this country; but the reception at Keston of KDKA on December 15th, 1925, when American dance music was relayed through 2LO to Olympia and all stations of the B.B.C., in connection with the Radio Revels, was far more satisfactory than any previous attempt. All these transmissions were carried out on short waves, varying between 100 and 63 metres.

oooo

FUTURE FEATURES.

Sunday, January 17th.

LONDON.—3.30 p.m., The Band of H.M. Scots Guards.

BOURNEMOUTH.—3.30 p.m., A Symphony Concert.

Monday, January 18th.

5XX.—8 p.m., An Hour of Musical Comedy.

BIRMINGHAM.—8 p.m., An Hour with the Operas.

NEWCASTLE.—8 p.m., Mozart and Weber.

Tuesday, January 19th.

LONDON.—8 p.m., Variety.

ABERDEEN.—9 p.m., Light Orchestral Programme.

BELFAST. — 8.50 p.m., "View Hulloa"—Programme of Hunting Music.

Wednesday, January 20th.

LONDON.—8 p.m., Chamber Music.

BIRMINGHAM.—Opening of New Studio.

CARDIFF.—8 p.m., "In Praise of Musicke."

NEWCASTLE.—8 p.m., "In Spain."

GLASGOW.—8 p.m., Choral and Orchestral.

Thursday, January 21st.

LONDON.—8 p.m., "A Pickwick Party." 9 p.m., Farewell Performance of the Radio Radiance Revue Company.

5XX.—9 p.m., An Hour's Variety.

BOURNEMOUTH.—8 p.m., A Mock Trial.

MANCHESTER.—8 p.m., Lancashire Talent Series: Preston.

ABERDEEN.—8 p.m., A Scottish Programme.

Friday, January 22nd.

LONDON.—8 p.m., The String Band of the Royal Regiment of Artillery.

NEWCASTLE.—8 p.m., Instrumental Variety.

GLASGOW.—8 p.m., Empire Phono-Flight—David Livingstone, an Epic of Africa.

Saturday, January 23rd.

LONDON.—8 p.m., Light Russian Programme. 9 p.m., Reminiscences of the "Follies."

Long Waves Best?

The virtues of short-wave broadcasts are not, however, yet proved; for on January 1st-2nd of this year Daventry made its first real attempt to transmit a special programme to America on 1,600 metres. Music and speech were picked up clearly at Belfast, Maine, super-ceiving station, relayed on a short wavelength to Bound Brook, New Jersey, re-broadcast throughout the American continent, and simultaneously picked up at the British receiving station and relayed back to 2LO.

oooo

A Grand Howl.

One member of the small party present at the studio inquired what would have happened if 2LO had relayed the programme, as it was received from WJZ, to Daventry for re-transmision—his idea apparently being that something in the way of perpetual motion would thus be achieved. The result would have been that 5XX would set up a howl that would have been heard right across the American continent.

oooo

Daventry's New Aerial.

The exact type to be used for the new aerial at Daventry has not at the time of writing been decided; but it is probable that the top part will be of steel, as phosphor bronze is rather difficult to manage, owing to the weight involved in an aerial of the extraordinary length of 800 feet. There is a pull of 10,000 lb. on the stays; multiplied by two to provide the necessary factor of safety, we have a pull of about 10 tons. In a gale of wind the strain is enormous.

oooo

Improvements Effected During 1925.

Among the outstanding accomplishments of the year 1925 were the opening of the Daventry station; the design and construction of a special lines simultaneous board which is unique in the world; the design of speech transformers which, thanks to practical and theoretical researches, have an equal response characteristic between 100 and 8,000 vibrations a second and practically equal between 50 and 10,000; and investigations in the characteristics of transmitters, resulting in greatly improved response curves.

○○○○

Forward in 1926.

All these have been described fully from time to time in *The Wireless World*, and it is only necessary to say here that the year 1926 will see a vast amount of steady, painstaking work on similar lines going forward to the benefit of broadcasting and the listener. Research and experiment are as vital to wireless art as they are in all industry to-day. We are on the threshold of new developments in broadcasting, and the B.B.C. tell me that the best talent is to be engaged on this work when and where it is available.

○○○○

The Savoy Bands.

The reported intention of the Savoy Hotel to withdraw its bands from broadcasting on February 27th next has disturbed a number of listeners, and has drawn some protests from many who do not think that one of the reasons given by the Savoy, viz., that the bands have been broadcasting for two years and a half and require a rest, is adequate to account for their withdrawal from the programmes. The second reason reported is that a change of policy has taken place at the Savoy.

○○○○

A Question of Contract.

All that is known at the B.B.C. is that the present contract with the Savoy expires at the end of February and that negotiations for a new contract were in progress when the Savoy's alleged decision was published in the Press. No one, as the Savoy officials have themselves indicated, could have foreseen, when their dance bands started broadcasting, that dance music by broadcast would gain the immense popularity that it has gained. To meet the demand for dance music, the B.B.C. engaged other dance bands than those of the Savoy; but everybody will be sorry if the Savoy bands for that or any other reason drop out.

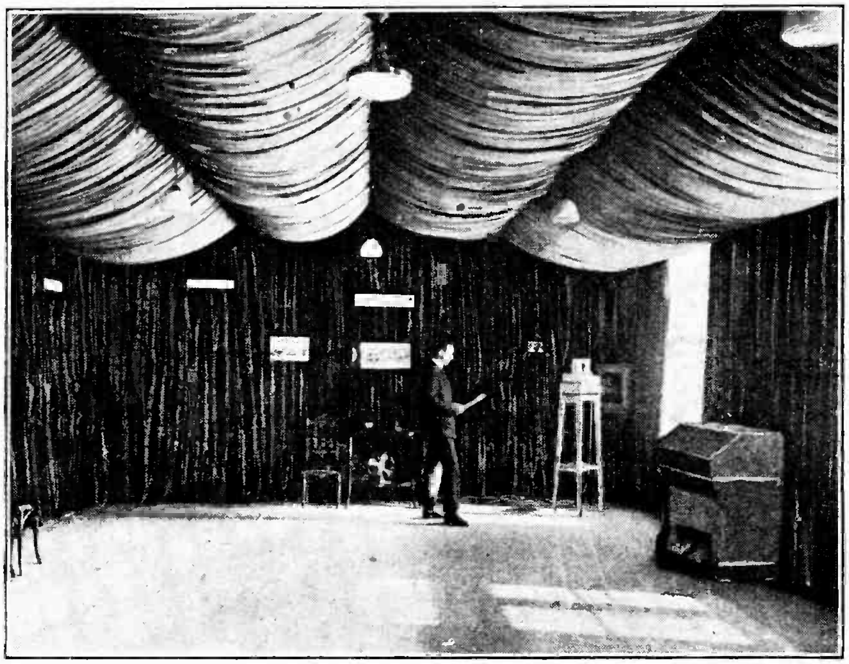
Mr. Donald Calthrop.

After three months' service with the B.B.C. as organiser of dramatic and musical programmes, Mr. Donald Calthrop has resigned his position in order to return to his own branch of the entertainment industry.

○○○○

Theatrical Canutes.

While he will apply himself chiefly to the production of revues, he will take an active part in establishing liaison between the entertainment world and wireless. "What one has to fight," he says, "are the vested interests of the entertainment world, the resident managers and owners who have not yet seen the advantage of having their shows broadcast. I, for one, will never sign a contract that prohibits me from broadcasting and I shall represent to theatrical producers, wherever I go, that it will be all to their advantage to cease acting as theatrical Canutes in trying to stop the wavelengths. Broadcasting has come to stay, and the sooner the theatrical profession as a whole comes to realise it, the brighter will be their own prospects so far as the box office is concerned."



"HIER RADIO WIEN!" A new photograph of the studio at the Vienna broadcasting station. Special attention has been given to the draping to avoid undue echo.

○○○○

Sunspots.

The effect of sunspots on broadcasting is not likely to be known until 1927, when results will be judged over a period. Ordinary broadcasting as well as long-distance reception have not yet suffered, despite their recent appearance.

○○○○

"What Wireless Does."

"It may come to it yet," says an Eastern Counties newspaper, in a leading article on "What Wireless Does," "that before they (theatrical producers) give consent to their performances being broadcast they will not be satisfied with less than generous terms, sufficient to indemnify them against any potential loss through the broadcasting of excerpts from plays." It would be amusing to see a theatrical manager fixing the figures of "potential" loss. Obviously, he would start by assuming that every play he staged would be a roaring success if broadcasting did not exist. In the end it would pay theatrical managements to put on failures and get their money back from the B.B.C.

○○○○

"A Message from Mars."

Listeners who enjoyed the surprise item in the programmes a few days ago, when Captain Eckersley got into communication with Mars, will learn with interest that the chief engineer is to figure on February 9th, in an oscillation "tragedy." Geneva will be supposed to put him on the track of a mad musical genius who lives in Berkeley Square and who is upsetting receiving sets, far and wide, with his oscillation pranks. The chief engineer runs him to earth, but is captured by the oscillator, a foreign gentleman of Bolshevik tendencies, and imprisoned in one of the pipes of a magnificent organ which he has in his house. "When I do blay vun certain chord," cries the musician, "zen pouf! up you vill go, Mistare Eckairslee, and to ze B.B.C. you vill go no more." Captain Eckersley's appeals for release should cause much merriment.

○○○○

A Tragedy Averted.

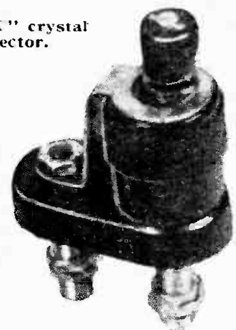
The Eastbourne transmissions have invariably been of first-rate quality and the matter transmitted has been equally excellent. But somehow on the first Sunday broadcast that they have ever given, namely, on December 27th, Sandler and his orchestra were not altogether felicitous in their choice of items. The programme would have finished up with Handel's Largo, followed by the well-known fox-trot, "I Want to be Happy," as the last two items, had not the announcer at Savoy Hill sent an urgent telephonic request that the orchestra should conclude with "The Lost Chord." The closing prayer following a fox-trot would have been deplorable.

A Review of the Latest Products of the Manufacturers.

THE "K" CRYSTAL DETECTOR.

A simple form of plug-in crystal detector is sold by Wates Bros., Ltd., 12-14, Great Queen Street, Kingsway, London, W.C.2. differing in design from the galena type which is now so generally adopted.

The crystal itself is probably an artificial product, for it completely fills the cup into which it is fitted, whilst the surface is rubbed down to be quite flat. The pressure exerted by the wire contact is maintained by a coiled spring, the contact point passing through a small eye in a brass guide piece which holds it in place and prevents it from becoming bent as it travels over the face of the crystal. Both the adjusting knob and the outside of the container are provided with milled edges, the former controlling the rotation of the wire contact on the crystal surface and the latter by means of an eccentric mounting searching the surface of the crystal.


The "K" crystal detector.

An unusual feature is that no provision is made for adjusting the pressure of contact, thus simplifying the operation of the detector.

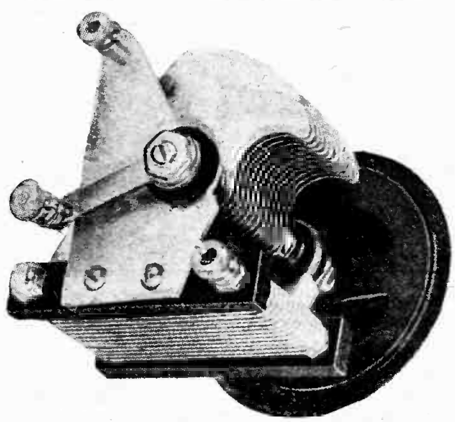
On test, the detector was found to be easy to set and quite sensitive, and judging by its effect on the tuned circuit one may conclude that the resistance of the contact is higher than that of most galena detectors. The manufacturers recommend this detector for use in reflex circuits.

oooo

THE LAMPLUGH SQUARE LAW CONDENSER.

The Lamplugh condenser, with its peculiar spade shaped plates, was recently referred to in these columns, and a new model has now been introduced in which minor modifications have been made with a view to offering it at a really popular price.

The fixed plates are mounted on two ebonite bars to separate them from the end mounting pieces so that the spindle and moving plates can be connected up with the earthed side of the tuned circuit. Ebonite insulating bushes are also inserted in the aluminium end plates, though their purpose is not apparent. A spring washer is employed to hold the moving plates centrally in position between the fixed plates in conjunction with an adjusting screw. The spindle is threaded and passes through a one-hole fixing bush. A good feature is the pressing of a pattern into the surface of the aluminium plates to stiffen them. A certificate of the National Physical Laboratory is included in the carton, and shows that a tuning range of 170 to 750 metres is produced when a coil for broadcast reception is bridged with a Lamplugh condenser having a capacity of 0.0005 mfd.

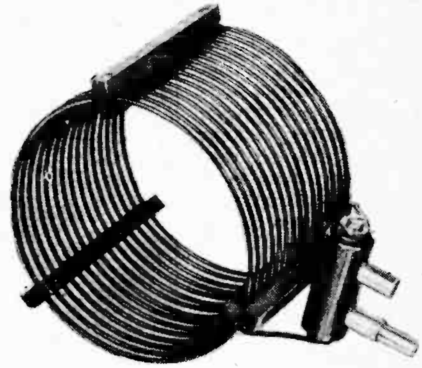

The new model Lamplugh variable condenser.

oooo

EDDYSTONE NEW SHORT-WAVE COILS.

Messrs. Stratton & Co., Ltd, Balmoral Works, Bromsgrove Street, Birmingham, manufacturers of Eddystone tuning inductances, have recently extended their range of coils to include a set of three for use on the wave band of 25 to 100 metres.

The form of construction is obvious from the accompanying illustration and consists of a helix with turns clamped in position by means of slotted ebonite strips. The coil is particularly robust and, although the only support between the winding and the plug and socket mount is provided by the leads themselves, the coil will remain firmly in position when plugged into a coil holder.


One of the Eddystone low loss coils, which supplied as a set of three can be used for tuning over the wave band of 25 to 100 metres.

This type of inductance is in constant demand for the construction of short-wave receivers, and one can, of course, easily detach the two-pin mount where the design of the set does not call for the interchanging of inductances.

oooo

CONDENSERS FOR CURRENT FROM MAINS.

The rapid progress which is being made towards the adoption of public supply for providing current for the operation of receiving sets calls for a word of warning with regard to the type of fixed capacity condensers permissible for use in circuits connected to the mains.

The Telegraph Condenser Co., Ltd., West Park Works, Mortlake Road, Kew Gardens, London, draw attention to the need for employing condensers which are designed especially to withstand high potentials in all circuits connected to the mains. Included among the many types of condensers produced by this company is a series intended to withstand D.C. potentials up to 1,500 volts and available in sizes having large capacity values. A comparison in the relative size of this type with the well-known H.T. battery bridging condenser is made in the accompanying illustration, both condensers having a capacity of 2 mfds.

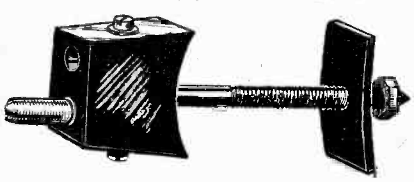
A constant D.C. potential of 2,000 volts was applied across the terminals of this condenser, and there was no indication of breakdown or low insulation. The condenser charged in this way was discharged several times by short circuiting, and the dielectric showed no signs of breaking down when subjected to this strain.

Condensers of this type will be found particularly useful in the smoothing circuits of low power transmitting apparatus, and many transmitting amateurs will be glad to learn of their existence. When used in conjunction with a transmitting set, however, care must not only be taken to avoid the application of oscillatory potentials across the terminals of the condenser, but in the smoothing circuit one must bear in mind that high potentials are often set up when the current through the smoothing inductances is interrupted. It is advisable also to heat the transmitting valve filaments before applying the plate voltage to the smoothing condensers to prevent undue voltage rises occurring.

oooo

THE BURWOOD COIL MOUNT.

The winding of basket coil tuning inductances is an easy matter, though difficulty is usually experienced in providing



The Burwood coil mount.

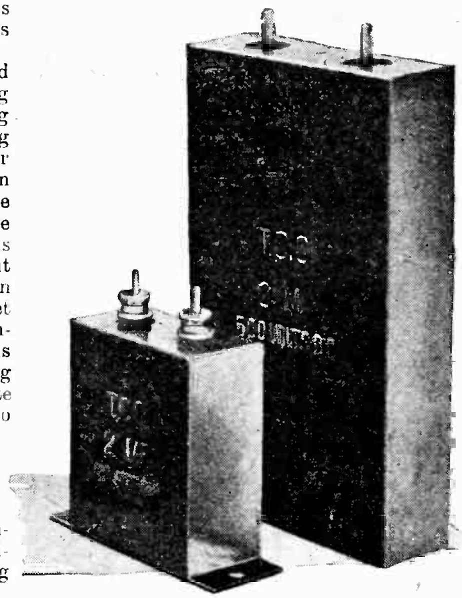
a robust form of mounting which will hold the coil securely in position on the plug and socket.

Burwood (Concessionaires), Ltd., 41, Great Queen Street, Kingsway, London, W.C.2, manufacture a useful coil mount by the use of which the amateur can construct tuning coils according to his own design, and carefully adjusted in size to suit his particular requirements.

UTILITY VALVE SWITCH.

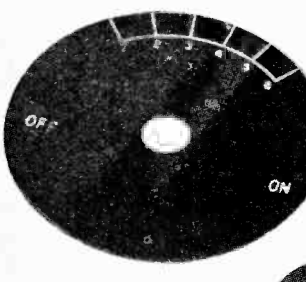
The change-over Utility switch manufactured by Wilkins & Wright, Ltd., Utility Works, Kenyon Street, Birmingham, is well known to readers.

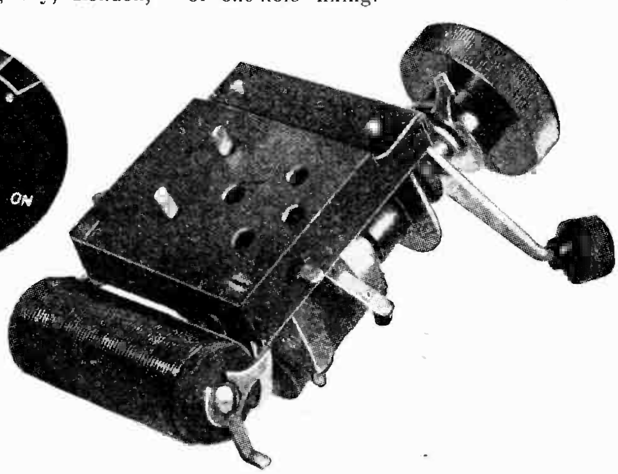
It is now available in an elaborated form consisting of a two-pole



T.C.C. condenser of 2 mfd. capacity and capable of withstanding potentials up to 1,500 volts compared in size with a H.T. bridging condenser of the same capacity. This condenser is recommended for use in apparatus connected to public supply mains.

switch fitted with a valve platform, valve holder and filament resistance. Combining these three components in a single unit, space is saved both in front and behind the panel, a considerable amount of wiring is avoided, while the unit is secured in position by means of a single hole in the panel, making use of one-hole fixing.





The Utility valve switch unit incorporating the Utility two pole switch, valve holder and filament resistance.

Accompanying the unit is a pamphlet of instructions suggesting several circuits in which it can be employed and showing the method of connecting up. The circuit arrangements chosen, however, are not the best that could have been advised for general use, and one of them, a resistance-capacity coupled set with two high frequency amplifiers and two L.F. stages, does not illustrate to the best advantage the application of this unit. It would be most useful in building up a four-valve receiver consisting of a single high frequency amplifying stage followed by a detector valve and two optional low frequency amplifiers. In this case four units would be employed to carry the valves, whilst only three switches strictly will be needed. The switch on the detector valve can, however, be put to the useful purpose of disconnecting the high and low tension batteries.

This new unit is of particularly reliable construction, and the knob with indicating scale, pointer and concentric switch lever presents an attractive appearance upon the instrument panel.

oooo

PARAGON PANELS.

The convenience of being able to procure panels and terminal strips accurately cut to size will be appreciated by those who have endeavoured to shape up a large instrument panel without suitable facilities.

The Paragon Rubber Manufacturing Co., Ltd., of Sculcoates, Hull, have therefore introduced a complete range of panels in $\frac{3}{16}$in. and $\frac{1}{4}$in. ebonite, and either with matt black finish or polished in black or mahogany. The panels are perfectly rectangular, and the edges square, with freedom from tool marks. By adopting one of these panels the purchaser knows that he is obtaining high-grade ebonite produced by a reputable manufacturer.

oooo

CATALOGUES RECEIVED.

"H.T.C. Electrical Co., Ltd." (2, Boundaries Road, Balham, London, S.W.12). Catalogue of wireless components.

oooo

"P. Capel" (3 and 4, Queen Street Arcade, Cardiff). 82-page catalogue of wireless components of leading makes.

oooo

"Burwood (Concessionaires), Ltd." (41, Great Queen Street, Kingsway, London, W.C.2). Radio catalogue of Burwood apparatus and accessories.

oooo

"Houghton, Ltd." (Ensign House, 88-89, High Holborn, London, W.C.1). 64-page catalogue of Radio receiving sets by leading makers.

oooo

"Eagle Engineering Co., Ltd." (Warwick). Leaflets descriptive of Chakophone radio receivers.

oooo

"Radio Instruments, Ltd." (12, Hyde Street, New Oxford Street, London, W.C.1). Leaflet illustrating and describing the RI reactive anode unit.

DICTIONARY OF TECHNICAL TERMS

Definitions of Terms and Expressions commonly used in Wireless Telegraphy and Telephony.

This section is being continued week by week and will form an authoritative work of reference.

Radiation Coefficient (of an aerial). Another name for *radiation resistance*. See AERIAL RESISTANCE.

Radiation Efficiency. Expressed as a percentage the radiation efficiency of an aerial is the percentage of the total power supplied to the aerial which is radiated into space in the form of electric waves.

Radiation Resistance (of an aerial). That quantity which, when multiplied by the square of the effective value of the aerial current, gives the power being radiated into space in the form of electric waves. See AERIAL RESISTANCE.

Radio Beacon. A transmitting station which sends out special signals as an aid in the navigation of ships at sea. By means of *direction finding* apparatus a ship receiving the signals is enabled to find its bearing with respect to the radio beacon, the position of which is known.

Radio Compass. See DIRECTION FINDER.

Radio Frequency. A *frequency* within the band of frequencies used for wireless telegraphy and telephony, *i.e.*, within a range from about 12,000 up to nearly 100,000,000 cycles per second, representing a range of wavelengths from 25,000 metres down to about 3 metres.

Radio-Frequency Amplifier. See HIGH-FREQUENCY AMPLIFIER.

Radio-Frequency Choke. See AIR-CORE CHOKE.

Radio-Frequency Resistance. See HIGH-FREQUENCY RESISTANCE.

Radio-Frequency Transformer. See OSCILLATION TRANSFORMER and HIGH-FREQUENCY TRANSFORMER.

Radiogoniometer. An instrument used in connection with the Bellini-Tosi system of *direction finding*. For description see DIRECTION FINDER.

Radiophare. See RADIO BEACON.

Radiotron. A name sometimes applied to an ordinary *thermionic valve*.

Range Finder. See DIRECTION FINDER.

Ratio of Transformation. The ratio of the *primary* to the *secondary* voltage of a *transformer*. For ordinary iron-cored transformers the transformation ratio is approximately equal to the ratio of the primary to the secondary turns of the windings. This is not usually the case for *air-cored transformers* unless the *coupling* between the windings is very tight.

Rat-Tail (of an aerial). The bunch of wires which connects a multi-wire aerial to the *leading-in wire*.

Reactance. That component of the *impedance*, of an *alternating current circuit*, which is due to the inductance or capacity of the circuit or both. For a circuit containing *inductance* without the presence of capacity, the reactance is equal to $2\pi fL$ ohms, where f is the frequency of the current and L is the inductance in henries. For a condenser of capacity C, the reactance is given by $1/2\pi fC$ ohms, and is negative with respect to the inductive reactance. See ALTERNATING CURRENT CIRCUITS and IMPEDANCE.

Reactance Coil. Another name for *choke coil*. (Not to be confused with *reaction coil*.)

Reaction. The arrangement of a *three-electrode valve* circuit in such a manner that part of the energy of the amplified signals in the plate circuit of the valve is fed back to the grid circuit, *i.e.*, it is made to *react* on the grid, so that losses in the grid circuit may be compensated for and much greater signal strength obtained. The degree to which this reactive effect is allowed to take place is usually under control and may be adjusted to suit the circumstances under which signals are being received. For instance, for *beat reception* of *continuous wave* signals by the *self-heterodyne* method the reaction is made sufficiently strong to produce *self-oscillation* of the receiving circuit, and the frequency of this self-oscillation is adjusted to give a suitable beat frequency with the incoming signal. For reception of weak telephony the reaction is adjusted just below the point at which self-oscillation starts, in which case maximum signal strength will be obtained.

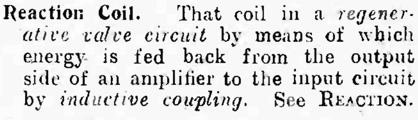
Reaction is effected in a number of ways depending on the nature of the receiving circuit. The most common method is to have a coil, known as the "reaction coil," in series with the plate circuit of a valve and couple it inductively to the grid circuit, the *coupling* between the two circuits being variable in order that the reaction may be controlled. Another name for reaction is "regeneration."

Reaction Coil. That coil in a *regenerative valve circuit* by means of which energy is fed back from the output side of an amplifier to the input circuit by *inductive coupling*. See REACTION.

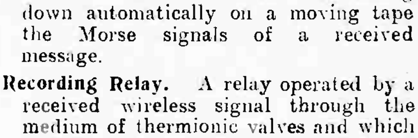
Recorder. An instrument for taking down automatically on a moving tape the Morse signals of a received message.

Recording Relay. A relay operated by a received wireless signal through the medium of thermionic valves and which in turn operates a *Morse inker* or *recorder*.

Rectification. The name given to the operation of converting an alternating current into a *unidirectional pulsating current*. Conversion by means of a motor-generator or rotary converter does not come under this heading. The term is applied to the conversion of high-frequency oscillations into unidirectional currents, *i.e.*, detection of wireless signals, as well as to low-frequency alternating currents, *e.g.*, as in the case of the charging of accumulators from the A.C. mains.



HALF-WAVE RECTIFICATION



FULL-WAVE RECTIFICATION

Wave-forms of half-wave and full-wave rectification.

Rectification may consist of the partial or complete suppression of all of the negative half-waves of the alternating current (or *vice versâ*), this being known as "half-wave rectification"; or all the negative half-waves may be reversed in direction through the circuit, giving "full-wave rectification." Sometimes the pulsations of the rectified current are "smoothed out" by special circuits known as "smoothing circuits."

Rectified Current. A *unidirectional current* which has been produced from an alternating current by the process of *rectification*.

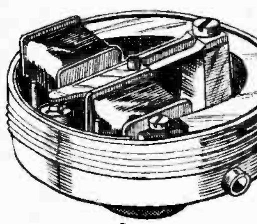
Dictionary of Technical Terms.—

Rectifier. A device which converts an alternating current into a unidirectional current (see RECTIFICATION). See MECHANICAL RECTIFIER, NODON VALVE, RECTIFYING DETECTOR, and CRYSTAL DETECTOR.

Rectifying Detector. That part of a wireless receiver which acts as the *detector* of the high-frequency oscillations by rectifying them and producing unidirectional currents which give audible sounds in the telephones, such as a crystal or thermionic valve rectifier. There are other detectors, such as the *coherer*, which do not employ the principle of *rectification*.

Rectifying Valve. In general any valve such as an electrolytic valve, thermionic valve, etc., which is used for rectifying alternating currents. It also refers in a particular sense to that valve in a wireless receiver which acts as the *detector*. See GRID RECTIFICATION and ANODE RECTIFICATION.

Reed Type Telephone. A telephone receiver in which the variations of magnetic pull actuate a semi-tuned "reed" or armature, and this in turn transmits its vibrations to a cone-shaped aluminium diaphragm. This type of telephone can be made extremely sensitive, but as it is more or less tuned to a small band of frequencies its reproduction of speech and music is not as true as that obtained with the ordinary flat diaphragm type.



Reed type telephone.

Reflection (of wireless waves). Ether waves striking a plane conducting surface induce *eddy currents* therein, and these eddy currents in turn send out ether waves, so that in effect the waves striking the conducting surface are partially reflected in much the same manner as light is reflected from a mirror. Reflection from the *Heaviside layer* in the upper atmosphere is supposed to account for the transmission of wireless waves round the curvature of the earth.

Reflex Circuit. A thermionic valve circuit arranged to give *dual amplification*, *i.e.*, simultaneous H.F. and L.F. amplification by means of the same valve or valves. After the signals are amplified at high-frequency by one or more valves, they are rectified by the detector and passed through the same valves again and amplified at low-frequency. See DUAL AMPLIFICATION.

Regeneration. Another term for *reaction*.

Regenerative Circuit. A valve circuit in which *reaction* is employed. See REACTION.

Reinartz Tuner. A special valve receiving circuit for short waves, its chief features being (*a*) easy control of *reaction*, (*b*) only one tuning adjustment, and (*c*) good selectivity.

Rejector Circuit. A tuned oscillatory circuit consisting of an inductance and a condenser in parallel used to offer a very high *impedance* to oscillations of the frequency to which the circuit is tuned and low impedance to all other frequencies. If L is the inductance of the coil in henries, R is its resistance in ohms, and C is the capacity of the condenser in farads, the impedance offered to currents of the frequency to which the circuit is tuned is equal to L/CR ohms, the tuned frequency being $\frac{1}{2\pi\sqrt{LC}}$. Sometimes called a "wave trap" or "wave filter." These names only apply when the oscillating potential difference produced across its ends is not made use of; for instance, when the voltage across the ends of the circuit is applied to a *detector* or to the input side of an amplifier, the circuit completely reverses its function, *i.e.*, it selects the particular frequency to which it is tuned and more or less rejects all other frequencies.

Relay. A device, usually electromagnetically operated, which closes a local circuit when a weak current flows through the coils of the magnet. The closing of the local circuit brings into operation a local battery which operates some local piece of apparatus which requires a comparatively heavy current. The weak current through the magnet coils may be that due to received wireless signals, in which case it would be too weak to operate the local apparatus; for instance, a Morse inker. See POLARISED RELAY.

Relay or Relaying Station. A wireless telephony transmission station which receives its broadcasting matter from a distance either by ordinary telephone line or by wireless.

Reluctance. The opposition which is offered by a *magnetic circuit* to the passage of *flux* through it. Reluctance is applied to the magnetic circuit in the same manner that *resistance* is applied to the electric circuit. (See MAGNETOMOTIVE FORCE.) The reluctance of a given part of a magnetic circuit is equal to $\frac{l}{\mu A}$, where l is the length of that part in centimetres, μ is the permeability of the material forming that part, and A is the cross sectional area in square centimetres. Reluctance may be defined as the ratio of magnetomotive force to magnetic flux, just in the same manner as resistance is the electromotive force divided by the current.

Reluctivity. The reciprocal of *permeability*.

Remanence or **Remanent Magnetism.** That *magnetic flux* which remains in the iron parts of an electromagnet after the magnetising current has been switched off.

Remote Control. The operation of wireless and other apparatus by electromagnetically operated switchgear controlled from a convenient centre which may be in the same room as the apparatus or in another room, or the apparatus itself may be distributed in various rooms. This system is particularly useful where high voltages have to be dealt with.

Residual Charge. See ABSORPTION.

Residual Magnetism. See REMANENCE.

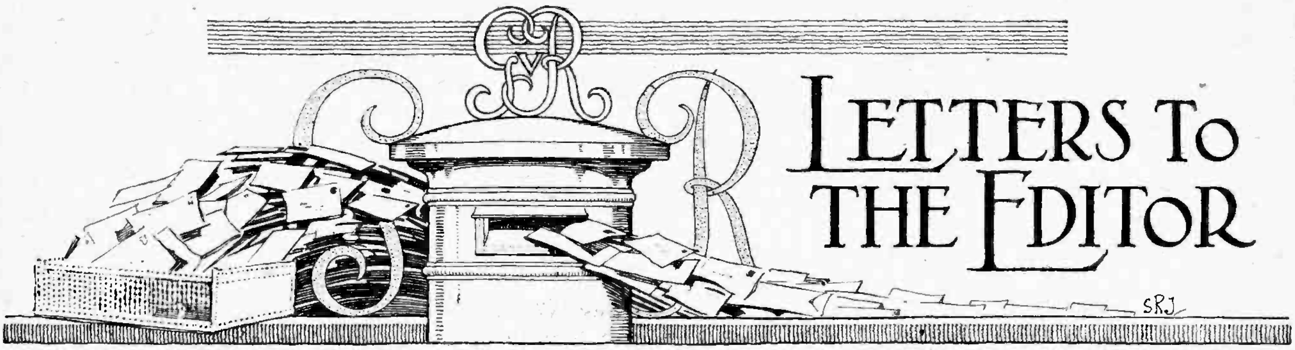
Re-Radiation. When wireless signals are received by a receiver employing *reaction* to a degree which brings the set nearly to the point of *self-oscillation*, the signal oscillations in the aerial are strengthened and energy is "re-radiated" from the aerial, and receiving stations in the immediate neighbourhood can pick up the particular signals with greater strength. This in many cases accounts for the reception on crystal receivers, of stations which are normally a long way outside the range of a crystal receiver; the signals actually heard on the crystal set are issuing by re-radiation from a near-by aerial on which a valve set using reaction is in operation. This must not be confused with *self-oscillation*, which causes interference and does not re-radiate the received signals.

Resistance. The opposition which an electric circuit offers to the passage of a current through it, this opposition being due to the material of the circuit itself, and not due to any counter electromotive forces which may be set up, so that the whole of the energy put into the circuit is converted into heat. The practical unit of resistance is the *ohm* being 10^9 absolute *electromagnetic units* of resistance, where one absolute unit is that resistance which allows 1 absolute unit of current (10 amperes) to flow under a pressure of 1 absolute unit of potential (10^{-8} volt). The International *Ohm* is defined as the resistance offered to an unvarying current by a column of mercury at the temperature of melting ice, 106.3 centimetres long, weighing 14.452 grams, and of constant cross-section.

A resistance of one *ohm* requires a pressure of one *volt* to drive a current of one *ampere* through it (see Ohm's Law).

The resistance of a wire of any given material is proportional to the length of the wire, and inversely proportional to the cross-sectional area. It depends sometimes also upon the temperature of the wire. (See TEMPERATURE COEFFICIENT.) The resistance offered to the passage of an alternating current through a circuit is very often greater than that offered to a direct current, this being due to *skin effect*. See HIGH-FREQUENCY RESISTANCE.

Resistance Amplifier or **Resistance-coupled Amplifier.** A multistage valve *amplifier* in which the valves are coupled in *cascade* by *resistance-capacity couplings*.



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.

THE PHILIPS RECTIFYING VALVE.

Sir,—We should like to refer to an article which appeared in your issue of October 28th, entitled "Thermionic Rectifier for Battery Charging," as contributed by Mr. J. F. Sutton.

We were very interested in Mr. Sutton's account of the Philips rectifying valve, and we take this opportunity to amplify some of his statements, which we hope will be of interest to your readers.

(1) As the Philips rectifying valve has been specially designed as a full-wave rectifier, connecting it in accordance with Figure 3, as a half-wave rectifier, does not present any particular advantages for the valve, though as a full-wave rectifier it can produce a charging current of double intensity without impairing its life.

(2) When connecting the rectifying valve as in Figure 4, each of the two plates in the valve should only contribute 0.65 amp. to the charging current, whilst the tension of each of the secondary windings of the transformer should not be more than 23 volts. Should the secondary windings 2 and 4 (in Figure 4) be connected wrongly, the valve will act as a single-wave rectifier with double intensity of current on one plate. This risk is avoided with the Philips rectifier, as it is supplied ready to operate with an automatic regulating valve for the charging current.

(3) The scheme of connections as shown in Figure 5 appears to be dangerous for the valve, as the heating current is not limited, and the filament is likely to burn out. If the rectifying valve is charged without heating current, the charging current cannot be reduced below a certain value without the cessation of the glow-discharge.

The diagrams referred to above, of course, are those used in Mr. Sutton's article.

We should be very happy to give any further information on the points we have brought forward.

W. T. E. BLUNDEN,
General Sales Manager, Philips Lamps, Ltd.

Sir,—May I reply to the letter from Messrs. Philips Lamps, Ltd., referring to my article entitled "Thermionic Rectifier for Battery Charging," which appeared in the issue of *The Wireless World* for October 28th?

With reference to paragraph 1 of the letter, I agree that it is no advantage for the valve to use it as a half-wave rectifier, but it may be a considerable advantage to the amateur, as it was to me, to use it in this way because only a single transformer secondary winding is needed, giving a voltage between, say, 25 and 50 volts. For complete wave rectification it is necessary to use a transformer having a centre tapping in the secondary winding. Also, the possible danger referred to in paragraph 2 is avoided. The "automatic regulating valve" is nothing more than the special resistance referred to on page 574.

I beg to differ from the writer on the question of maximum discharge current. It is borne out by experiments, and there is no theoretical reason to believe otherwise than that the factor which limits the charging current in this particular valve is the power wasted in the valve itself, which must be dissipated in the form of heat from the glass bulb. With full-wave rectification the maximum charging current is stated in the specification to be 1.3 amp. Assuming this to be the average current as indicated by a moving coil instrument, the R.M.S. (or heating current) will be 1.3 multiplied by the form factor (1.15 approximately) or 1.49 amps. As the voltage drop is about 8.4 the watts dissipated will be $8.4 \times 1.49 = 12.5$, neglecting filament current. With single-wave rectification the form factor is about 1.57 and the voltage drop is the same, so the charging current will be $1.49 \div 1.57 = 0.95$ amp. The maximum charging current is therefore $1.3 \div 0.95$ or 37 *per cent. greater* with double-wave rectification than with single-wave, and not twice as much as stated by the writer.

I have found by experiment that the voltage drop from anode to filament is the same for each anode and for both connected together, so that either can carry the maximum current without harm although the temperature distribution would be better with both connected together.

With reference to the third paragraph, I fail to see where the danger lies in my diagram (Fig. 5, page 574). As I have explained in the article, there is a resistance of 17 ohms connected in series with the filament, which itself has a resistance of 0.1 to 0.4 ohms. The input is at 50 volts so that the current will be 2.9 amps., which will heat up the filament sufficiently to start the valve action (see page 573), after which it can be switched off. Even if the switch were left on no harm could be done.

I have pointed out, however, that the minimum anode current which will keep the filament at a temperature high enough to maintain the glow discharge is about 0.15 amp.

The advantage of switching off the filament current is the saving in power, and also the fact that it allows a slight increase in the charging current. The maximum current which flows in the filament is the charging current *plus* the heating current, so that the average temperature of the filament will be lower without the heating current, but, of course, whether this has much effect on the life of the valve can only be found by experiment.

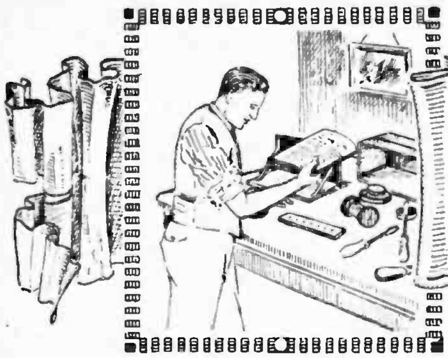
My personal experience of the valve is that it is a most useful accessory for the amateur who is fortunate enough to have A.C. supply laid on, and it seems to be a much more robust piece of apparatus than the writer would have us believe.

I appreciate the fact that for the average listener-in much time (and possibly damage) would be saved if he bought a Philips Rectifier complete and ready for use instead of making it up, but my object in writing the article was to explain the nature and characteristics of the valve itself to readers of this journal. JOHN F. SUTTON, B.Sc. (Eng.).

MICA CONDENSERS.

Sir,—Your correspondent who enquires when British manufacturers are going to produce a mica dielectric coupling condenser for resistance and choke coupling may like to know that these may be obtained to order from the Telegraph Condenser Company, Mortlake Road, Kew Gardens, at a very moderate price. R.P.G.D.

London, S.W.



READERS' PROBLEMS

"The Wireless World" Information Department Conducts a Free Service of Replies to Readers' Queries.

Questions should be concisely worded, and headed "Information Department." Each separate question must be accompanied by a stamped addressed envelope for postal reply.

Easily Controlled H.F. Receiver.

Having had excellent results with a conventional 0-v-1 receiver, I am desirous of rebuilding the instrument and incorporating an H.F. stage, but am somewhat deterred by the thought of unduly complicating the tuning of the receiver, since, of course, there will be an added control for tuning the H.F. stage. Is there no method of adding an efficient H.F. stage without adding an additional tuning control, other than resistance-coupling, which, I understand, is only efficient on long wavelengths. J.N.O.

The disadvantage of an H.F. stage is, as you suggest, that an additional tuning control is added to the receiver. This is, of course, the reason why so many people fail to obtain any additional range after adding H.F. stage to a receiver, and it may be said that in the case of the vast majority of listeners better results can be obtained with a plain regenerative detector receiver, since owing to the single tuning control they will obtain a large percentage of the possible results obtainable with such a receiver, whereas in the case of a receiver employing an H.F. stage and therefore an additional tuning control, the percentage of possible efficiency they obtain is low, with the nett result that less range is sometimes obtained after adding an H.F. stage. A resistance-coupled H.F. stage is ideal on long wavelengths, since no additional tuning device is brought in to complicate the handling of the set. Unfortunately, however, the efficiency of this method when used on the normal B.B.C. wavelengths is so low that it is scarcely noticeable, quite apart from the added disadvantage of a higher H.T. value being necessary. If, however, we can find an instrument to take the place of the anode resistance, but which is efficient on both the B.B.C. and longer wavelengths, and yet does not require any tuning, we shall have achieved our object. Fortunately such an instrument is now available, owing to the success of the manufacturers in producing a really efficient H.F. choke, and we illustrate in Fig. 1 a suitable circuit. The choke need not be interchangeable, and provided that it is properly designed, will be efficient from about 250 metres to a maximum of 4,000 metres, thus easily including all the world's broadcasting stations with the exception of those working on very short waves, in whose case, of course, no form of H.F. amplification is of much use. The success or otherwise of this circuit depends entirely on the efficiency of the H.F. choke, and it is absolutely imperative that a good type be used; one of inferior make will usually be very successful on the Daventry and higher wavelengths, but will give little or no amplification on the normal B.B.C. wavelengths. It may be said, therefore, that unless a reliable choke is employed, poor results will be obtained. It will generally be found that in the hands of the average amateurs a receiver of this type will have a larger range than the more conventional tuned anode or tuned transformer receiver, owing to its entire simplicity of tuning, and its complete stability.

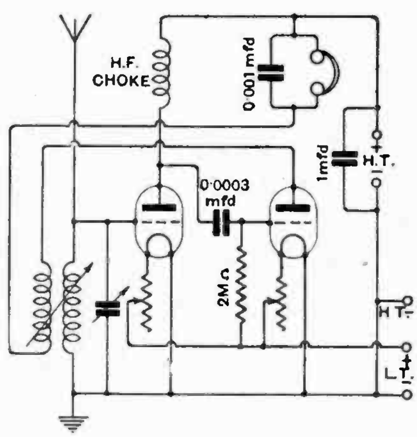


Fig 1.—Two-valve H.F. receiver designed for ease of tuning.

○○○○

Safeguarding Valve Filaments.

Having constructed a three-valve receiver, and not possessing a great deal of technical skill, I should be glad if you could inform me of the best way of testing the instrument in order to prevent the valves being burnt out in connecting up the batteries in case I have wrongly wired the instrument. H.R.S.

The best plan would be to first connect your accumulator to the H.T. terminals of your receiver and turn on the filament rheostats. If all is in order, the valves should *not* light up, but should they do so, it will indicate that there is a faulty connection such as would have caused a complete burn-out of all the valve filaments had you connected up the batteries in the normal manner and you should go carefully over the wiring once more in an endeavour to trace the error. You should then repeat the test, and on no account attempt to connect up the H.T. battery until the receiver has passed through this test in a satisfactory manner. When satisfaction has been attained in this way, connect up the receiver normally and attempt to tune in signals. This test, when successfully passed, will not indicate that all connections are correctly carried out, but is only intended to reveal errors which would have a disastrous result on the valves; and if, therefore, signals fail to come in, all connections should be again examined, and any noticeable fault remedied. It is most important, however, in order to preserve immunity from valve destruction that the test referred to be repeated after any alteration whatever has been made to the internal wiring of the receiver.

○○○○

Constructing Components at Home.

I wish to build a receiver followed by three L.F. stages, the first resistance-coupled, the second choke-coupled, and the third transformer-coupled using a 3 to 1 ratio instrument, but having all materials and tools handy I desire to construct anode resistance, choke and transformer myself, and should be glad of constructional details of these components. S.E.G.

Needless to say, the anode resistance should be a non-inductive wire-wound instrument. A convenient method of construction is to obtain an ebonite rod two inches in diameter, and about three inches in length, eight equally spaced grooves 1in. wide and about ¼in. deep, should be cut in the rod. Wind about 30 turns of No. 47 d.s.c. "Eureka" resistance wire in the first slot, and then pass on to the second slot and wind a similar number of turns *in the same direction* in this slot. Now return to the first slot, and wind thirty turns in the reverse direction, treating the second slot in a similar manner. Return again to the first slot and repeat with the original direction of winding, and so on until both slots are filled, when the remaining slots may be taken in pairs and treated in a similar manner. A suitable choke may be constructed by first building up a core to a diameter of half an inch with No. 22 gauge soft iron wire. A bobbin 3½in. long and 2¼in. in outside diameter may be threaded on this core. About 40,000 turns of No. 42 d.s.c. copper wire should be wound on the bobbin and covered with a few layers of Empire cloth. The ends of the iron wire should then be bent back and bound down in order to form a closed magnetic circuit, a further covering of Empire cloth be placed round the outside of the instrument. The transformer should also have a core built up of No. 22 gauge soft iron wire. It is advisable, however, that it have a diameter of threequarters of an inch. About 14 inches is a suitable length for the iron wire. Two cheeks 2½in. in diameter by $\frac{3}{16}$in. thick should be mounted on the core about 3½ inches apart. After wrapping a few layers of Empire cloth round the core the primary, consisting of about 9,000 turns of No. 42 s.s.c. copper wire, may be put on, and covered by Empire cloth; 27,000 turns of No. 45 s.s.c. copper wire to form the secondary may now be put on. Needless to say, a protective covering of Empire cloth should be placed over the secondary before the ends of the iron wire are bent back and bound down as in the case of the choke.

oooo

A Modification of the "Quality Four."

Being greatly interested in the "Quality Receiver" described in a recent issue, I intend to construct a receiver on similar lines, but wish if possible to use variometers with switching arrangements to cover the B.B.C. and also the Daventry and Paris wavelengths, and shall be glad of a suitable circuit. L.R.D.

We indicate in Fig. 2 a suitable modification of this circuit using variometers. The minimum wavelength obtainable with both switches to the left is about 250 metres, whilst the maximum wavelength obtainable with both switches to the right is approximately 2,750 metres, thus enabling the Eiffel Tower to be received. It is most important in a circuit of this description that a really efficient H.F. choke be employed, and you are not advised to depart from the one specified in the original receiver design, described in our September 16th issue. The less reputable type of H.F. choke will be found quite efficient on the Daventry wavelength, but almost useless on the other B.B.C. wavelengths. This choke need not, of course, be interchangeable, since it will more than cover the wavelength ranges covered by the variometers. See also the reply to "S.W.B." in our December 2nd issue in the matter of H.F. chokes.

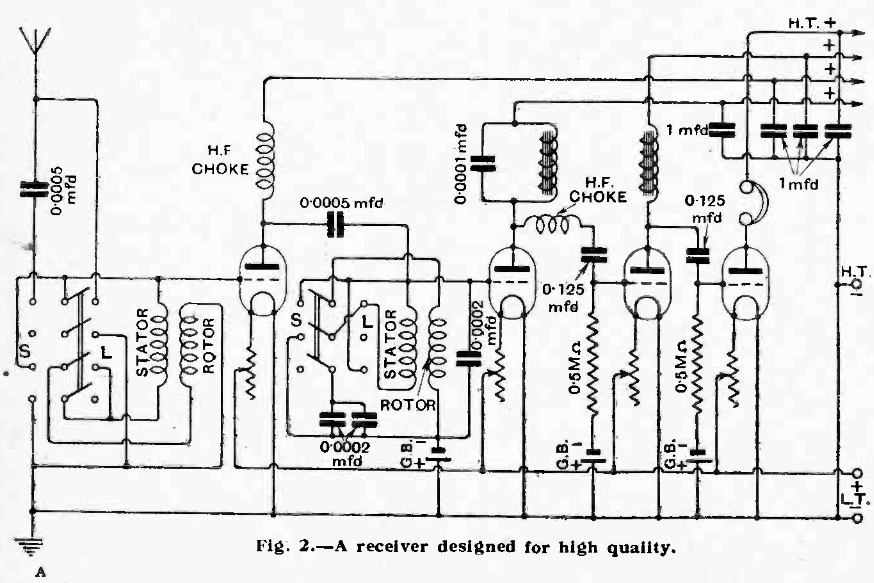


Fig. 2.—A receiver designed for high quality.

Stabilising Intermediate Amplifiers.

I notice that in most diagrams of superheterodyne receivers the intermediate amplifier is stabilised by means of potentiometer control of the grids of the intermediate valves. Surely this method of stabilisation is equally as pernicious on long waves as on short waves? Could not the neutrodyne method be adopted in the intermediate amplifier of a superheterodyne? R.C.D.

It is undoubted that excessive positive biasing of the grids of H.F. valves is productive of great amplification losses in long waves, in addition to flat tuning and ruining of the H.T. battery. The inefficiency of this method is, however, not so apparent on long waves as on short, since, owing to the inherently greater stability of a long-wave amplifier over a short-wave instrument, not so much positive bias is needed to cause a cessation of oscillation in the former as in the latter, consequently greater efficiency results. Of course, it must not be forgotten also that a stage of H.F. will *ipso facto* give a greater degree of amplification on long waves than on short. At the same time the shortcomings of this method of stabilisation cannot be denied, and it would be well to attempt some form of neutralisation. It should be pointed out, however, that the neutralisation of three stages of H.F. is a task not to be lightly approached. In *The Wireless World* "All Europe" six-valve receiver this method of stabilising a long-wave amplifier is brought into use very successfully.

oooo

Why not a Wire-wound Grid Leak?

Why is it that, although the advice of using a wire-wound anode resistance is invariably stressed in technical journals, no mention is made of using a wire-wound grid leak? D.E.B.

In the case of a resistance connected in the anode circuit of a valve, it must be remembered that the steady anode current, which may rise to a value of several milliamps, passes through the resistance. If graphite resistances are employed, this steady current speedily disintegrates the resistance material, and gives rise to noises in the telephones and loud-speaker. In the case of grid leaks, however, the current flowing through them is at the most only a few microamps, which is insufficient to disintegrate the graphite or other material of which the resistance is constructed. When using a variable grid leak, however, noises frequently arise in the telephones after a short period of use, but this is due to the fact of the material being disintegrated by mechanical compression, and not by the grid current. In any case it would be extremely difficult to design a wire wound resistance of millions of ohms value in a convenient size and having a low capacity. In practice it is found that about 120,000 ohms is the largest value in which it is convenient to construct a wire-wound resistance.

The Wireless World AND RADIO REVIEW

(13th Year of Publication)

No. 336. WEDNESDAY, JANUARY 20TH, 1926. Vol. XVIII. No. 3.

Assistant Editor: F. H. HAYNES. | Editor: HUGH S. POCOCK. | Assistant Editor: W. JAMES.

Editorial Offices: 139-40, FLEET STREET, LONDON, E.C.4 - Telephone: City 4011 (3 lines).

Advertising and Publishing Offices: DORSET HOUSE, TUDOR STREET, LONDON, E.C.4. - Telephone: City 2847 (13 lines).

Telegrams: "Ethaworld, Fleet, London."

COVENTRY: Hertford Street. Telegrams: "Cyclist Coventry." Telephone: 10 Coventry.

BIRMINGHAM: Guildhall Buildings, Navigation Street. Telegrams: "Autopress, Birmingham." Telephone: 2970 and 2971 Midland.

MANCHESTER: 199, Deansgate. Telegrams: "Iliffe, Manchester." Telephone: 8970 and 8971 City.

Subscription Rates: Home, £1 1s. 8d.; Canada, £1 1s. 8d.; other countries abroad, £1 3s. 10d. per annum.

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.

A WIRELESS "BUYERS' GUIDE."

"TIMES have changed," and wireless is no longer the wonderful mystery to the general public which it was a year or so ago. To-day there is scarcely anyone who has not a friend or two taking a practical interest in the theoretical side of the subject. Our experience shows that a very large proportion of those who purchase wireless sets complete do so only after consulting their technical friends, and as a result we are constantly receiving enquiries from our readers and others as to the types of sets available on the market, with particulars as to price, etc. For some time past we have felt that the need existed for some up-to-date list of complete sets to be drawn up and presented to our readers in some convenient form for reference.

With this aim in view we are arranging to include, in the issue of *The Wireless World* for February 10th, a list of the complete sets available to-day with all essential particulars necessary to enable the reader to identify the type. This is an entirely new departure, and we believe that it will be found of great service, not only to those who contemplate the purchase of a set, but also to those who are so frequently appealed to for advice on what set to get. After the appearance of this special feature, we should welcome any suggestions from our readers for improvement in the method of presenting the information in order that such suggestions may be considered when the time arrives for this feature to be repeated.

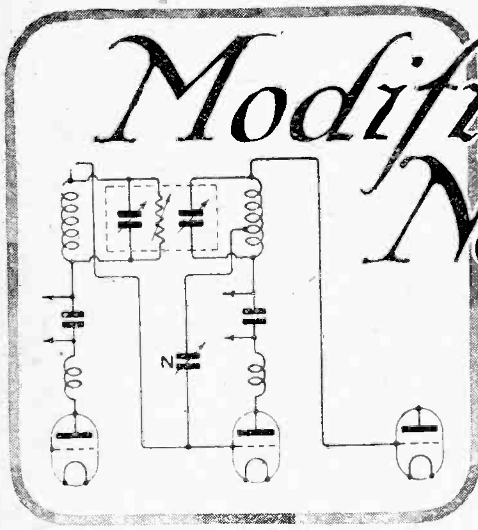
CONTENTS.

TECHNICAL SENSATIONS.

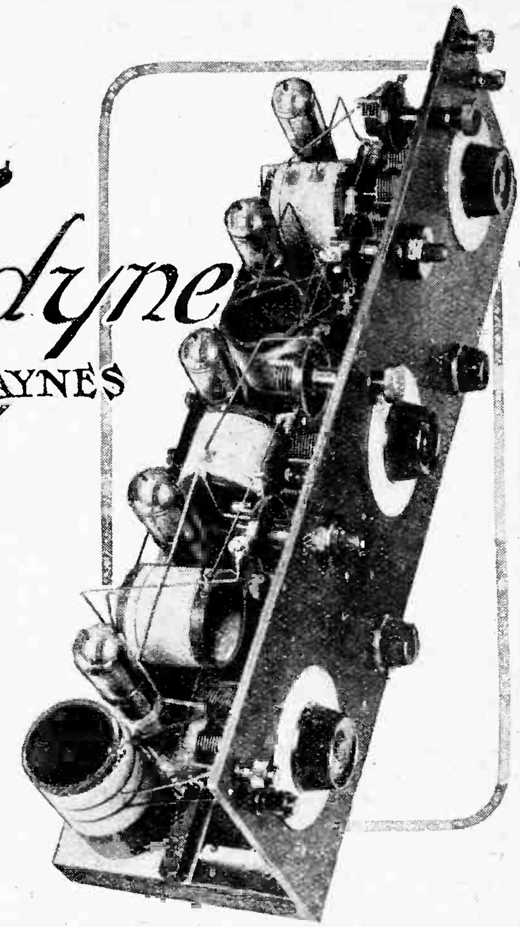
IT is fortunate that the general public has by now learned to accept only with a fair degree of caution technical wireless news of a startling character which is all too often served out by certain sections of the daily Press. From time to time there is a dearth of general news, which compels recourse to other possible sources of intelligence to supply the requirements of the newspaper, and wireless, it seems, is regarded as an easy prey in such instances. But surely the time will very soon arrive when it will be necessary for the Press to exercise a good deal more discretion in the manner in which technical wireless matters are treated, because the public is becoming too well acquainted to be easily taken in.

Perhaps one of the most daring instances amongst a number of Press misrepresentations which have occurred of late is the repeated statements to the effect that crystal receivers are shortly to supersede valve receivers. Everyone knows that a loud-speaker can be operated from a crystal set if the receiver is located very near the transmitting station, but even then the results are very poor. The Press statements, however, suggest a new invention making loud-speaker crystal reception possible almost anywhere in the country. The Press has probably not set out deliberately to deceive in order to produce sensational "copy," but the responsibility for publishing such information without full investigation is just as great and must in the long run be very damaging to the offenders.

Modified Neutrodyne



By F. H. HAYNES



Tuned Five=Valve H.F. Amplifier with Three Controls.

AMATEUR activity at the present time is showing a decided leaning towards the development of high frequency amplifiers. The majority of the sets put forward this winter include some form of radio frequency amplification, and the concentration of effort to produce long-range receivers by improved H.F. amplifying systems has been responsible for the innovation of multi-stage H.F. amplifiers incorporating stabilising devices to control self-oscillation.

Range with a Neutrodyne.

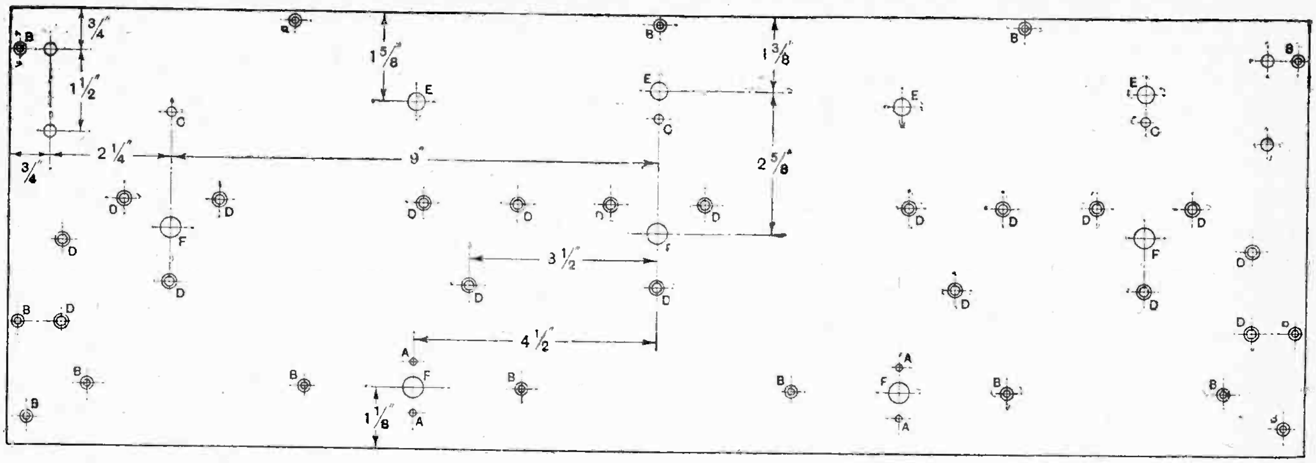
The neutrodyne method of stabilising has greatly contributed towards the present popularity of the H.F. set, though it cannot be said that a two-stage neutrodyne set followed by a low-frequency amplifier is capable of giving good quality loud-speaker reception from broadcasting stations within a thousand miles' radius when the receiving aerial is small and in a screened position, as is so often the case. It is safe to say that there are very few sets in which the neutrodyne method of stabilising is employed which are not invariably operated in an oscillating condition. Some degree of self-oscillation is often deliberately stimulated in the plate circuit of the detector valve or one of the amplifying stages, bringing about an improvement in range and selectivity together with manipulating difficulties, the loss of accurate calibration, and the usual distortion attendant upon an oscillating set.

It is to overcome these difficulties that the writer was induced to consider providing two additional H.F. amplifying stages to the usual two-stage neutrodyne. The first obvious step was to experiment with the addition of a third H.F. stage similar in arrangement to those already in the set, and it was found that this definitely had the effect of increasing the range of reception obtainable on a small indoor aerial, but the control of self-oscillation became unquestionably difficult, particularly towards the lower scale settings of the tuning condensers, while the manipulation of the four tuning dials almost rendered it impossible to search for a given station without the aid of a wavemeter. The open scale provided by 360° tuning dials solved, to some extent, the tuning difficulty, for the discrepancies in the settings of the three intermediate dials were more obvious, yet it was considered advisable to endeavour to limit the tuning controls, including the aerial circuit tuning, to three.

Damped Intermediate Stages.

It was thought that two resistance-coupled stages introduced between the first and second and second and third valves might produce a useful increase in the degree of amplification, but it was found that a resistance-coupled stage in front of the second valve, a position where its effect on the amplification obtainable with the set should be most marked, produced only a very doubtful increase and not sufficient to warrant the use of the additional valve and apparatus.

The design thus turned to one in which condenser-tuned amplifying circuits were interposed between the existing stages, the tuning condensers being operated simultaneously with those controlling the neutrodyned circuits. Some degree of flatness of tuning was, of course, essential to cover the discrepancies bound to exist in the tuning of these additional stages, with their condensers propelled by means of pinions meshed with the condensers of the



PANEL DRILLING DETAILS. A, 1/8in.; B, 1/8in., and countersunk. C, 5/32in.; D, 5/32in., and recessed with 1/4in. drill; E, 5/16in.; F, 3/8in. The panel measures 24in. × 8in. × 1/4in., and is rubbed down with fine carborundum cloth and pumice powder to produce a horizontal scratch line finish. The templates, which are supplied with the components, show the location of the securing holes. There are no tapped holes. The terminal strip, which is not shown in detail, may be substituted by a five-wire flexible cable passing through a hole in the cabinet and terminating on tags.

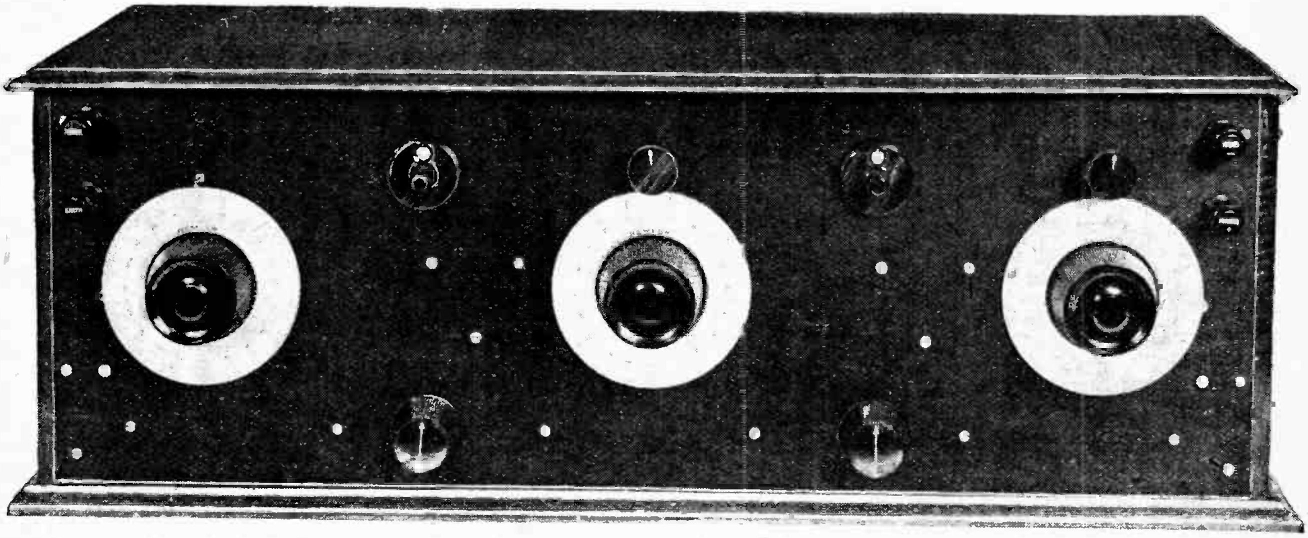
neutrodyned stages, while means had to be introduced to prevent self-oscillation, the neutrodyne method being found quite impracticable, in this instance, as the circuits thus sharply tuned could not be brought sufficiently in step. Both the tendency to self-oscillate and the sharpness of tuning increase as the tuning capacity decreases, and consequently a resistance of suitable value, determined experimentally, is connected in shunt across each of the two additional stages, producing both stability by preventing self-oscillation and the required degree of flatness without appreciably cutting down the amplification.

Interlocked Tuning and Damping Controls.

In the design given here difficult construction must necessarily be avoided, yet the reader with instrument-making facilities can not only render the tuning of the additional stages automatic, but can interlock the stabilising resistance so that its value decreases as the capacity of the condensers increases. Maximum amplification is thus obtainable at all tuning adjustments, and the tendency to oscillate is controlled without undue damping in any position, the extra stages introducing no additional adjustments. For simplicity of construction, however, the resistances are set up on the front panel.

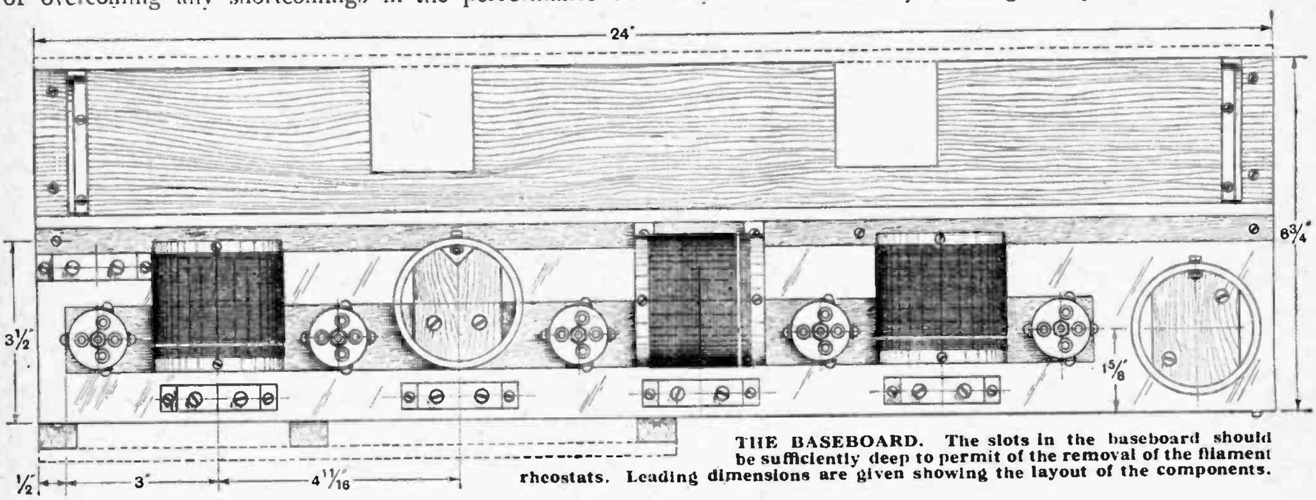
Stabilising by Damping Alternate Stages.

An examination of the circuit will reveal that the damping of alternate stages of a tuned H.F. amplifier will prevent self-oscillation apart from stabilising by neutrodyning, and this can be tested by setting the neutrodyning condensers at zero, but it will be observed that the stabilising shunt resistances must be adjusted to produce a greater load on the circuits when the neutrodyning condensers are not correctly adjusted. The shunt required on alternate circuits to permit of the omission of the



FRONT VIEW OF THE RECEIVER. The securing holes for two of the tuning condensers, here shown white, are recessed so that the heads of the screws may be covered with black filling or plugged with pieces of 1/4in. ebonite rod, and rubbed down smooth. The heads of all other screws may be treated with steel bronzing solution or camera black.

Modified Neutrodyne.—
neutrodyne condensers is altogether too heavy to prevent a satisfactory degree of amplification being obtained, yet the shunt resistances certainly have the effect, by increasing the load on the circuits as the capacity is reduced, of overcoming any shortcomings in the performance of transferring the dimensions. It is advisable to check them over carefully with dividers, while the spacing between the centres of the intermeshing condensers must be set out with extreme accuracy. The precaution of attaching the dialless condensers by a single screw, first, may save inaccurately meshing the pinions, though the



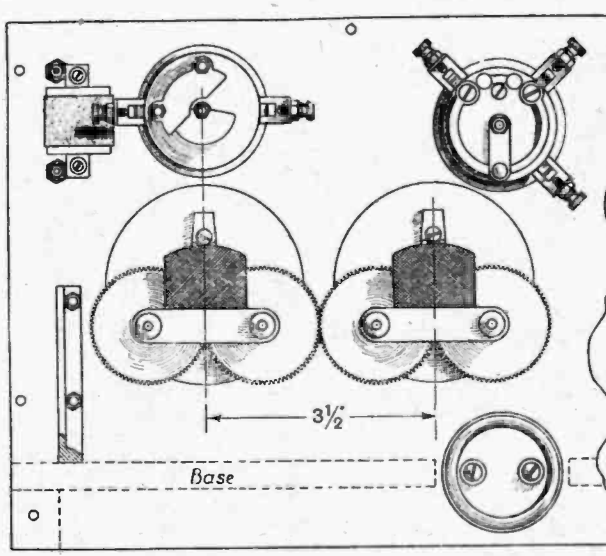
THE BASEBOARD. The slots in the baseboard should be sufficiently deep to permit of the removal of the filament rheostats. Leading dimensions are given showing the layout of the components.

the neutrodyned stages by which they sometimes break into oscillation, thereby requiring adjustment of the balancing condensers.

Constructed as a Three-valve Set First.

The reader who has never previously built a set with two high-frequency stages is recommended to proceed with the construction, omitting V_1 and V_3, the transformers T_2 and T_4, the condensers C_2 and C_4, and the two stabilising resistances R_1 and R_2, so that the set is the orthodox two-stage neutrodyne with valve detector. The circuit changes are obvious, for with the apparatus of the two damped stages omitted the grid terminal of V_2 picks up the lead shown connected to the grid of V_1, and the grid of V_4 is joined to the lead shown connected to the grid of V_3. After experience has been gained in the operation of this set, the two additional stages may be added. To save trouble later, it is advisable to drill the front panel exactly as shown in the drawing. The two sets of three holes for attaching the condensers C_2 and C_4 may with advantage be counterbored well below the surface of the panel, so that by covering them with black wax the panel is not disfigured by a number of screw-heads.

Templates are supplied with the condensers, and great care must be taken in



THE TUNING CONDENSERS. The pinions are interlocked and care must be taken to accurately set out the spacing between the condensers so that the pinions will mesh smoothly. Ordinary soldering tags are used to secure the blocking condenser to the telephone terminals.

condensers can, of course, be relied upon to be so accurate in dimensions that the centres can be set out according to the spacing shown. The spindles of C_2 and C_4 are easily removed by taking off the terminals and nuts and sliding off the plates, though it is advisable not to unmesh the Bakelite pinions while doing this.

To permit of the rheostats being removed from the panel, portions of the baseboard are cut away. The valve holders are supported upon a strip of wood which lifts the wiring from the baseboard and, in conjunction with another strip of ½in. square section, gives support to the transformers.

A sheet of tin plate is attached to the base, which may form part of a screening box completely enveloping both valves and transformers, though this can be added, if thought desirable, after the set has been brought into operation. Screening of the condensers is scarcely thought necessary, and in the case of the two pairs of condensers the plates which approach each other are at equal oscillation potential.

The Transformers.

The aerial circuit transformer has a centre winding of 18 turns, and on either side of it, allowing a space of ⅛in., are two sections each of 30 turns connected in series. Wires are terminated by passing in and out of small holes.

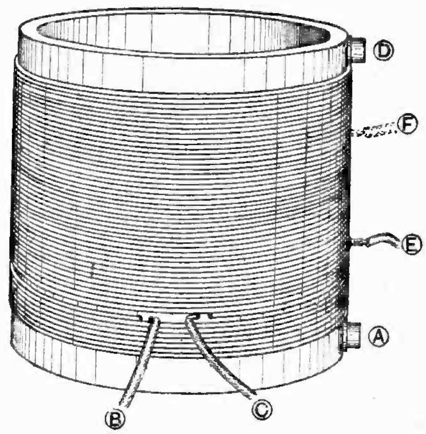
Modified Neutrodyne.—

The intervalve coupling transformer T_2 has a primary winding of 10 turns, and a secondary of 60, with a space of one turn between them. The beginning and finishing ends of the entire winding terminate on tags held down by 6B.A. screws and back nuts, while the finishing end of the primary and the beginning end of the secondary pass out from the inside of the former on the side opposite to which the terminating tags are fixed. The primary is set up towards the back of the instrument to facilitate wiring, the two leads from the inside being taken directly to the terminals of the blocking condenser.

T_3 differs inasmuch as the end of the primary and beginning of the secondary come away from the outside of the former after being passed through holes at a position where they connect by short leads to the blocking condenser. The tapping point for connecting to the neutrodyne condenser is made by levering up the tenth turn from the commencement of the secondary, and, after slipping a piece of empire cloth underneath it, soldering on a small piece of wire or copper foil. This transformer is set up with primary end towards V_2.

The transformer T_4, which stands upright, has its primary and secondary blocking condenser connections taken through on the outside of the former and on the opposite side to the tags carrying the beginning of the primary and the end of the secondary.

T_5 resembles T_1, excepting that tapping points are made at the tenth and fortieth turns, regarding the sixtieth turn as that which terminates on the tags at the end of the former.



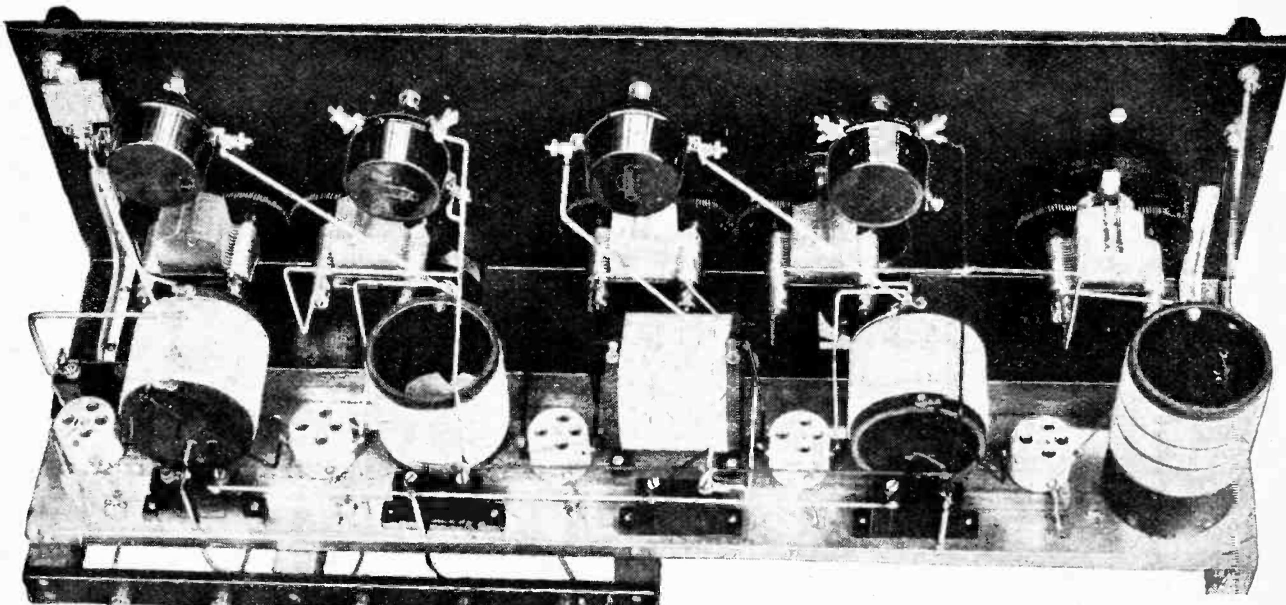
TUNING COILS. The formers are 2½in. in length and diameter. The primary consists of 10 turns, and leaving a space of one turn to ensure good insulation between primary and secondary, the secondary is wound on in the same direction and consists of 60 turns. (A) and (B) are the ends of the primary, (C) and (D) the secondary, (E) the stabilising tap on the 10th secondary turn and (F) the detector valve tap at the 40th.

The number of turns and the winding space occupied by the coils of the intermediate transformers must be identical. Plug-in pieces are used to attach T_1 and T_4, whilst T_2 and T_5 are screwed down to the wooden strips with ⅛in. ebonite spacers. T_3 is bolted to two ⅛in. wood or ebonite pieces, which are in turn held down by four screws to the wooden strips. The wiring up is comparatively easy, though the leads must be kept away from the windings of the transformers, and in many instances are run by the shortest path, using No. 16 "Glazite" above the baseboard, and No. 20 india-rubber covered wire for the battery leads underneath.

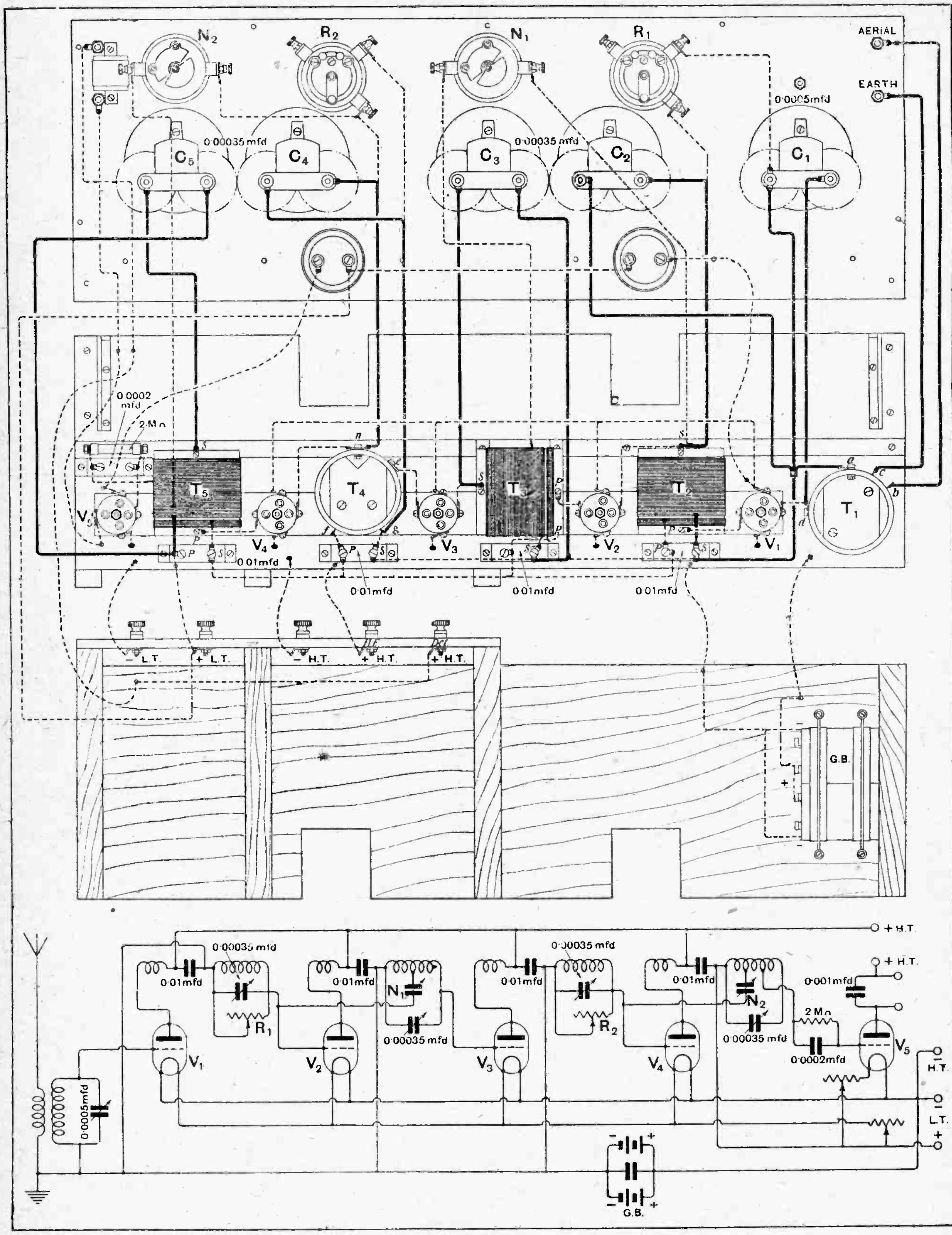
Testing Out and Operating.

For stable working and in an amplifier such as this, in which damping by means of shunt resistances is introduced, the use of general purpose valves is recommended, working with a negative grid bias and moderate H.T. battery potential. The set is now in use with D.E.5 type valves both in the H.F. and detector stages, leaky grid condenser rectification being adopted.

It is advisable even when using telephone receivers for these preliminary tests to connect in circuit a single stage L.F. amplifier so that changes in the performance of the set can be easily observed. One L.F. stage should in fact always be used with this set, for the elaborate radio frequency amplifying equipment is not warranted



INTERIOR VIEW. This illustration will serve as a good guide as to the general layout and wiring.

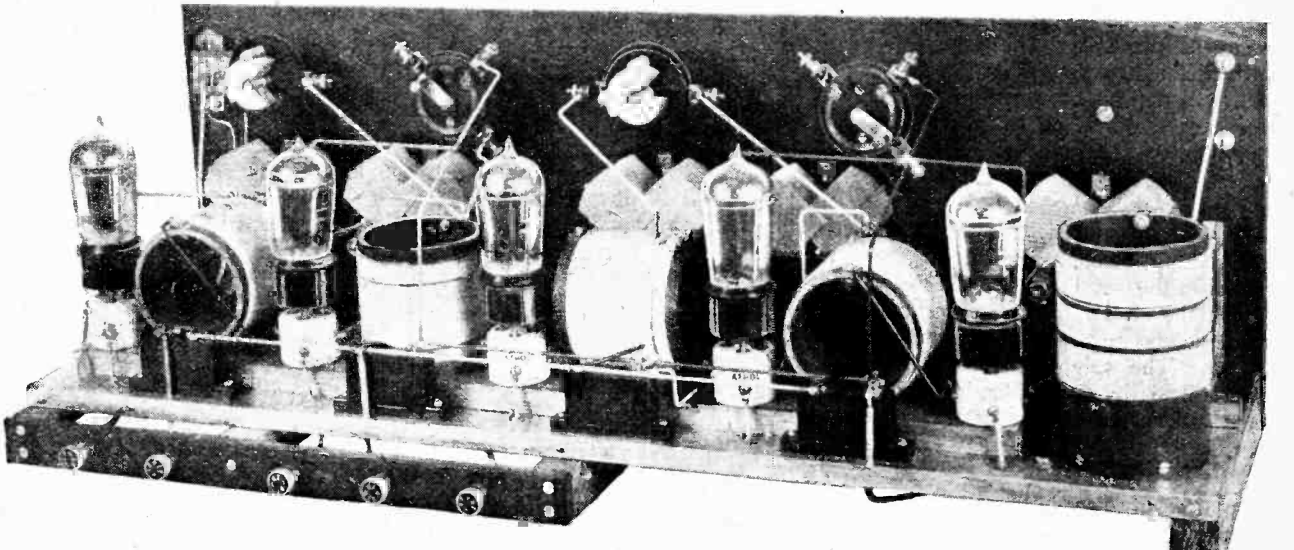

N₂
R₂
N₁
R₁
AERIAL
EARTH
0·0005mfd
0·00035 mfd
C₅
C₄
C₃
C₂
C₁
0·0002 mfd
2 MΩ
T₅
T₄
T₃
T₂
T₁
V₅
V₄
V₃
V₂
V₁
0·01mfd
− L.T.
+ L.T.
− H.T.
+ H.T.
G.B.
+ H.T.
0·001mfd
0·0002mfd
H.T.
L.T.

Ebonite panel, 24in.×8in.×¼in., adjusted to fit cabinet.
Polished mahogany cabinet, 24in.×8in.×7½in. deep type (Compton Electrical and Radio Supplies, Ltd., 63, Old Compton Street, London, W.1).
18in. Ebonite tube, 2¼in. external diameter, ⅛in. wall thickness.
5 Athol valve holders (Athol Engineering Co., Cornet Street, Higher Broughton, Manchester).
4 Fixed capacity condensers, 0.01 mfd. (Dubilier type 620 or Paragon).
1 Fixed capacity condenser, 0.0002 mfd.
1 Aerial tuning condenser, 0.0005 mfd.
4 Intermediate tuning condensers, 0.00035 mfd. Remler type (R. A. Rothermel, 24-26, Maddox Street, London, W.).
1 Filament rheostat, 8 ohms.
1 Filament rheostat, 2 ohms.
2 Stabilising condensers, Igranic type 2,231/17.
2 High resistance potentiometers, Igranic type 2,233/1.
½lb. No. 26 D.C.C. wire.
2 Packets No. 16 Glazite connecting wire.
Baseboard, 24in.×6¾in.×½in., planed mahogany (Hobbies, Ltd.).
3ft. soft wood or mahogany, 1in.×¼in., for battening the baseboard.
Ebonite for terminal strip, 13in.×1in.×¼in.
4 Small flash lamp cells for making up grid battery.
1 Grid leak, 2 megohms.
1 pair cast aluminium angle brackets, 2¾in. (A. J. Dew & Co., 33-34, Rathbone Place, Oxford Street, W.1).
Strips of ½in. planed mahogany (i.) 24in.×¾in. wide; (ii.) 20in.×1¼in. wide, for valve holder and coil platforms.
4 Bakelite covered terminals, aerial, earth, phones +, and phones − (Belling & Lee, Ltd., Queensway Works, Ponders End, Middlesex).
5 Nickel plated terminals, L.T.+, L.T.−, H.T.+, H.T+, H.T.− (Belling & Lee).
1 Telephone condenser, 0.001 mfd. (Metrocicks Supplies, Ltd., 4, Central Buildings, Westminster, London, S.W.).

if the user does not first avail himself of the range increasing properties of a low-frequency amplifier. The set should normally be followed by a two-stage power amplifier fitted with a switch for cutting out one of the valves.

When testing out as a complete five-valve set each amplifying stage should be successively brought into operation and its correct performance verified. For this purpose the lead from T_5 to the grid condenser and leak should be detached and extended to reach the grid socket of V_1, and with the detector valve only inserted signals received from the local station. The first valve is then inserted and signals tuned in on the left and centre dials and with the detector tap in the socket of V_2. With the shunt resistance at minimum position the circuit should be made to oscillate by adjusting the H.T. potential (normally 60 to 80 volts) and the performance of the shunt resistance can then be tested. The second valve is next introduced, and should it be observed that maximum signal strength is obtainable at two positions a few degrees apart on the second dial it may be concluded that the two stages are not tuning together, and remembering the setting of the previous test, with only one H.F. valve, adjustment can be made to one of the intermediate transformers. The inductance of the coil requiring the larger condenser reading can usually be sufficiently increased by pressing the turns of the winding closer together with the finger nail. The testing process is continued, inserting the third and fourth valves.

It is worth while unsoldering the grid leads from transformers T_2 and T_4, removing V_1 and V_3, and connecting the grids of V_2 and V_4 to the grid sockets of V_1 and V_3. The set can thus be tested as a straight two-stage neutrodyne. The success of the set depends entirely upon getting the interlocked stages fairly well in step.



THE FINISHED AMPLIFIER. The tin plate which covers the base forms part of a screening case which may be fitted should it be considered necessary after the set has been completed. It is omitted here as it is somewhat difficult to construct.

The tuning dials are divided into 100 divisions, and the tuning range on the intermediate dials from 20 divisions to maximum is from 250 to 550 metres, the aerial tuning condenser reading roughly coinciding.

British and European broadcasting stations are received during the evening at every few divisions around the dial. The local station, 2LO, some 12 miles away, occupies a space of five divisions on the aerial tuning dial and about two to three on the intermediate tuning dials when the set is followed by a single-stage note magnifier. This is moderately broad perhaps, and as a result "Petit Parisien" is slightly jammed. Interference by the French coast stations, FFB and FFH in particular, is bad at times near the position of maximum wavelength.

* * *

On a good outdoor aerial 60 feet in height the set was only slightly better than another fitted with two neutrodyned stages, though tests with a short indoor aerial gave remarkable results with many of the European stations.

WIRELESS CIRCUITS
in Theory and Practice.

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

A CURRENT of electricity through a circuit manifests itself only by its peculiar physical effects or properties, and these effects are utilised in various ways in wireless telegraphy and telephony and other branches of electrical engineering.

The three chief effects of a current of electricity are (*a*) the heating effect, (*b*) the magnetic effect, and (*c*) the electrolytic effect. All three of these properties are made use of in wireless work.

The first instalments of this series of articles will deal with the principles of circuits in general. Consideration will then be given to specific receiving circuit arrangements, and it will be shown how, by simple means, the electrical constants of each part of the circuit may be calculated with a view to obtaining maximum efficiency.

The unit of current is the *ampere*, and is based upon the electrolytic effect of the current, i.e., on its property of decomposing a compound in solution or in the liquid state into its constituent elements. The ampere is legally defined as that steady current which will deposit 0.001118 gram of silver per second on a platinum cathode immersed in a 15 per cent. solution of silver nitrate, the anode being of silver.

A current of electricity must be considered as a flow of something through the circuit, and the current in amperes as the *quantity of electricity* which passes a given point in the circuit in one second. One ampere flowing for one second represents a quantity of electricity of one *coulomb*. The weight of an element in grams deposited by electrolysis by one coulomb of electricity is called the *electrochemical equivalent* of that element.

Constants of an Electric Circuit.

The flow of electricity or the current in a circuit is governed by the electromotive force, or driving force, available, and by the constants of the circuit itself, namely, *resistance*, *inductance*, and *capacity*. All three constants are present to some extent in every circuit, but under certain conditions the effects of one or two of them may be negligible compared with the effects of the other two or the third respectively. For instance, a straight piece of resistance wire is not without a certain amount of inductance, but for currents of all ordinary frequencies the inductance has a negligible effect compared with that of the resistance, and for a steady direct current the inductance has no effect at all on the value of the current. This does not mean that the inductance varies according to the nature of the current, but simply that its effects depend on the nature of the current, the inductance itself being a property of the circuit and a constant quantity.

These three constants will be discussed separately, and subsequently the combined effects of resistance, inductance, and capacity in alternating current circuits will be considered, leading up to the theory of oscillatory circuits. Mechanical analogies will be used wherever possible in order to simplify the reasoning.

The beginner is referred to a series of articles entitled "Introduction to Wireless Theory," by N. V. Kipping and A. D. Blumlein.[1]

Electrical Resistance.

Resistance is that property of an electric circuit or conductor which opposes the flow of a steady current through it, the extent of this opposition or resistance depending on the dimensions of the conductor and the material from which it is made, and to a small extent on the temperature. A long, thin conductor offers more resistance to the passage of electricity through it than a short, thick one, just as in a water-pipe system a long pipe of small gauge offers more opposition (in the form of friction) to the flow of water than a short pipe of large bore. The electrical resistance of a conductor is directly proportional to the length of the conductor, and inversely proportional to its cross-sectional area.

The resistance of a conductor, or a given material, 1 centimetre long and 1 square centimetre in cross-section, is called the *specific resistance* or *resistivity* of that material; so that a conductor of the same material l cms. long and a sq. cms. in cross-sectional area would have a resistance $R=\rho\frac{l}{a}$ units, where ρ is the specific resistance.

The practical unit of resistance is the *ohm*, and is defined legally as the resistance offered to an unvarying current by a column of mercury 106.3 cms. long of constant cross-section equal to 1 square millimetre, its temperature being 0° Centigrade. The specific resistance ρ is expressed in ohms per centimetre cube or in *microhms* (millionths of an ohm) per cm. cube. Thus we have—

$R=\rho\frac{l}{a}$ ohms, where ρ is in ohms per cm. cube, l is in cms. and a is in sq. cms. If d is the diameter of a round wire in centimetres, then $a=\frac{\pi d^2}{4}$, so that

$$R=\rho\frac{4l}{\pi d^2} \text{ ohms.}$$

In order to drive the current through the resistance of a circuit some sort of driving force or electrical pressure is necessary, just as in ordinary mechanics a definite force is required to move a body against, say, a frictional resistance. This electrical force, which is produced by the dynamo or battery driving the current round the circuit, is called the *electromotive force* and is measured in *volts*. One volt is the electromotive force (E.M.F.) required to drive a current of one ampere through a

[1] *The Wireless World*, October 21st to November 28th, 1925.

Theory of Wireless Circuits.—

resistance of one ohm. It is found by experiment that in a circuit of fixed resistance the ratio of E.M.F. or voltage to current is constant. Using the units as defined above we see then that we have a definite relation between E.M.F., current and resistance, namely,

$$\frac{E}{I} = R \text{ ohms, or } I = \frac{E}{R} \text{ amperes,}$$

where E is the E.M.F. in volts. This is known as Ohm's Law, and is always obeyed by a steady current. The laws obeyed by alternating currents are somewhat different, and will be considered at a future date.

The difference of electrical pressure set up between the ends of a resistance R when a current I flows through it is given by $V = IR$ volts and is called the potential difference (P.D.) and is sometimes called the *potential drop* or *voltage drop* in the resistance. The resistance of a conductor is the same for all values of the current providing the temperature remains constant.

Electrical Power.

When a current of I amperes is driven through a conductor having a resistance of R ohms a certain amount of electrical energy is being used up and this energy is converted into heat in the conductor itself. The rate at which the electrical energy is being converted into heat is equal to the *power* taken by the resistance. In mechanics power or rate of doing work is given by the product of driving force and rate of movement (velocity) and similarly in the electric circuit the power is given by the product of electromotive force and current. The electrical power is measured in *watts* where one watt is the power represented by a current of one ampere flowing under a pressure of one volt. Thus in a circuit where the pressure is E volts and the current I amperes, the power is given by

$$P = EI \text{ watts.}$$

But since $E = IR$, by Ohm's Law, we get power $= I^2R$ watts, where R is the resistance in ohms. Hence the power is proportional to the *square* of the current and to the resistance.

We see then that whenever a current flows through a resistance heat is produced and, conversely, wherever heat is produced by an electric current, resistance is present in the circuit. Once the electrical energy has been converted into heat it is lost from the circuit, and power lost in this way is often referred to as I^2R loss.

Resistance in A.C. Circuits.

When we come to consider high-frequency alternating currents it will be seen that the resistance of a conductor depends to a certain extent on the frequency of the current and that the effective resistance actually increases as the frequency is raised. But for the present we shall deal with low-frequency alternating currents only, and it is assumed that the resistance is constant for all values of the frequency.

An alternating current is one which flows first in one direction and then in the opposite direction alternately round a circuit, the time intervals for the two directions being usually equal. The current is taken as positive when flowing one way round the circuit and negative the other way round. The variation of the current through one complete set of positive and negative values constitutes one *cycle* and the time of one cycle is called a period. The *frequency* or *periodicity* is the number of cycles passed through in one second. Alternating electromotive forces may be defined in a similar manner.

The simplest alternating current is one which varies according to a sine law, i.e., one which gives a sine wave when all the instantaneous values are plotted as a graph to a time base (see Fig. 1). In working out alternating current problems it is usually assumed that the currents, E.M.F.s, etc., obey a sine law.

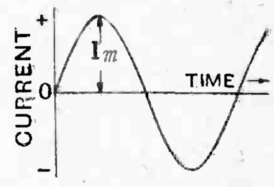


Fig. 1.—Sine wave of current of maximum value I_m.

It will be seen by inspection of a sine curve that the average value taken over a whole number of cycles is zero, so that obviously we cannot apply the same definition of the unit of current as we did for the direct current. Actually the useful or *effective value* of an alternating current is measured in terms of the average heating value in a fixed resistance compared with that of a steady direct current in an equal resistance. The effective value of an alternating current is defined as the value in amperes of the steady direct current which would have the same average heating effect in a given fixed resistance. For instance, let i amperes be the value of the alternating current at any instant, and let I be the effective value. Then the power at that instant is given by i^2R watts, and by definition the average power $= I^2R$ watts.

Thus

$$\text{mean value of } i^2R = I^2R$$
$$(\text{mean value of } i^2)R = I^2R,$$

or

$$\text{mean value of } i^2 = I^2,$$

from which

$$I = \sqrt{\text{mean value of } i^2} \text{ amperes.}$$

Thus the effective value is equal to the square root of the mean value of the squares of all the instantaneous values, very often called for short the *root-mean-square* value or R.M.S. value. Another name commonly used is *virtual* value.

Effective Value of a Sine Wave.

Consider a sine curve of current as shown in Fig. 2, the maximum or peak value being one ampere (curve 1). If we square all the values of the current and plot a new curve showing the relation between the square of the current and the time, we get a second curve (2), the whole of which lies above the zero line. This is the curve of i^2. It will be seen by inspection that the mean value of this curve is exactly

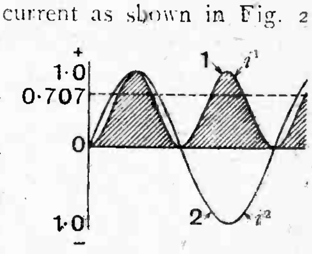


Fig. 2.—The root-mean-square (R.M.S.) value of an alternating current is $\frac{1}{\sqrt{2}}$ or 0·707 times its maximum value.

Wireless Circuits in Theory and Practice.—
half the maximum value of curve 1, i.e., mean value curve 1, i.e., mean value of $i^2 = 0.5$, therefore

$$\sqrt{\text{mean value of } i^2} = \sqrt{0.5} = \frac{1}{\sqrt{2}}$$
$$= 0.707 \text{ ampere.}$$

Thus the effective value or R.M.S. value of a sine wave of current is $\frac{1}{\sqrt{2}}$, or 0.707 times the maximum. This is an extremely important relation and should be remembered. Conversely if I is the R.M.S. value of a current obeying the sine law, the maximum or peak value will be $\sqrt{2}I$. The same rules apply to alternating voltages and magnetic fluxes.

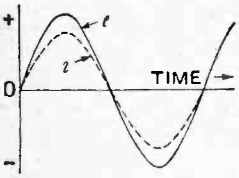


Fig. 3.—Alternating current and E.M.F. waves in phase.

Alternating Current Circuit Containing Resistance Only.

Suppose that a sine wave of alternating potential difference is applied to a fixed resistance of R ohms. Let e be the value of the voltage at any instant; then the current at that instant will be $i = \frac{e}{R}$ amperes, by Ohm's Law. Thus we see that the current is at every instant proportional to the voltage, so that the current curve will be another sine curve (see Fig. 3), which passes through its zero values at the same instants as the voltage curve, and has its maximum positive and negative values at the same respective instants as those of the voltage curve. These two curves are thus exactly "in step" and are said to be *in phase*.

If E_m is the maximum value reached by the voltage the maximum value of the current is $I_m = \frac{E_m}{R}$ amperes and the effective value of the current will be

$$I = 0.707\ I_m$$
$$= \frac{0.707\ E_m}{R}$$
$$= \frac{E}{R} \text{ amperes where } E = 0.707\ E_m$$

is the effective value of the voltage.

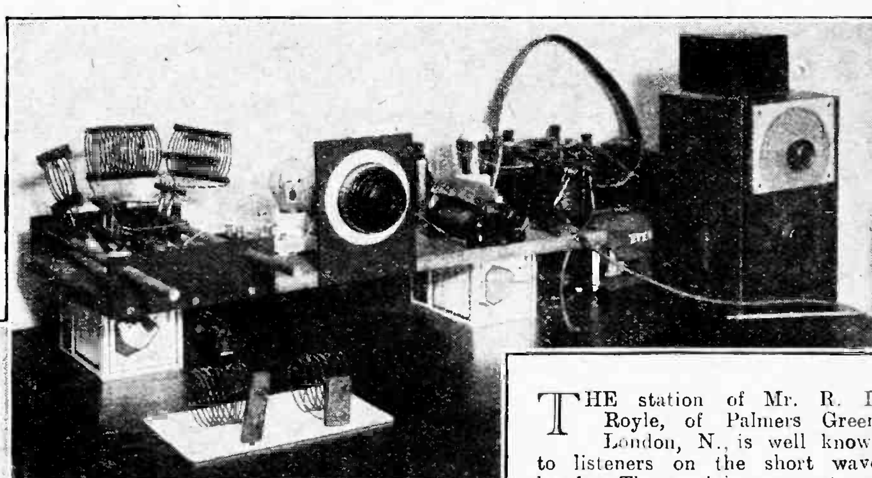
From the foregoing we see that Ohm's Law may be applied to an alternating current circuit where resistance only is present. It will be seen later that this is not the case if inductance or capacity is present.

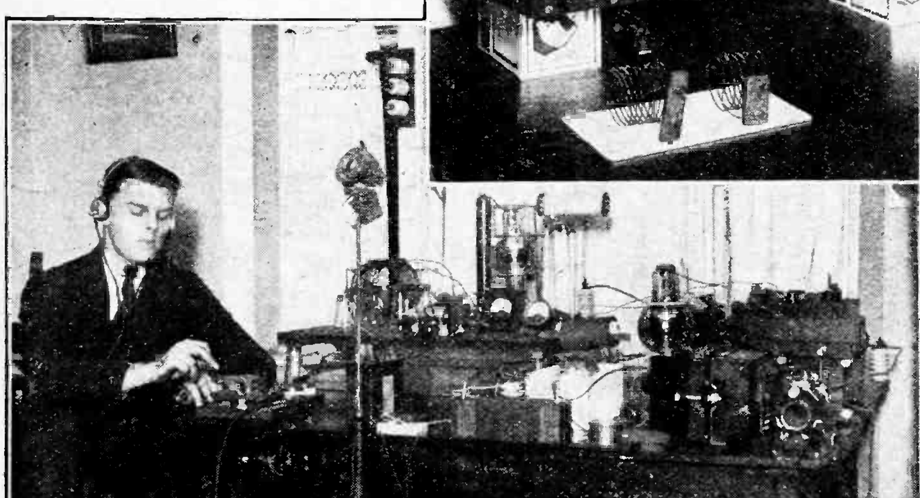
It can be shown in a similar manner that the average power in watts is given by the product of the effective values of voltage and current, i.e., power, $P = EI$ watts. This only applies to the particular case where the current and voltage are in phase. Where the voltage and current are not in step the actual power is less than the product of amperes and volts. This will be discussed more fully in a subsequent instalment.

(*To be continued.*)

WELL-KNOWN NORTH LONDON TRANSMITTER.

STATION 2WJ.





THE station of Mr. R. L. Royle, of Palmers Green, London, N., is well known to listeners on the short wavebands. The receiving apparatus is here shown in detail, as well as a general view of the station equipment. It is to be observed that the lay-out is by no means elaborate, yet evidently capable of good performance. High-tension supply for the transmitter is derived from the alternating current mains, making use of an electrolytic rectifier.

The receiver is quite simple in construction, and the three-coil low-loss tuner to be seen on the left is of interesting design, being fitted with wooden spindles carried between two pieces of ebonite.

PAST, PRESENT AND FUTURE of Wireless Telephony.

At a meeting of the Institution of Electrical Engineers in London on Thursday, January 7th, Capt. P. P. Eckersley, Chief Engineer of the B.B.C., gave a lecture on this subject and kept an unusually crowded audience both intensely interested and considerably amused for the space of over an hour.

AFTER expressing the strong opinion that wireless telephony will play only a secondary part in means of communication and that its great future lies in wireless broadcast, Capt. Eckersley remarked on the fact that in the United States the sales of wireless apparatus last year totalled $500,000,000.

The early part of the lecture was taken up with an explanation in popular terms of the general principles of how broadcast telephony is achieved, and discussing the attempts now being made to overcome distortion difficulties, Capt. Eckersley stated that for the most part these are based upon brute force and ignorance. The attempt to solve the problem in terms of higher power and longer wavelengths, as in the case of the Rugby station, was being watched with considerable interest, and he expressed the view that long-distance wireless telephony will never enter its wider field of development until a solution of the distortion difficulty had been found.

Capt. P. P. Eckersley.

Duplex Telephony.

If the fullest use was to be made of wireless telephony, it must link up with land lines, where it would not pay, or be possible, to lay a cable. This was actually done by Capt. Round between the East Coast and the coast of Holland, and enabled a man in his London office to speak with Holland. A similar experiment was carried out by Franklin in 1921 or 1922 on 15 metres between Hendon and Birmingham, and it had been shown to be perfectly feasible to work such a system. Indeed, he wondered why duplex wireless stations had not been used to a greater extent all over the world to link up scattered points.

Dealing with the general position of wireless broadcasting, Capt. Eckersley said that those responsible for the present system had started full of hope and ideas, but very little money, and had built up a system which had served as a model to the world. Nearly every other European station had adopted a system something like our own. He then related the gradual changes in policy which had come about since the B.B.C. started with its original idea of 8 stations to serve Great Britain; but when it was discovered how 50 per cent. of the crystal users were not being served, an extension was made by the installation of local stations, and finally how by the erection of Daventry, the largest high-power station in the world, it had been hoped to make the whole of the country a crystal area and, at the same time, to give alternative programmes. Even this, however, had not been found to be a complete solution because of the international situation which must be considered in relation to any national system. At the present time a station in Rome might seriously interfere with a transmission in London, and the general results had been that the multi-station idea would have to be abandoned in favour of the fewer station idea. Owing to the various uses made of wireless outside broadcasting, it was essential to get an international solution. At the present time there were some 250 stations working, or in contemplation, in Western Europe, and if these were to be able to work unhindered, it would be necessary to make one station do the work of five.

Interference Problems.

Difficulties in doing this, however, had been encountered, and in order to avoid the shutting down of stations and the building of new high-power stations, the suggestion had been put forward that certain selected important stations should be given an exclusive wavelength, whilst the other stations should be asked to work in groups on the same wavelength so that the limited number of wavelengths would go round. In order to test the possibilities of interference from two stations working on the same wavelength, he had arranged recently for Bournemouth to work on the same wavelength as 2LO, and riding in a motor car away from Bournemouth towards London, it was found that at five miles there was no interference and one would not know that London was working. At a distance of 10 miles a faint background of mush could be detected; and at 15 miles there was definite London interference. Thus it was established that two stations in different parts of the country working on the same wavelength would only have local significance, and only in their crystal areas would the local programmes be received.

Speaking of the difficulties of transmitting, Capt. Eckersley said that the problem concerning the B.B.C., whilst extraordinarily simple in essence, was amazingly difficult to achieve, because the aim was to transmit from frequencies of about 30 up to about 10,000 cycles with

Past, Present and Future of Wireless Telephony.—equal clearness at the receiving end. The difficulty was the lack of methods which render sound a measurable quantity, and although there were the advocates of the pressure method of testing and the audibility method, he believed eventually we should arrive at something between the two. For the moment the broadcast engineers were compelled to proceed on hit and miss methods. Finally, Capt. Eckersley discussed the question of transformer design, and showed how improvements have been effected in the type of transformer now being used for simultaneous broadcast work. The curve obtained was shown to approximate very closely to a straight line, and Capt. Eckersley claimed that there is little difference between a properly designed transformer and the vaunted resistance-capacity. This result, he said, had been obtained by a little trick which consisted of using a choke in the anode circuit and a condenser in series with the transformer primary.

Whilst paying a tribute to the advance that has been made in the design of receiving apparatus, Capt. Eckersley rather hinted that it is at the receiving end that the greatest attention still needs to be concentrated in order to ensure that whatever degree of accuracy and perfection is attained at the transmitting end should be faithfully reproduced at the receiving end.

The Discussion.

In the course of the discussion which followed the lecture,

PROF. C. L. FORTESCUE expressed the hope that in the fairly near future it will be possible to obtain receiving sets which are cheap, selective and efficient, because there were very few people in this country who could afford to pay £100 for a beautiful imitation of old furniture, most of the interior being occupied with a raucous loud-speaker.

MR. P. G. A. H. VOIGT recounted some of his experiments in endeavouring to improve loud-speakers.

MR. C. M. R. BARLBIE suggested that the B.B.C. should abandon its policy of not transmitting sounds of low frequency, in its programmes, the reason being, he believed, because the lower notes are not picked up by the receiving stations.

MR. E. H. SHAUGHNESSY suggested that one reason why we have not reached the 500,000,000-dollar mark in wireless apparatus sales in this country might be that Capt. Eckersley's crystal attitude had made it possible for everybody to make their own crystal set for half a crown! He disagreed with Capt. Eckersley that wireless telephony will only be useful for broadcast work, and incidentally remarked that he considers broadcasting a nuisance. He predicted the day when probably wireless telegraphy would be banned internationally and wireless telephony would take its place, and finally disagreed with Capt. Eckersley's implication that all reception and all loud-speakers are bad.

MR. D. KINGSBURY suggested that the arrangement shown by Capt. Eckersley of the choke in the anode circuit and the condenser in series with the transformer primary is the answer to the feathering which is noticeable in the reproduction of certain notes in the bass region.

MR. S. BRAENDLE referred to a form of cone loud-speaker, with which he claimed to obtain the lowest notes in music with equal clarity to the higher notes of the violin.

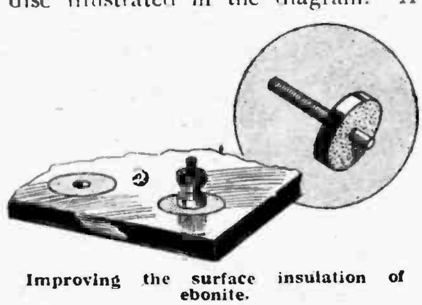
CAPT. ECKERSLEY, in an entertaining reply, said he had not claimed that broadcasting is the only field for wireless telephony, but he still believed it would be the greatest field. Neither did he suggest that transmission was so very much superior to reception, although it was a little discouraging to find that the efforts to produce the best transmission were sometimes hideously ruined in the homes of the listeners. After remarking that statements in some papers that the B.B.C. is going to alter its wave-length can only be characterised as inaccurate, he referred again to the problems of the broadcast engineer and asked what the feelings of the Post Office would be if every telephone user was allowed to make his own receiver.

He corrected Mr. Barlbie on the question of the B.B.C. not transmitting the lower notes, and said this is not the case; and in reply to Mr. Kingsbury said that whilst he did not believe the circuit referred to was responsible for the feathering effect mentiond, it was possible that it was caused by experiments on microphones. If, however, the B.B.C. was not able at times to experiment on the public, little progress would be made.

SURFACE INSULATION OF EBONITE PANELS.

A Useful Tip for the Home Constructor.

THE process of giving a glossy surface to ebonite sheets reduces the surface insulation. This is due to the use of tin foil, which combines chemically with the ebonite and produces a conductive surface. It is therefore customary to remove this surface by rubbing down with emery cloth. Many, however, prefer the polished appearance to the matt surface so produced. It is possible to effect a compromise by removing the surface film in the immediate vicinity of terminals, bushes, etc., by means of the emery disc illustrated in the diagram. A short piece of brass rod is screwed at one end and fitted with an ebonite disc cut from $\frac{1}{4}$in. ebonite sheet. A lock-nut firmly secures the disc to the spindle. A circular piece of emery cloth is then fixed to the surface of the ebonite disc by means of strong glue, and is applied to the panel by rotating in a hand-drill. The diameter of the disc should be such that the surface film is removed for a distance of approximately $\frac{1}{4}$in. round each terminal.—H. L. H.



Improving the surface insulation of ebonite.

HINTS and TIPS for NEW READERS

A Section Devoted to the Practical Assistance of the Beginner.

THE CARBORUNDUM DETECTOR.

Mention has already been made in these pages of some of the advantages of the carborundum detector, more particularly with reference to its use in conjunction with a valve amplifier. The same remarks regarding its stability apply when it is used without amplification in a simple crystal set, and the high resistance of the rectifying contact will reduce damping, giving consequently sharper tuning. The disadvantage of having to use a potentiometer and dry cells may be reduced by taking care that the former has a fairly high resistance winding, in order that the current consumption may be reduced as much as possible.

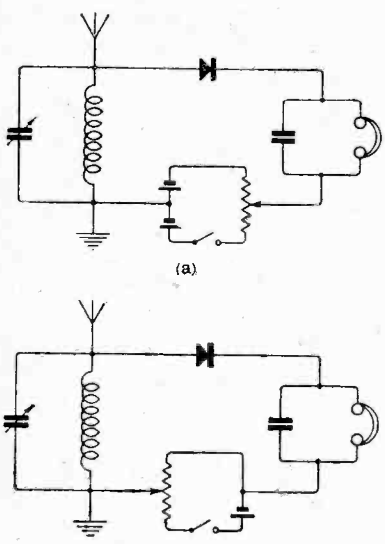


Fig. 1.—Carborundum crystal receivers.

A convenient method of connecting the potentiometer is shown in Fig. 1 (*a*). If this scheme of connections is adopted, the polarity of the voltage applied to the crystal may be changed, as, when the "slider" is making contact with the centre of the resistance winding, the applied voltage is at zero, movements to either side giving a positive or negative bias.

If the second method of connection (Fig. 1 [*b*]) is adopted, it may be necessary to reverse the crystal, as the applied voltage will always be of the same polarity. This scheme has the advantage that only one dry cell is needed, and, due to the consequently reduced current flow, it will have a longer life. It should be pointed out that all carborundum crystals do not rectify in the same direction, so if adjustment of the potentiometer fails to improve reception, reversal should always be tried.

It is generally stated that specimens having a blue-grey colour make the best rectifiers, but very often pale sea-green crystals are equally, or even more, efficient. A steel point may be used as a contact (a gramophone needle is convenient), but if full advantage is to be taken of the stability of the crystal a steel plate is recommended, with fairly firm pressure.

○ ○ ○ ○

INDOOR AERIALS.

Elaborate arrangements of wire in spiral or zig-zag formation are often used as indoor aerials, but it is more than doubtful if these devices give improved results compared with the simple plan suggested in Fig. 2 (*a* and *b*).

Assuming that it is possible to erect the aerial on an upper floor, the type shown in Fig. 1 (*a*) will probably be convenient in many cases. The two horizontal wires will be stretched along a passage or corridor, as high up as possible, while the wire connecting to the set may be led down the well of the stairs, and should be fairly heavily insulated.

The second aerial shown is probably the more effective arrangement possible when it becomes necessary to have all the apparatus contained in one room of normal dimensions. It should be as long as space permits, and as high as possible, taking into consideration the fact that the wire should not actually touch the walls or ceiling, although generally no great reduction of efficiency will be noticed if it is allowed to do so, provided that it is reasonably well insulated. An indoor aerial cannot be considered as an ornament to a room, so, from the point of view of appearance, it will be as well in many cases to carry the horizontal wires along a picture rail at either side of

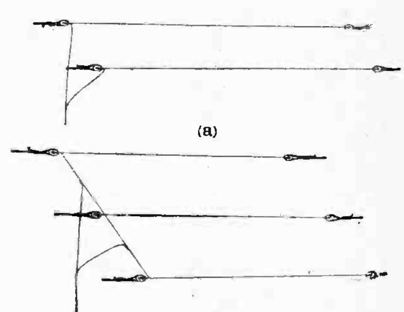


Fig. 2.—Indoor aerials.

the room, dispensing with the middle wire.

If long-distance reception is desired, either of the aerials suggested may be installed in the loft, if one is available, bearing in mind that there is no advantage in increasing the number of parallel wires, unless it is possible to space them by at least six or eight feet. As the woodwork and tiles will probably be damp, more care should be taken to keep the wire well clear than would be necessary if the aerial were installed in a living room. The insulators should also be more carefully chosen, for the same reason, but where there is no risk of leakage through dampness quite small and inconspicuous insulators may be used.

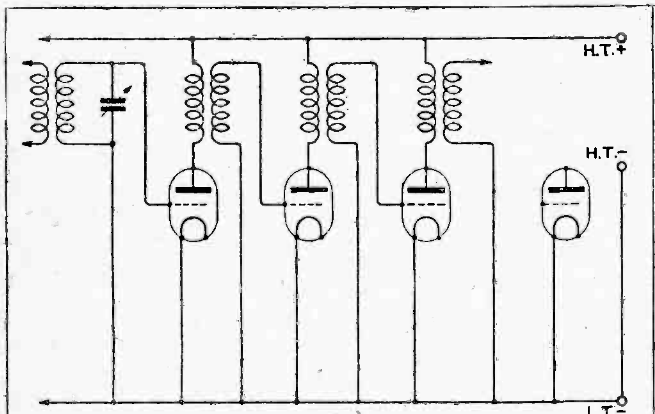
There is little need to use heavy wire for indoor aerials; for spans supported by insulators, No. 18 S.W.G. bare wire is suitable, while for downleads and in cases where no extra insulation is provided, the so-called 4-millimetre rubber-covered low-tension cable is adequate.

The indoor aerial should only be regarded as an indifferent substitute for the outdoor variety, made necessary by special circumstances, and every effort should be made to erect the latter when possible. Users of sets which radiate strongly are sometimes under the impression that by using an indoor aerial they run no risk of interfering with their neighbours; this is, most emphatically, incorrect.

DISSECTED DIAGRAMS.

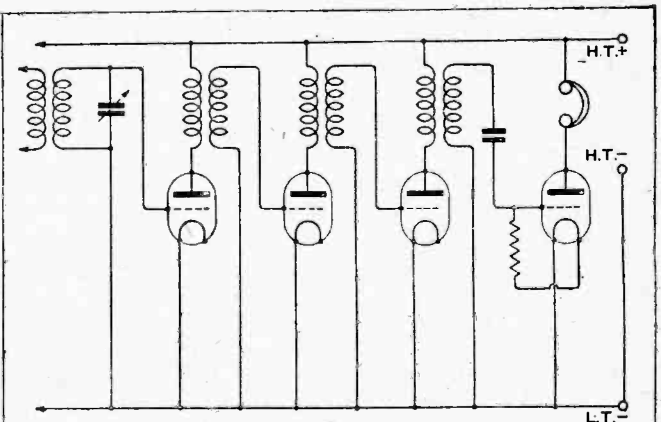
No. 14b.—A Practical Superheterodyne with One Stage of Neutralised H.F. Amplification.

For the benefit of readers who find difficulty in reading circuit diagrams, we are giving weekly a series of sketches, showing how the complete circuits of typical receivers are built up step by step. Last week we showed the early stages of a superheterodyne receiver, and give below the remainder of the circuit.



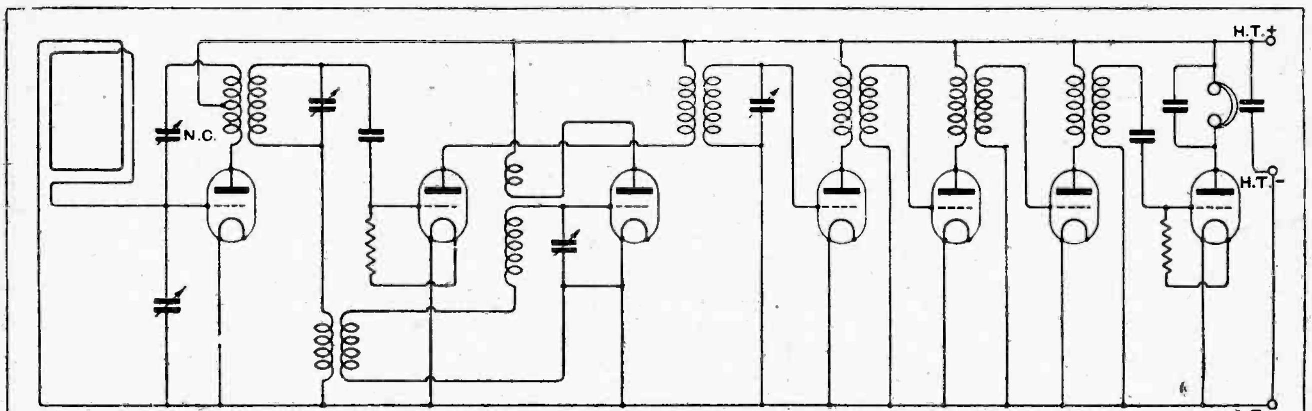
5

The secondary winding of the input transformer (which is usually tuned by a fixed, semi-variable, or variable condenser) is connected between grid and filament of the first intermediate frequency amplifying valve. Coupling between this and the succeeding valves is by transformers—



6

—broadly tuned to the wavelength of the input transformer by virtue of their inductance and self-capacity. The last valve operates as the second detector, a grid condenser and leak being inserted for rectification. Telephones (or the primary winding of an L.F. transformer) are connected in the anode circuit of this valve.



7

The complete circuit of the receiver. To avoid complication, the valve filament circuits have been omitted. It might be desirable, under certain conditions, to apply different high tension voltages to some of the valves. Separate tappings might be provided for (1) H.F., first and second detectors; (2) oscillator; (3) intermediate-frequency amplifiers. For the sake of simplicity these refinements are not shown.

RECENT SHORT WAVE WORK.

The Development During the Past Year.

DURING the past year considerable attention has been paid to wavelengths below 50 metres by amateurs and experimenters all over the world, and many startling long-distance communications have been effected with surprisingly low powers.

Undoubtedly the most popular wavelength, and at the same time the most peculiar, is 45 metres, the wavelength allotted at the beginning of the year to experimental stations by the Post Office.

The 20-metre band has not perhaps received the attention it should have received owing to the fact that very few stations were to be heard in that region, and reports of individual tests were few and far between, at least in England, during the earlier part of the year.

With the coming of the winter months foreign and colonial amateur stations were received with strength and reliability around 40 metres entirely unknown on the higher wavebands, and progress has been so rapid that it is now possible to effect communication with Australia or New Zealand practically the whole of the day.

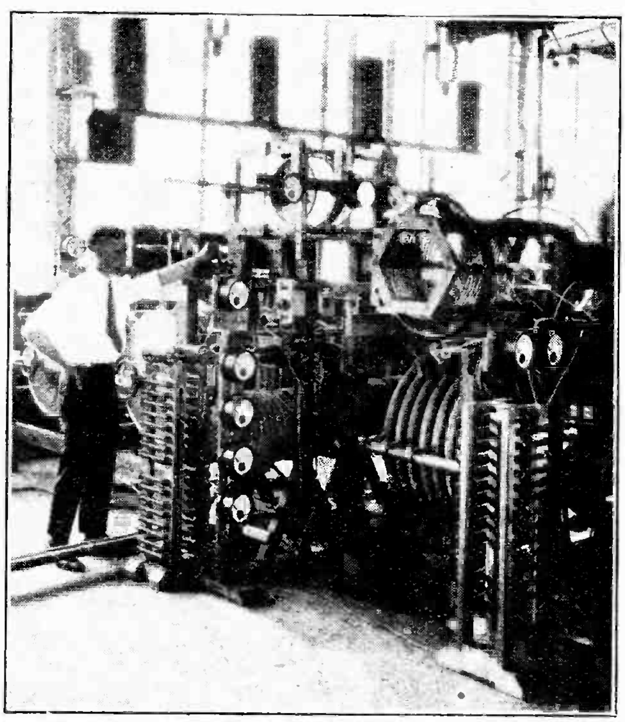
South Africa Enters the Field.

Early morning finds New Zealand stations filling the log, followed quickly by Australian stations, which are audible at intervals until 8 or 9 p.m.

South Africa and India have also produced a number of keen experimenters who reach this country on 35 metres with exceptionally low power transmitters. South Africa, which was only a few months ago regarded as practically impossible as regards short-wave communication, now boasts at least half a dozen experimental stations which are regularly in touch with England, U.S.A., and the Philippine Islands.

2BC, who has frequently reported reception of British stations at his station in India, has been heard recently in this country, whilst a Government station, CRP, at Delhi, has also exchanged signals with England; most of these results being obtained in the late afternoon or early evening.

Western Australia has produced a good station in A6AG, whose signals are audible from mid-day until 5 p.m., the operator being a keen experimenter, who is running a broadcasting station during the day and breaking records in long distance working on 38 metres at night.



A corner of the transmitting room at 2XAF, the experimental station of the General Electric Co., at Schenectady. Concerts are relayed by this station from WGY on a wavelength of 41.5 metres and are received without difficulty in this country.

Several American enthusiasts located in or near the Philippine Islands have succeeded in establishing regular and reliable contact with the West Coast of the United States, England, South Africa, and Australia, the foremost of these being PI1HR, situated at Manilla. Signals from this station on 37 metres are received each day with regularity in England whilst he is engaged in conducting a traffic service with the American 6th District amateurs, and working two-way with British stations.

American Short-wave Telephony.

Amateur and commercial stations of the U.S.A. can be copied practically at any time during the day or night, the most notable of the commercials being WIZ, whose test signals "ABC," etc., are well known to British listeners.

The telephony from WGY on 41.5 metres is audible on occasions at 7 p.m. G.M.T., and often the whole of his lunch-hour concert may be heard on ordinary straight-circuit two-valve receivers between 6 and 7 p.m. G.M.T. Canada has a pioneer of short-wave work in C1AR of Dartmouth, Nova Scotia, whose signals, so well-known to the 90 and 40 metre bands, are now equally strong on 20-18 and 15 metres, where he is often to be heard exchanging signals with the U.S.A. and France. C1AR held a regular schedule with the McMillan Arctic Expedition, during the latter part of the voyage, on 18 metres, and complete success was attained through his efforts.

Within the last few months many countries have equipped cargo and commercial ships with short-wave apparatus for experimental purposes, and in many cases amateurs have been placed in charge of the gear. Sweden has led the field in this direction, and several ships trading between that country and South America have been logged on 40 metres in England.

British amateurs have now effected two-way contact with most countries of the world, but have still to work with Japan. Already a station in Tokio (1PP) has been heard by "G" stations, and it is only a matter

Notes on Recent Short Wave Work.— of time before reliable two-way communication will be established.

With regard to the peculiarities experienced on the 40-metre band, it is noticed that at certain periods during day and night signals from stations within a few miles of the receiver vary enormously in strength, and at times become almost inaudible, although the power at the transmitting end remains unchanged. For instance, a station located 30 miles from that of the writer, who is received at strength R.7 in the morning and early afternoon, almost entirely fades out soon after dusk and remains so until daybreak. At the same time this station is probably being received in Australia, South Africa, etc., quite well. It would appear from this phenomenon that when a signal from a local station is coming in weakly after dusk the same signal is being received at great distances at good strength, conversely when the local signal is strong it is not covering great distances. Another peculiarity of this interesting waveband is that during exchange of signals in daylight between "G" stations a hundred or so miles apart rapid and irregular fading is very pronounced. This effect is even more noticeable when low clouds are passing over the transmitting aerial.

Again, it has been observed that whilst signals from United States East Coast stations have been subject to fading, transmissions from such stations as A6AG, A2CM, and PI1HR can be copied for long periods without any fading worthy of mention.

Within the narrow band (44-46 metres) recently allocated to British experimenters, very many stations are now working who jam one another without being aware of the fact until notified by the distant station co-operating in their tests.

Considerable interference is caused by Continental stations employing unsmoothed A.C. for plate, supply, and are particularly troublesome because they are using the wavelengths allotted to Australians, South Africans, etc.

With few exceptions British stations are now employing D.C. or well-rectified carriers, and only on very rare occasions does one hear a "G" station with a signal spreading

Some of the recent achievements by British amateurs include the establishment of communication with the Philippine Islands, South Africa, India, China and Western Australia, and for work in this direction the following stations are worthy of note:—2LZ, 2NM, 2SZ, 2KF, 5QV, whilst on the reception side 6LJ and 5MO have heard many Philippines and J1PP. 2LZ, 2NM and 2SZ are using telephony with great success on 45 metres, and the latter has reported working NPP, who is believed to be at Pekin.

In Ireland, where amateur transmitting licences have just been granted, at least two stations are in communication with the United States and the Antipodes.

It is strange to note that although all U.S.A. districts have been heard, and recently the sixth which had always been considered the most difficult to work owing to the distance has been communicated with frequently by several "G" stations, the seventh district remains practically silent and unworked.

TRANSMITTING NOTES AND QUERIES.

Mr. F. A. Mayer (G 2LZ), "Stilemans," Wickford, Essex, writes:—

"The 12,000 odd miles to New Zealand appears to be the greatest DX possible for the transmitting amateur, as it is practically at the Antipodes, but I claim to have beaten this.

"Last Sunday, the 3rd inst., I was in communication with U-601, Berkeley, California, at 3.30 p.m. Signals at this time of the day must be travelling the longest distance round, *via* the darkness, which makes the distance about 16,000 miles. I work the Philippines nearly every day at this time, and hear stations in French Indo-China, and Hawaii, but there is no communication west with U.S.A., so it is practically certain that our signals travelled east. Anyway, I claim it as such until someone proves it otherwise."

oooo

A correspondent wishes to identify a station heard on January 5th between 6 and 7 a.m. on a wavelength between 40 and 50 metres. The transmission consisted of fairly long talks, believed to be in German, followed by orchestral music. Can any reader identify the station from this description?

oooo

Mr. R. G. Banker (U 3BHV), 300, Eleventh Street, N.E. Washington. Pa., transmits on 15 watts and will welcome reports from British amateurs.

oooo

With further reference to the note in our issue of November 18th, about South African stations, Mr. Brian W. Warren (G 5CI), 19, Melville Road, Coventry, informs us that he has recently received A 4Z, A 3E, and A 6N between 1,800 and 1,900 G.M.T. on an 0-v-1 receiver. He has also heard several Australian stations at this time, and, on December 31st, A 2YI was heard at 1,430 G.M.T. In all cases the signal strength was good.

oooo

Mr. J. Hanson (6YU), 56, Falstaff Gardens, Radford, Coventry, reports having been in direct communication with FI 8QQ (Saigon, French Indo-China) at 1,900 G.M.T. on December 31st. 6YC's signals were reported as being R4, but badly jammed by atmospherics.

Mr. R. Pollock (G 5KU), 4, Glenhurst Avenue, N.W.5, has also been in touch with FI 8QQ, though, in this instance, the message from Saigon intended for Mr. Gerald Marcuse (G 2NM) was relayed *via* Z 2AC, F 8JN, and G 5KU.

We understand that FI 8QQ is now using the call sign FI 8JL.

New Call-signs Allotted.

2BLM.—J. C. Martin, 50, Holyhead Road, Coventry (artificial aerial).

2CO.—G. E. Pohu, 16, Colville Road, Bayswater, W.11.

2NT.—A. C. C. Willway, Knole Hill, Mayfield, Sussex, transmits on 45 metres.

2YG.—W. H. Andrews, "Tramore," Totnes Road, Paignton, transmits on 150-200 metres.

5FQ (in place of 2BBQ).—E. H. Capel, "Sunnyside," 23, College Road, Harrow, transmits on 45, 90, and 150-200 metres.

6FT (in place of 2BIU).—T. T. Frost, 19, Highfield Road, Felixstowe, transmits on 23 and 45 metres.

6NK.—R. J. Denny, 1, Hillside, Waverley Road, Weybridge, transmits on 23 and 45 metres.

6OG (in place of 2BDQ).—R. A. Webber, 8, Theresa Avenue, Bishopston, Bristol, transmits on 8, 23, 45, 90, and 150-200 metres.

6SQ.—G. A. Heaney, 5, Dunedin, Antrim Road, Belfast, transmits on 23, 45, and 90 metres.

oooo

Stations Identified.

G. 5BY.—H. L. O'Hefferman, 69, Lower Addiscombe Road, Croydon.

G. 6HF.—M. H. Wynter-Blyth, Tankersley, near Barnsley, Yorks, transmits on 23, 45, 90, and 180 metres.

FI 8QQ.—R. James, 21, Rue Richard, Saigon, French Indo China.

U 99X.—U.S. Naval Air Station, Coco Solo, Canal Zone, Panama.

CURRENT TOPICS

News of the Week in Brief Review

MICROPHONIC WELSH.

The Swansea broadcasting station is transmitting fortnightly talks in "Conversational Welsh." English listeners should note that they are accurately tuned-in when the crackle is loudest.

o o o o

DUBLIN IMPROVES.

Reports on reception from the new Dublin broadcasting station are growing more favourable.

To secure variety of talent in the programmes it is hoped to secure co-operation with outside interests. If possible, complete programmes, especially concerts, will be broadcast from such centres as Belfast, Cork, Limerick, and Waterford.

o o o o

SCHOOLBOY "HOWLERS."

A few days ago suggestions were made in the daily Press that the oscillation nuisance would show signs of abatement when schoolboys' holidays were over. This idea, besides being uncharitable, is probably unfounded; it seems quite likely that many fathers, bereft of their sons' guidance, will "howl" more than ever during the next few months. The average schoolboy knows as much about wireless as his elders.

o o o o

BROADCAST TOURING SERVICE.

A wireless touring bureau for the benefit of motorists has been opened by the WBBM Broadcasting Station, Chicago. The bureau, which is under the direction of an experienced tourist and traffic expert, broadcasts information concerning road and weather conditions, besides planning tours for individual listeners.

o o o o

THE BROADCASTING COMMITTEE.

Further meetings of the Committee, appointed by the Postmaster General under the chairmanship of Lord Crawford, to advise as to future policy in regard to broadcasting, will be held in Committee Room No. 4 of the House of Lords at 4 p.m. as follows:—

Date.	Evidence (by or on behalf of).
20th January	The Radio Society of Great Britain.
21st ,,	The Radio Association. Mr. Filson Young.
22nd ,,	The Performing Right Society. The National Association of Radio Manufacturers and Traders.
27th ,,	Sir Walford Davies, Mus.Doc.
28th ,,	Sir Hugh Allen, Mus.Doc.
29th ,,	Secret Wireless, Ltd.

OPENING OF NEW PRAGUE STATION.

On Friday last an inaugural programme was broadcast from the new broadcasting station at Prague, Czecho-Slovakia. It is understood that the new station operates on 400 metres, with a power of 5 kilowatts.

o o o o

WHERE SILENCE IS GOLDEN.

Unlicensed owners of receiving sets have apparently one impregnable line of defence, according to a decision made by the Leeds stipendiary magistrate.

George Cox, the defendant, was summoned for installing and working wireless apparatus without a licence. For the defence it was stated that the set had been built by a friend, but it had never worked. Cox had tried it, but all he could get was silence.

In dismissing the summons, the stipendiary remarked that he could not accede to the argument that an attempt to work the set was the same as having worked it.

AUSTRALIA'S B.C.L.'s.

Proposals are afoot in New South Wales for the formation of a Broadcast Listeners' League. It is estimated that the State contains thirty or forty thousand listeners.

o o o o

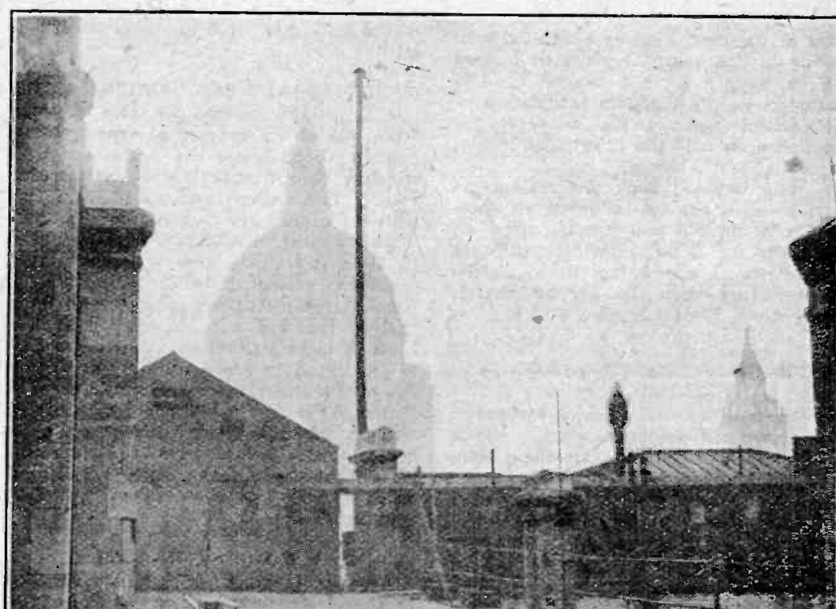
LOUD-SPEAKER DEMONSTRATION.

At a general meeting of the Radio Society of Great Britain, to be held at the Institution of Electrical Engineers, Savoy Place, W.C., on Wednesday, January 27th, Dr. N. W. McLachlan, M.I.E.E., F.Inst.P., will give a lecture on "Loud-Speakers," with demonstration.

o o o o

WIRELESS FOR POLAR FLIGHT.

The famous explorer, Roald A. Amundsen, has placed an order with the Marconi Company for wireless apparatus to be installed on the airship in which he hopes to make his next trip to the Pole. The apparatus will consist of transmitters and receivers for Morse and telephony.



A HUB OF COMMUNICATION. A picturesque view of the receiving aerial above the Central Telegraph Office at the General Post Office. The bulk of reception is carried via the high power stations, signals being relayed to London by wire.

SUPER BROADCAST ADVERTISING.

The city of Cincinnati, U.S.A., is broadcasting from station WSAI a series of "super programmes," by which it hopes to proclaim its "international reputation as a centre of musical art and culture."

oooo

BRITISH APPARATUS IN SPAIN.

British wireless apparatus is steadily entering into general use in Spain, particularly in the Vigo district, according to a *Times* correspondent. There is a heavy customs tariff, but this has not deterred traders. French and German firms have secured a large amount of business, and American and Italian manufacturers are competing in the market.

oooo

PROGRAMMES A MONTH AHEAD.

The Canadian National Railways, which control a chain of broadcasting stations across the Dominion, now issue an attractive booklet giving the programmes for a month ahead. The "CNR" stations, which number ten, are situated at Monckton, Montreal, Ottawa, Toronto, Winnipeg, Regina, Saskatoon, Edmonton, Calgary, and Vancouver.

oooo

AMERICAN WIRELESS INVASION?

The pending establishment of factories in Great Britain for the manufacture of American wireless apparatus is suggested in a message from the New York correspondent of the *Daily Express*.

The message states that Mr. Percy L. Deutsche has sailed for England for the purpose of establishing factories and organisation in this country to manufacture apparatus designed by the General Electric Company of America, the Westinghouse Company, the Radio Corporation of America and the Brunswick-Balke-Collender Company.

oooo

BEAM STATION FOR PERU.

One of the most bitterly contested concessions in the recent legislative history of Peru, says a Lima message, has terminated with the Senate's ratification of the Marconi contract for 25 years for administration of the Peruvian posts, telegraphs, and wireless.

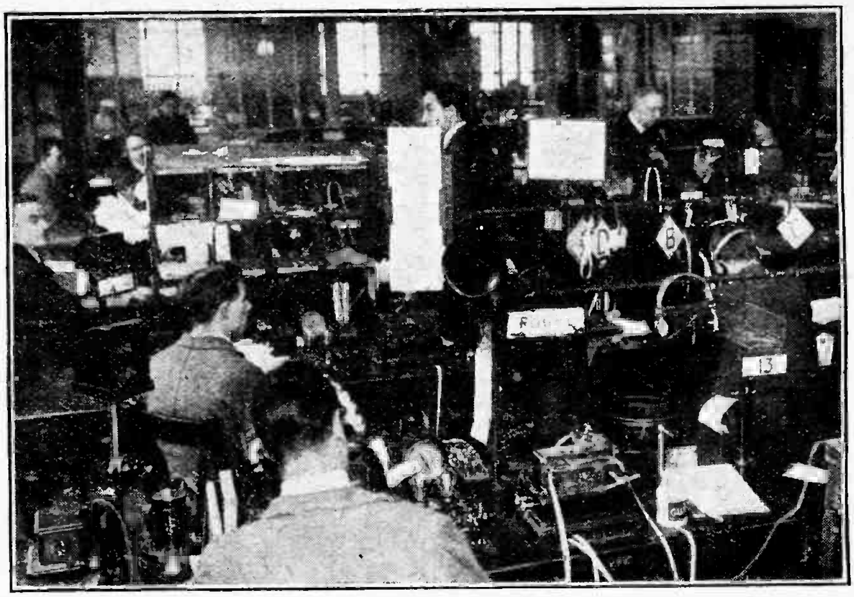
It is understood that the ratification coincides with the initiation of an energetic construction programme, with an expenditure of £500,000, which includes the erection of a powerful beam station communicating with the United States, Buenos Aires, Rio de Janeiro, and Bogota.

oooo

INDIAN BROADCASTING LICENCE GRANTED.

Broadcasting in India, which so far has been carried out only through the efforts of radio clubs to Calcutta, Bombay, Rangoon, and Madras, will shortly be put on a commercial basis by the granting of a licence to the Indian Radio Telegraph Co. This company was the only one to apply for a licence when the Government of India last year invited applications, and the Government has decided to issue a licence to it.

It is understood that two new 12-kilowatt stations will be erected at Bombay and Calcutta.



WIRELESS AT THE G.P.O. An interesting glimpse in the Central Telegraph Office. Transmission and reception via the new Rugby station are conducted from the desk in the foreground.

AN IRISH DILEMMA.

Broadcast developments in Dublin are being badly hampered by lack of funds. Reviewing the position, the *Irish Times* states that nobody has any authority to arrange anything involving expenditure. Consequently no programme engagements or contracts can be made. A station "orchestra" of four members has been sanctioned, but no appointments have been made. Up to the present artistes have given voluntary performances at the personal request of the station director.

The Minister of Posts and Telegraphs recently said: "Any kind of Irish station would be better than no Irish station at all."

oooo

WIRELESS CLUB FOR WORKING MEN?

A Northern newspaper has received from one of its readers a request to be put in touch with the secretary of a wireless club "suitable for the working man." The enquirer adds: "I am surprised I cannot get to know one."

This appeal ventilates what is believed to be a prevailing impression in certain quarters, where it is forgotten that a wireless society differs from a night club and is founded on grounds other than those of class distinction. A wireless club is conducted to assist all its members in the study and practice of wireless. The "working man" need not fear that he will be asked to confine his attention to crystal sets, what time the "middle class" member dabbles with "straight" valve circuits and the "idle rich" with superheterodynes.

oooo

A HUMAN "SHORT."

A recent incident which nearly resulted in the electrocution of one of the engineers at WIBO, Chicago, is referred to by Carl Dreher in the current issue of *Radio Broadcast*, New York. During the transmission of an evening programme an engineer was severely injured through the gold frame of his spectacles coming in contact with a live lead. The frame of the glasses fused immediately, and it was necessary to close down the station temporarily before the unfortunate man could be released. He was badly burned.

oooo

WIRELESS FOR EAST AFRICA.

Referring to the means which might be adopted to bring about the federation of the East African provinces, Major A. G. Church, in his recent lecture before the Royal Geographical Society, said there was no reason why the Imperial Wireless Committee should not insist upon the erection of a chain of wireless stations throughout East Africa.

The establishment of regular communication between the territories would give the strongest hopes for their future unification.

oooo

AUTHORISED WAVELENGTH FOR CANADA.

The department of Marine at Ottawa has authorised a wavelength of 52.51 metres as the "Trans-Canada" wavelength exclusively for long-distance relay work. This is also the authorised wavelength for communication with other parts of the Empire.

oooo

INTERESTING B.B.C. APPOINTMENT.

Another well-known experimental transmitter has joined the ranks of the B.B.C. in the person of Captain R. Gambier-Parry, owner and operator of 2DV.

Captain Gambier-Parry, who has been appointed personal assistant to Captain Eckersley, also holds the post of Head of the Technical Correspondence Branch. During the last seven years he has been attached to the Royal Air Force and has held a technical appointment in the Air Ministry.

PIONEERS OF WIRELESS.

By ELLISON HAWKS, F.R.A.S.

3.—Oersted.

THE Ancients knew that when rubbed with fur, amber attracts light objects, such as pith balls or feathers. It is very curious that until 1820 no one compared this peculiar property with the attractive power of the magnet. Indeed, after the work of Dr. Gilbert in connection with magnets, we do not find that there was any further advance until the time of Oersted (1777-1851), the celebrated Danish physicist.

Hans Christian Oersted was born on August 14th, 1777, at Radkjobing on the Danish island of Langeland. Here his father carried on an apothecary's business, and Hans was brought up to follow this profession. A German barber taught him German and his (the barber's) wife taught him to read and write. A minister's son taught him Greek, Latin, and French.

Early Training.

When twelve years of age Oersted was apprenticed to his father to study chemistry, and in 1793 he went to the University of Copenhagen to study pharmacy. He had a passion for knowledge, and absorbed everything that came his way. Passing his examinations in pharmacy, he took a prize in medicine, and became a Doctor of Philosophy. He was then appointed assistant to the professor of surgery, and distinguished himself in chemical research. In 1800 he was one of the first to use the newly invented electric battery in connection with an investigation into the acids and alkalies set free by the electric current.

When twenty-four years of age Oersted won a travelling scholarship, and spent five years travelling through Holland, Germany, and France gathering scientific knowledge. On his return he was appointed (in 1806) Professor of Physics at Copenhagen University. After having devoted a great part of his life to the study of electricity and magnetism, he held many scientific appointments and honorary offices, and attained numerous scientific distinctions. He died on March 9th, 1851.

Although Oersted was the pioneer of the science of electromagnetism, he is better remembered by his famous discovery, that a freely swinging magnet, such as a compass needle, is deflected if placed near a wire through which an electric current is flowing. As in the case of Galvani and the frogs' legs, Oersted's epoch-making discovery was made quite by accident.

Hans Christian Oersted.

Discovery of Electro-Magnetism.

On July 20th, 1820, he was demonstrating the principles of the electric current, and seems to have been arranging a compass needle to observe whether there were any deflections during a storm. Quite by chance he placed the compass near a platinum wire, through which a galvanic current was passing. The magnetic needle was at once deflected and the first discovery in electro-magnetism had been made.

To make quite certain of his discovery, however, Oersted experimented to see that the nature of the wire did not influence the results. He soon realised that the phenomenon must be due to what he called "the electric conflict" around the wire. He noticed the fact that the compass needle places itself more or less transversely to the wire, the direction depending on whether the wire is above or below the needle, and whether copper or zinc ends of the voltaic pile are connected to it. He clearly recognised the existence of the magnetic field around a conductor, and by this discovery showed that an electric current possesses magnetic properties similar to those of the lodestone of the ancients. The two forces, which had previously been regarded as separate phenomena, were thus shown to be intimately connected.

Oersted's original essay is written in Latin, but an English translation is found in "Annals of Philosophy" (November, 1821). It is called "Experiments in the Effect of a Current of Electricity on the Magnetic Needle," and describes the action Oersted considers is taking place around the wire. "It is sufficiently evident," he wrote, "that the electric conflict is not confined to the conductor, but is dispersed pretty widely in the circumjacent space. We may conclude that this conflict performs circles round the wire, for without this

Pioneers of Wireless.—

condition it seems impossible that one part of the wire when placed below the magnetic needle should drive its pole to the east, and when placed above it to the west."

For his work Oersted was awarded the Copley Medal of the Royal Society.

Incidentally, the discovery of the intimate connection between the lodestone and the electric magnet was a striking substantiation of a theory that Oersted had formed while on his five years' travels. This was that all natural forces are essentially identical, a doctrine that he expounded at great length when he took up his professorship at Copenhagen. The remarkable part of this theory was shown in an even more striking degree when Faraday developed Oersted's experiments, and when Clerk Maxwell showed that light was also an electromagnetic phenomenon.

Einstein has recently announced his belief that gravitation and electricity are one and the same, and even more recently the atom is being made to yield its secret of electrical centres of energy. Oersted could not have had more than an intuition of these things, and he could not have had more than a fraction of the advanced knowledge we now possess when he propounded his theory. Yet, perhaps, after all his theory will prove to be founded on fact.

NEWS FROM THE CLUBS.

A Demonstration in Soldering.

At a well-attended meeting of the Bristol and District Radio Society, held on January 1st, Mr. A. E. Pendock provided an interesting lecture on "Lead Burning, Soldering and Vulcanite Working." The practical demonstration which followed was of particular value, and special attention was given to the various pieces of work which were available for inspection.

oooo

"Acoustics."

The members of the same society are expecting an enjoyable evening on Friday, January 29th, when the Presidential Address will be given by Professor A. M. Tyndale, D.Sc. The President will deal with the subject of "Acoustics," and will illustrate his lecture with a number of experiments. The meeting will be held in the Physics Lecture Theatre at Bristol University, and all interested are cordially invited. The hon. secretary is Mr. S. J. Hurley, 46, Cotswold Road, Bedminster, Bristol.

oooo

Radio Drama.

To-morrow evening (Thursday) members of the Stretford and District Radio Society will listen to a talk on "Radio Drama" to be given by Mr. Victor Smythe, of 2ZY, at the Liberal Rooms. All interested are invited to attend. There is still a number of vacancies for membership, and the hon. secretary. Mr. Wm. Hardingham (6XA), 21, Burleigh Street, Stretford, will be pleased to forward particulars.

oooo

Town Mains for H.T. Supply.

Mr. H. Ingham, lecturing before the Manchester Radio Scientific Society on January 6th, had many interesting things to say on the subject of utilising the town mains as a source of H.T. supply.

Although the greater part of his lecture concerned the use of D.C., Mr. Ingham paid attention to the rectifying arrangement necessary in cases where A.C. mains occur. With regard to D.C. mains, many instructive diagrams were shown illustrating the various combinations of choke coils, condensers and neon lamps necessary for smoothing out ripples. A demonstration was given showing that it was possible to utilise D.C. mains in such a way that it was impossible to tell from the results whether the mains or an ordinary H.T. battery had been used.

The attitude of most participators in the ensuing discussion was that, while in some districts the mains are suitable for wireless purposes, in many others the nature of the supply precludes its being smoothed sufficiently to give satisfaction.

oooo

Suppressing the "Howlers."

A definite stand against the local propensity to "howl" and "squeal" is being taken by the Norwich and District Radio Society. At the first annual general meeting, held on New Year's Day, it was decided to hold a public meeting in the near future with the object of initiating listeners in the gentle art of tuning.

An attractive syllabus has been prepared for the new session. There are talks for experimenters, constructors and listeners, besides a series of lectures of special interest to transmitters.

Prospective members are invited to communicate with the hon. secretary, Mr. J. Hayward, 42, Surrey Street, Norwich.

FORTHCOMING EVENTS.

WEDNESDAY, JANUARY 20th.

Barnsley and District Wireless Association.—At 8 p.m., at 22, Market Street: Practical Difficulties Overcome.

Muswell Hill and District Radio Society.—Visit to 2LO at 2 p.m.

FRIDAY, JANUARY 22nd.

Sheffield and District Wireless Society.—At 7.30 p.m., at the Department of Applied Science, St. George's Square: Elementary Lecture (4)—"Valves and Valve Characteristics."

MONDAY, JANUARY 25th.

Swansea Radio Society.—Exhibition of Amateur Sets and Components.

TUESDAY, JANUARY 26th.

Halifax Wireless Club.—At 7.30 p.m., at the White Swan Hotel: Discussion Evening, to be opened by Mr. E. Pedley.

WEDNESDAY, JANUARY 27th.

Radio Society of Great Britain.—Ordinary Meeting. At 6 p.m. (tea at 5.30). At the Institution of Electrical Engineers, Savoy Place, W.C.2. Lecture and Demonstration: "Loud Speakers," by Dr. N. W. McLachlan, M.I.E.E.

"Doing" the Accumulator.

Entertaining disclosures concerning the practices of certain garage proprietors and their methods of "doing" accumulators were made by Mr. L. C. Holton, lecturing before the North Middlesex Wireless Club on January 6th.

Mr. Holton referred to an actual case in which a garage proprietor, before returning an accumulator to its owner, had been seen to turn the hose on it! Such incidents emphasise the desirability of charging accumulators at home, and this formed the subject of Mr. Holton's lecture.

Dealing first with D.C. supply, the lecturer explained an economical method of connecting batteries in series with the lighting supply, stressing the importance of connecting the accumulator in the earthed lead.

Referring to the various types of rectifier used with A.C. supply, Mr. Holton advanced strong opinions in favour of the valve rectifier, which has the advantage of being entirely automatic and silent in action.

The Hon. Secretary is Mr. H. A. Green, 100, Fellatt Grove, N.22.

oooo

New Headquarters.

A move to new and better quarters always infuses vigour and enthusiasm. This was amply demonstrated on January 5th, when members of the Ilford and District Radio Society held their first meeting in the new headquarters at 241, High Road, Ilford.

The Society is growing in membership, and it is hoped that the comfort and convenience of the new surroundings will induce still further support. A Morse class is in process of formation.

oooo

Short Waves and the Heaviside Layer.

Several original theories for the so-called "silent zones" were advanced by members of the Muswell Hill and District Radio Society on January 6th, when a discussion took place on "Short waves, with particular reference to the Heaviside Layer."

The Society is attempting to overcome unnecessary oscillation in the neighbourhood. Copies of the B.B.C.'s Anti-Oscillation leaflet may be obtained from the Hon. Secretary, Mr. Gerald S. Sessions, 20, Grasmere Road, Muswell Hill, N.10. Particulars of membership will also be gladly forwarded.

SPEECH AMPLIFIER DESIGN.

Details of a Two-stage Amplifier with Variable Characteristics.

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

(Continued from page 48 of the previous issue.)

THE customary procedure in connection with the sale and advertisement of valves is to give a list of coefficients associated with each valve. From our present point of view, the main considerations are (*a*) the amplification factor, (*b*) the impedance, and (*c*) the degree of linearity of the characteristic. Now the internal resistance or, as it is often termed, the impedance of a valve is sometimes a necessary defect. High impedances are usually accompanied by large magnification factors. Valves would, in general, have low impedances, without sacrificing the amplification factor, if it were physically possible. In transformer-coupled amplifiers the effect of high-impedance valves is to cut off the high and low tones unless the primary inductance is high. A good example of this would be a D.E.Q. detector, followed by any transformer on the market. As a matter of interest, actual curves are given in Fig. 10 with transformers of high primary inductance. The reader can readily surmise the steepness of the two sides of the curve if an ordinary transformer with a primary of 10 henries were used.

Ratio of Primary Inductance to Resistance.

Weakening of the lower tones is due to the resistive component (valve resistance *plus* effective resistance of primary winding) being large in comparison with the reactance of the primary. When the reactance ωL is appreciably in excess of the resistance, the greater part of the alternating voltage drop occurs across the primary in the form ωLi. This means that the transformer is stepping up the voltage in the ratio $\frac{\text{secondary turns}}{\text{primary turns}}$. At the higher audio-frequencies the droop in the curve is due to the capacity reactance of the transformer being small in comparison with the valve impedance. The peak value of amplification of Fig. 10 is in the neighbourhood of the resonance point of the transformer. It is to be remarked that the effect of high valve impedance is simulated if the primary has a large D.C. resistance compared with its inductance. Moreover, even with low impedance valves there is a lower limit for the ratio L/R where L equals primary inductance, and R equals primary resistance, if the lower tone amplification is to be preserved and a correct tonal balance maintained

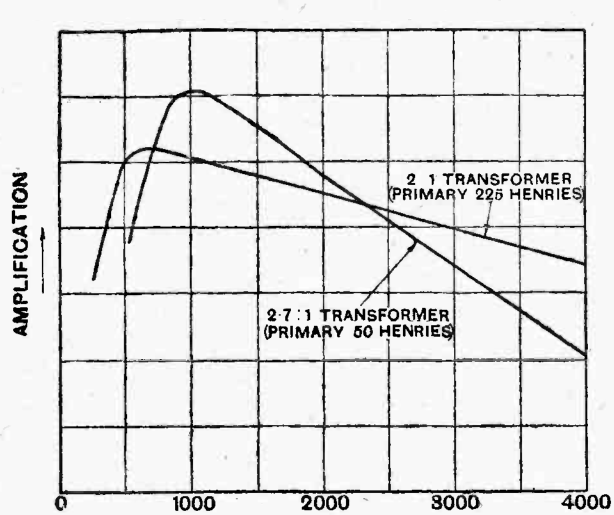


Fig. 10.—Characteristics of L.F. transformers with D.E.Q. valve (internal resistance 37,000 ohms) operating as anode rectifier. The amplification scale is arbitrary.

Acoustic Quality in General.[1]

Throughout this article the chief thread of the argument has been on the subject of boosting low tones. In fact, with the average loud-speaker many of the low-toned instruments in an orchestra are never heard in their proper proportion—owing to reduction in intensity of the fundamental—if they are heard at all. The reasons for this are threefold: (1) the characteristic of a loud-speaker often shows a marked cut off on the lower frequencies, (2) transformer-coupled speech amplifiers in general do not amplify the lower frequencies in their proper proportion, (3) the ear is relatively insensitive to low tones. Effects (1) and (2) are cumulative, so that if we assume at 50 cycles the amplification (voltage) of each of two transformers of a double note magnifier is one-quarter its value at 1,000 cycles, then the voltage on the grid of the power valve at 50 cycles is proportional to $\frac{1}{4} \times \frac{1}{4} = \frac{1}{16}$. The energy being directly as the square of the voltage, we have the acoustic intensity at 50 cycles proportional to $(\frac{1}{16})^2 = \frac{1}{256}$.

Thus the intensity ratio $\frac{1{,}000 \text{ cycles}}{50 \text{ cycles}} = \frac{256}{1}$. If the characteristic of the loud-speaker shows an intensity ratio of 4 : 1 for equal grid volts at 1,000 cycles and at 50 cycles, the overall intensity ratio becomes $4 \times \frac{256}{1} = \frac{1024}{1}$. This appears to be an extremely large figure. Put in plain language, under the above conditions the lower tones simply are not present. Now these comments may be rather difficult to believe, but with a change-over switch from such an amplifier to that of Fig. 1 (page 44 of the previous issue) and a loud-speaker with a good characteristic showing a 1 : 1 instead of a 4 : 1 ratio, all doubts would vanish. There is often a feeling that, since the higher tones carry the interpretation and characteristic part of speech and music, the inclusion of the lower tones does not matter. Granted that "high-pitched" reproduction can be quite pleasant, it does not follow that "even-pitched" reproduction is repellent, for it is natural. The proper amplification of low-

[1] Some of the remarks on loud-speakers and quality may appear redundant in view of the recent article on this subject in this journal (November 4th), but the points are important, and the MS. was written long before that on loud-speakers, although it reached the Editor at a later date.

Speech Amplifier Design.—

toned instruments such as the double-bass, 'cello, drums, and pedal pipes of the grand organ, which are often inaudible in reproduced versions of the orchestra, adds a richness to the music which must be heard by a quick change from one condition to the other to be fully appreciated. Even so, there are some who, on a first hearing, prefer "high pitch"; but this taste gradually vanishes until the even pitch gains the day. The ear is a peculiarly elusive organ and is most unreliable as regards loudness and quality, unless the changes are made very rapidly. In fact, one can live with a certain type of acoustic quality from a low-toned loud-speaker and imagine it to be perfect—until one hears something better, the comparison being made with a change-over switch. In fact, it may be said that one becomes "aurally drugged" to a certain quality or type of reproduction.

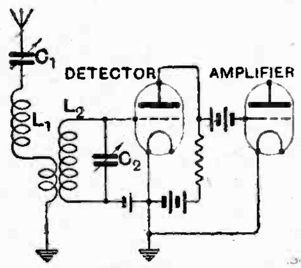


Fig. 11a.—High-frequency circuits associated with the detector valve. Inductance values are as follow: L_1 400 mhys.; L_2 250 mhys. H.F. resistance of aerial circuit, 22 ohms, and of secondary circuit L_2 C_2, 7 ohms, both measured at 360 metres.

Distortion in H.F. Circuits.

We have indicated how to secure variable amplification at will. Now, different types of loud-speaker have different characteristics, and it is possible to find a setting of the amplifier which gives the most pleasing—not necessarily faithful—reproduction. In juggling with a speech amplifier, the effect of the high-frequency circuit must not be omitted. Any well-designed non-reactive high-frequency circuit is bound to reduce the higher tones, but the effect is counteracted by the lack of low

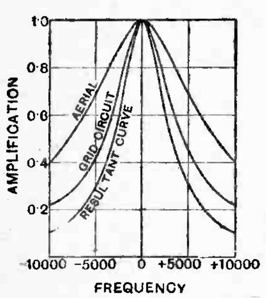


Fig. 11b.—Selectivity curves for aerial and tuned grid circuit, with resultant curve of the two circuits in combination. A loose coupling between the two circuits has been assumed.

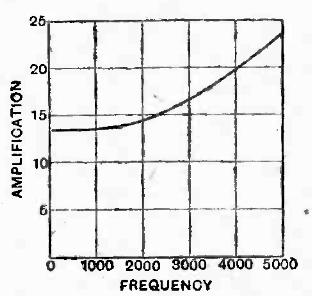


Fig. 11c.—2 : 1 ratio transformer with D.E.5 valve and no condenser.

tones in both low-frequency amplifier and loud-speaker. Moreover, for any given characteristic H.F. input to the aerial, there is a certain overall characteristic of the amplifier from the aerial to the grid of the power valve, which, with a certain type of loud-speaker, yields the most comfortable and consoling auditory output.

There are—apart from the human ear—clearly four main characteristics: (1) that from the broadcasting station, (2) the aerial and its associated H.F. circuits, (3) the speech amplifier, (4) the loud-speaker.

Examples of (2) and (3) combined are given in Fig. 11, and have been found to give good reproduction in general, although it would be better to avoid the droop in the curve at the upper frequencies, i.e., above 4,000 cycles. The H.F. characteristic is a combination of an aerial circuit loosely coupled to a tuned circuit on the grid of a valve, whilst the low-frequency portion is that of the amplifier described above. For comparison the combination of the same H.F. circuit and an ordinary two-stage note magnifier is given in Fig. 12, from which the relative reduction of low tones will be obvious. In

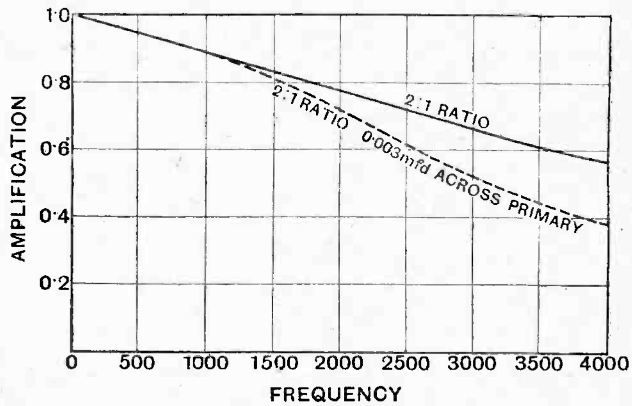


Fig. 11d.—Amplifier output applied to power valve.

cases where there are more cascaded high-frequency circuits, say three or four, the higher tones are much reduced, and the upward tilt of the speech amplifier characteristic is sometimes extremely useful. Moreover, an apparent defect—in this case leakage between the primary and secondary windings of an iron-cored transformer—can be put to good service. To the *uncritical ear* it is doubtful whether any difference would be detected whether two or four tuned high-frequency circuits were being employed, provided the general intensity was equal in both cases. It is probably akin to a discovery one makes with difficulty when another person points out what is to be discovered. There are some features associated with high-frequency amplifiers which require comment. Taking the most commonly used artifice, namely, reaction, it has

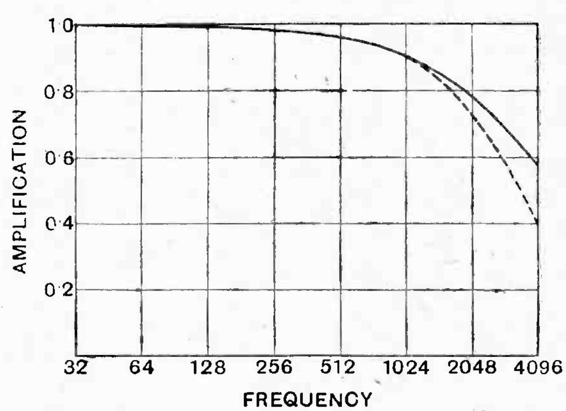


Fig. 11e.—Curves of Fig. 11d plotted to a logarithmic scale of frequency.

Speech Amplifier Design.—

been amply demonstrated in the technical Press and by practical experience that, in general, the use of reaction must be abandoned to get the best quality. There are, of course, limits and conditions under which reaction is probably not so bad as it is painted, but we have only to take the average valve set which uses reaction up to and beyond the datum of stability to see that, in general, good quality is not obtained. It is a fact that improper reflex circuits and badly designed speech amplifiers cause much more unpleasant reproduction than carefully handled reaction. Although reaction, especially with large grid leak condensers, enables the low tones to be enforced, the penalty is paid by a characteristic muffling or merging together of succeeding sounds. This lack of crispness is due to (1) the large leak condenser giving a slow condenser discharge, (2) the reduced damping of the H.F. circuit whereby the aerial current variations are slow in building up and in dying away. In fact, there is a sustentation of the current analogous to acoustic echo, and this in phones or loud-speaker yields a like effect. The only excuse for using reaction is "economy" in valves and associated apparatus.

Relation between Loudness and Quality.

There is an aural aspect of our quality query which has not yet been broached. This is concerned with what may be designated the "loudness level." Assume we have a set with loud-speaker, and that a military band is bearably loud, it being possible to carry on comfortable conversation in the same room without getting seri-

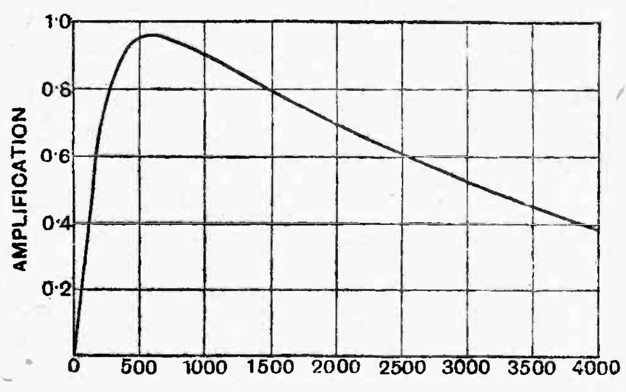


Fig. 12a.—Relative amplification curve of H.F. circuits with ordinary double note magnifier (D.E.3 with 2·7 : 1 transformer followed by D.E.5 with 4 : 1 transformer).

ously jammed. Now reflect upon the loudness of the same band if one be seated, say, thirty yards from the bandstand. On the average, conversation would then resolve itself into each person shouting into his neighbour's ear. The loudness of the band, barring jamming noises, at 200 yards is probably about equal to that indoors from the loud-speaker. The band at 200 yards certainly sounds very different from that near the bandstand. In other words, what we loosely term the "quality" varies with the distance from the band. The reader, if he has not already done so, can try the experiment himself. The effect in general is to give the impression of a rise in pitch with increase in distance from the band, so that the lower-toned instruments appear at a distance to be less effective. The high-frequency overtones are also weakened by distance. This is chiefly attributed to the ear falling off in sensitivity at low and at high audio-frequencies, and the effect becomes more pronounced as the loudness decreases. Applying this simple observation to our loud-speaker, we get what

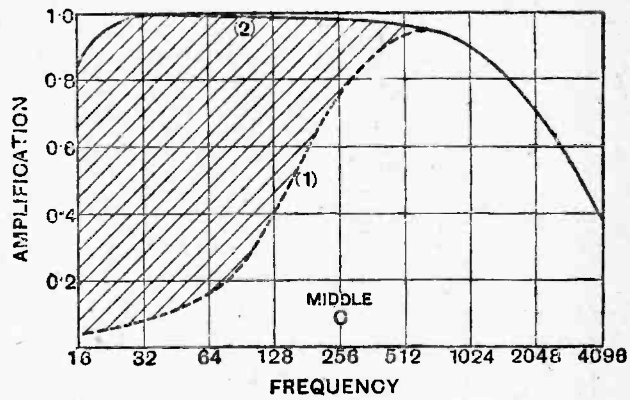


Fig. 12b.—Comparison of composite curves of H.F. circuits with variable characteristic amplifier (full line) and ordinary transformer coupled amplifier (dotted line). The shaded area represents the loss due to the use of the ordinary amplifier (D.E.3 with 2·7 : 1 transformer followed by D.E.5 with 4 : 1 transformer).

appears to be high-pitched music when the sounds are weak. By increasing the loudness, the pitch appears to be lower. But one could not tolerate a degree of loudness equal to that of the band at a moderate distance (or even an orchestra in a concert room) from one's loud-speaker night after night (even if distortionless), so that, in order to satisfy the aural demand for low tones, it is necessary to accentuate these either in the amplifier or the loud-speaker or in both. Under such conditions the human voice, which is probably reproduced at its normal strength, will sound lower pitched than the original, but it depends largely on the resonances in the loud-speaker.

Testing the Quality from Loud-speakers.

There are three aspects of this problem to which attention must be directed in order to carry out a comprehensive test: (1) the characteristic curve of the complete amplifier showing frequency plotted against amplification,[1] (2) the characteristic curve of the loud-speaker showing the power output plotted against frequency for equal voltages on the grid of the power valve, (3) the acoustic properties of the human ear, in which the sensitivity varies at different frequencies, and the variation in aural appreciation at different loudness levels. If reaction is employed in a receiver, the characteristic curve will vary according to the setting of the reaction coil and its associated high-frequency circuits. Thus one can never be certain of the shape of the characteristic under such a condition. On the other hand, in the absence of reaction and of extreme selectivity, if one knows the characteristics of the transformers or resistance-capacity units in the amplifier, the amplifier characteristic can be determined approximately by taking the product of the amplification curves at corresponding

[1] This varies with the wavelength and is modified by reaction.

Speech Amplifier Design.—

frequencies. However, there are probably few cases in which an accurate knowledge of such curves exists, and under such circumstances a criticism of the performance of the loud-speaker *per se* is ludicrous. The object of having the characteristic of the loud-speaker is to be able to arrive at definite conclusions more readily. For example, suppose the amplifier characteristic is uniform and there is an indication of a resonant note or coloration from the loud-speaker. Then, if the loud-speaker characteristic shows over-sensitivity in the same frequency region as the note or coloration occurs, this accounts for the origin of the note. The characteristic will also indicate whether a loud-speaker is high pitched or low pitched. Characteristics of this nature are difficult to determine without special apparatus. In fact, quantitative work in acoustics is usually beset with obstacles chiefly arising from the available sound energy being so small and the conditions complex, thus making measurements extremely tricky. Moreover, a characteristic will not usually be available, and therefore we must for test purposes fall back entirely—for the present at any rate—upon the human ear. After all, it is the ear which demands satisfaction, and, from a commercial viewpoint, when this is accomplished the shape of a loud-speaker characteristic is absolutely immaterial.

The fact that the quality of the input is not perfect makes it difficult sometimes to ascertain exactly where the defect in a particular loud-speaker resides. Because a transmission sounds passable in telephones is no criterion, since flaws which are then inaudible become audible from a loud-speaker. The position of the lecturer or of an orchestra relative to the microphone has an effect on the general tenor of the sound. The question of balance of the instruments—not positions—in an orchestra is, of course, one for the conductor.

In presenting a series of aural tests for loud-speakers, some hypothesis appears to be essential. Moreover, it will be assumed that the *overall* amplifier characteristic is uniform from 50 to 4,000 cycles.

The following aural tests put in the form of queries may be useful for testing purposes :—

(1) Has the loud-speaker any appreciable resonant note? This may be detected by local coloration of speech or other transients according to the pitch of the resonance. Or it may be evinced on a 'cello, violin, etc., by extraordinary loudness. Or with the piano there may be a certain roundness or lack of sharpness—a kind of woolliness. The resonance may be due to the horn, base, diaphragm, or reed, or other part capable of vibration. There may be a tone coloration due to metal parts which is not readily detected unless comparison is made with other types of loud-speaker.

(2) Does the room have any appreciable influence, i.e., is the room sufficiently damped to avoid unpleasant echoes? This is rather an awkward query to answer properly. Try the loud-speaker at various points in the room.

(3) Are the very low tones of the organ,[1] double bass, 'cello, the bottom register of the piano, and drums reproduced in proper proportion? Before coming to any definite decision, try a piano and listen carefully to the balance between treble and bass. Is *pizzicato* playing on stringed instruments, e.g., violin or harp, free from metallic or other colouring? Do drums sound like drums, or is there a local colouring? Are drums clearly defined, are they blurred, or do they resemble a metallic or a wooden tapping sound?

(4) Does the clapping of hands in concert halls, restaurants, etc., sound natural, or is there a metallic colouring?

(5) Do the various instruments in a military band, an orchestra, or a quartet stand out so as to be distinguishable, or is the reproduction of a composite massed variety resulting chiefly in a modulated noise? Can the entries of the various instruments in, say, a symphony or any orchestral piece be clearly distinguished, as they would be by the conductor himself? To test this, the listener must not be too near the loud-speaker and the intensity should be moderate.

(6) Is the quality good with large as well as with small sound intensities. The former is where resonance effects will show up, e.g., horn effect masking the music and giving booming or blaring so that the various instruments merge together and lose their individuality.

(7) Is speech clear cut, concise, and highly intelligible? In this connection it may be remarked that with many lecturers "high-pitched" reproduction is more intelligible than the original, due to a lack of overtones in the voice. In testing speech, stand well away from the loud-speaker, get someone else to read, and compare the two sounds. Resonances or coloration should be easily detected by a critical ear.

(8) Are the sibilants and other consonants clear in speech? For example, is the hiss in the "s" clearly defined when it occurs at the beginning and the end of a word, e.g., news. An absence of the higher tones results in "s" sounding like "f." This is not a conclusive test for the extremely high tones. In this case the shrillness or blare of the brass (trombone) and the piercing overtones of the violin must be looked for.

Some, if not all, of these tests require to be executed with care, since the human ear is readily deceived. Comparison with another form of loud-speaker whose acoustic characteristics are known is extremely useful as a guide. There is no doubt that a good diaphragm type of instrument is better than the horn variety.

(To be continued.)

[1] In the absence of adequate low tones the grand organ sounds like a harmonium.

AN ELECTRICAL RETROSPECT.

FOR sheer versatility in engineering production it must be difficult to find a record to beat that of the Westinghouse Electric and Manufacturing Co., of East Pittsburgh, Pa. In a well-filled book we have received, describing the engineering achievements of this energetic concern during 1925, illustrated particulars are given of electrical and mechanical undertakings covering the generation and distribution of electrical power, Diesel-electric propulsion, heavy railway traction, light traction, illumination, and, last but not least, wireless.

The famous KDKA station, owner and operated by the Westinghouse Company, is sufficient testimony to their prowess in the realm of radio.

Broadcast Brevities

Savoy Hill Topicalities: By Our Special Correspondent.

A False Report.

One gratifying feature of the Press scare concerning the alleged intentions of the B.B.C. to adopt a band of wavelengths between 100 and 200 metres is that the hold which wireless has secured on the public has been proved beyond dispute by the storm which the false report created.

o o o o

A Poor Effort at Justification.

When confronted with the official denial, the person who originated the report is said to have declared: "Well, if the B.B.C. does not at present intend coming down to 100-200 metres, it will have to do so sooner or later." This was about the weakest attempt at justifying a misleading statement that could have been devised.

o o o o

European Stations.

The number of broadcasting stations in Europe at present operating on wavelengths between 100 and 200 metres can be counted on the fingers of one hand. No other existing stations are likely to have their wavelengths brought down to that band; but in some remote circumstance new stations, *i.e.*, stations not yet constructed, might conceivably be given positions below 200 metres, as a possible alternative to the curtailment of building programmes. To prohibit the erection of stations, however, would be very difficult in the present state of broadcasting; and although the curtailment of building should not be lost sight of as a possible solution of the existing confusion, it may be kept in the background for the moment.

o o o o

Geneva's Plans.

The plan that the Conseil, or Board of the Office International de Radiophonie at Geneva, is first to try a re-allocation of wavelengths based on the population of a broadcasting country, the area of that country, the length of time that a broadcast service has been operating, and the language difficulty, that is to say, where two or more dialects are spoken in one territory, special consideration will be given. A system of duplication will be tried in an endeavour to discover if an economy of the usual wavelengths can be effected by repeating certain wavelengths for various stations; and, if so, at what distances such stations can operate from each other without interference. This plan will be put into operation immediately.

o o o o

Invoking the Muse.

Whether broadcasting is a blessing or an ill, it affords an interesting glimpse into the vagaries of human predilections. A well-known dramatic critic recently managed to turn out a page of matter relating how, having no thoughts worth while working up into printed words, he tuned in to London and found that the programme inspired him to such good purpose that he had no difficulty in writing a first-class article. Another illustrious journalist told the writer the other day that eagerly as he craved for a receiving set in his study, he was afraid that it would prove distracting and his work would suffer.

o o o o

Divided Opinions.

Now the Venezuelan Government is putting a stop to the importation of wireless sets, as the labourers in the fields are neglecting their work in order to listen to the broadcast programmes. The attraction of broadcasting will no doubt enable the field workers of the South American State to find a way out of the prohibition stricture; but opinion among labour authorities in other countries appears to be divided on the subject of the uses of broadcast reception as an aid to physical endeavour. As community

A HINT FOR THE B.B.C. The Australian broadcasting station 3LO, at Melbourne, recently scored a success by transmitting an under-water talk by a diver from the Duke and Orris Dock, South Melbourne. The photograph shows the diver with his apparatus.

singing in this country is becoming recognised as an incentive to work, so wireless installations in factories may presently be found a means of increasing output—if the day-time programmes are confined to music.

○○○○

Burns Night.

Monday next (January 25th) is the anniversary of the birthday of Robert Burns, the Scottish national idol. In the eyes of a Scot no Englishman is competent to commemorate Burns, or to appreciate his poetry. Sassenachs may have their own opinions on the subject, but on Robbie's birthday they will be given an opportunity of hearing what Scotland thinks about her poet. A commemoration programme will be relayed from Edinburgh.

○○○○

That Message from Mars.

A 2LO listener genuinely thinks that he has heard Mars and has written to the B.B.C. for confirmation of his exploit. What disillusionment he will suffer when he learns that he merely heard Captain Eckersley on a crystal set!

○○○○

The World's Dear Children.

Broadcasting is seizing the imagination of far Japan and an effort is being made to cultivate the youthful Japanese mind in radio matters. The principal of the Taisho English School, Tokio, is educating his young pupils in the writing of prose and verse especially for broadcasting. He has formed a world radio league and wishes to broadcast "the world's dear children's literary articles for the Japanese children." The literary attempts will be transmitted in English from the Tokio Broadcasting Station.

○○○○

B.N.O.C. Operas.

During the opera season next spring some regular relays of B.N.O.C. performances will be broadcast; but not so many as were relayed from the northern provincial towns during the autumn tour.

○○○○

Saturday Children's Corner.

To enable a first-class programme to be broadcast from 5 to 7 p.m. on Saturdays, the Children's Corner will be put forward one hour on that day, i.e., to 4-15 p.m., commencing on Saturday, January 30.

○○○○

Mr. N. Ashbridge.

Mr. N. Ashbridge's appointment as Assistant Chief Engineer of the B.B.C. will release Captain Eckersley from a good deal of the routine work which has hitherto fallen on his shoulders, and will enable him to visit personally the different broadcasting stations and keep in touch with the whole of the engineering activities on the spot. "P. P. E." has in the past been his own administrative and executive head, and has had more to do than one man can be expected to cope with if development and research are to receive an adequate share of his attention.

FUTURE FEATURES.

Sunday, January 24th.

LONDON.—3.30 p.m., Symphony programme conducted by Albert Coates.

BIRMINGHAM.—8.15 p.m., Studio Service. Address to be given by Mrs. George Cadbury (President of Free Church Council).

BOURNEMOUTH.—3.30 p.m., Symphony Concert. 9.15 p.m., Chamber Music and Art Songs.

MANCHESTER.—3.30 p.m., Harp, Song and Violin.

Monday, January 25th.

BIRMINGHAM.—7.30 p.m., Organ Recital relayed from the Town Hall.

MANCHESTER.—9 p.m., An Hour of Robert Burns.

NEWCASTLE.—8.30 p.m., Brahms Concert.

ABERDEEN.—8 p.m., Burns Night. Centenary of Peterhead Burns Club, relayed from Temple Masonic Hall, Peterhead.

GLASGOW.—8 p.m., Burns Night.

Tuesday, January 26th.

LONDON.—8 p.m., Band Music by Living British Composers. 9.25 p.m., Radio Military Tattoo.

BELFAST.—8 p.m., Song and Light Instrumental Music.

Wednesday, January 27th.

LONDON.—9 p.m., Mozart Programme.

BIRMINGHAM.—7.30 p.m., Choral Concert, "Dido and Æneas," relayed from the Town Hall.

CARDIFF.—7.30 p.m., Variety Concert, relayed from the Rhondda Institute, Tonypandy.

NEWCASTLE.—8 p.m., Ballad Concert.

GLASGOW.—8 p.m., Symphony Concert.

Thursday, January 28th.

CARDIFF.—8 p.m., Famous Love Scenes.—I.

MANCHESTER.—7.30 p.m. Hallé Concert, relayed from Free Trade Hall. 8.30 p.m., Lancashire Talent Series.—(6) Contribution by Blackburn.

NEWCASTLE AND 5XX.—7.30, Concert.

Friday, January 29th.

LONDON.—9.30 p.m., Pianoforte Recital by Sapellnikoff.

ABERDEEN.—8 p.m., Ballad and Orchestral Concert.

Saturday, January 30th.

BOURNEMOUTH.—8 p.m., Burlesque and Variety.

CARDIFF.—8 p.m., Sea Sprat.—II.

ABERDEEN.—8 p.m., Concert Opera, "A Romance in Spain."

BELFAST.—8 p.m., Variety.

○○○○

Closer Co-operation.

A number of additional changes in engineering organisation are to be made, consequent on Mr. Ashbridge's appointment, and liaison between the various departments and sections will be as close as possible. The strengthening of engineering efficiency should be reflected in an all-round improvement in the work of broadcasting, and in the perfecting of transmitting equipment.

○○○○

Cardiff's Birthday.

On February 13th the Cardiff Station will celebrate its third anniversary with a special programme which is now being planned. One item of special local interest will be the appearance of Mr. Rex Palmer, who will go down from 2LO to sing a song or two and broadcast a few words of greeting.

○○○○

Mr. Palmer's Early Connection with Cardiff.

When the Company consisted of some six individuals, Mr. Palmer went down to South Wales, found the premises for a station, and fixed up the arrangements for the opening. A local staff was appointed shortly afterwards, but things did not work smoothly and Mr. Palmer had to go down again and carry on as station director (*pro tem.*) for six weeks. His coming visit will therefore interest the older body of listeners.

○○○○

Listeners in South Wales.

If ever the power of any British broadcasting station were to be increased, the Cardiff station would merit, perhaps, first consideration. It is probable, however, that the Postmaster-General would raise an objection to putting up Cardiff's power on the score of shipping interests; although it would not be surprising to learn that the mind of the B.B.C. had already been exercised over the question of listeners' interests in South Wales, but the results of its proposals for overcoming the difficulties had not been very encouraging.

○○○○

Special Measure Required.

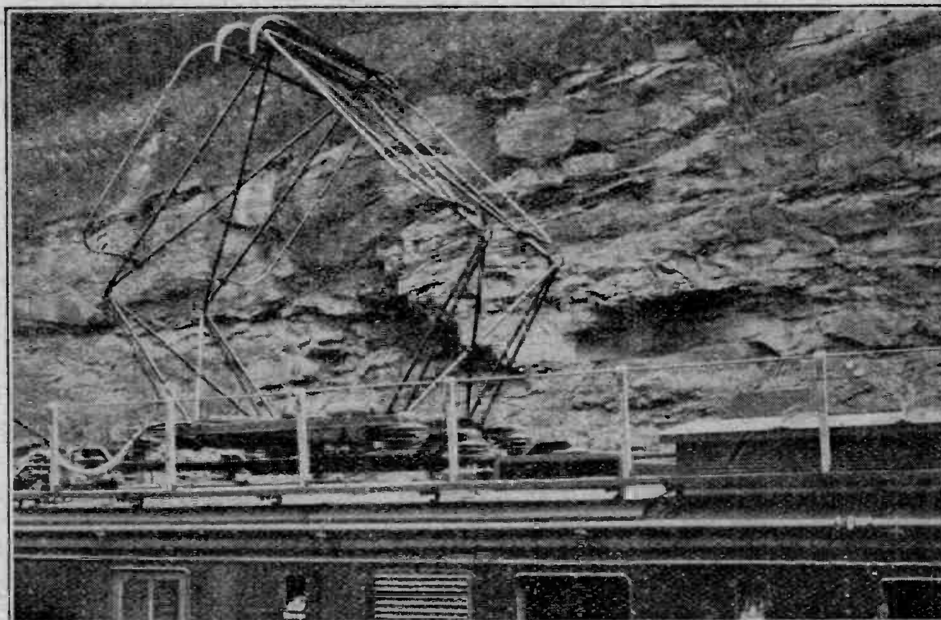
Wales is difficult to serve from the Cardiff station. Broadcasting is very popular in the Rhondda Valley, but nearly a million people only fourteen miles distant have great difficulty in getting crystal reception from Cardiff. In the other direction the station serves Bristol fairly well. It is the mining district for which special measures should be devised to provide listening facilities, as broadcasting could do much to brighten the lives of the miners and their families.

WIRELESS AND THE RAILWAY.

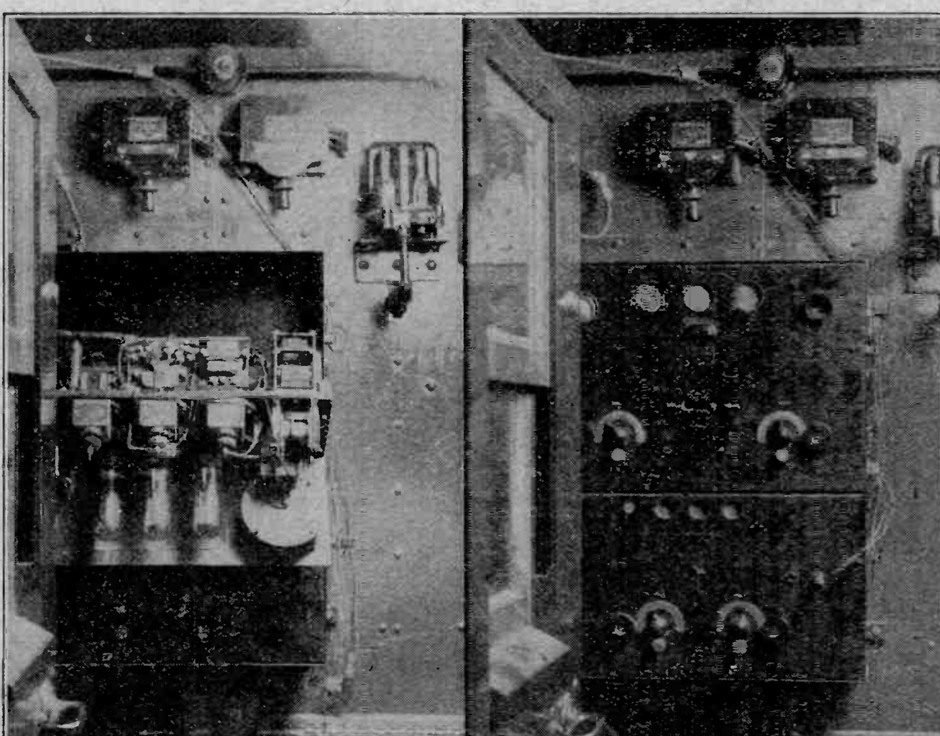
A Carrier Current System on American Trains.

FOR a number of years the American railways have been experimenting in co-operation with various radio manufacturers to determine the advantages and limitations of wireless in tackling railway problems.

The application of carrier-current equipment to communicate between the front and the rear of long freight trains is now being experimented with on the Virginian Railway by the Westinghouse Electric and Manufacturing Company. The course of the railway lies over the Allegheny and Blue Ridge Mountains, and a part of this line covers a gradient of 1 in 50 with numerous curves and tunnels. On a portion of this difficult line, which has recently been electrified, it is customary to run one locomotive at the head of the train and a helping locomotive at the rear. The primary problem is to get synchronous action between these two locomotives, particularly in starting and stopping.



The cab roof of an electric locomotive on the Virginian Railway, showing the aerial mounted on porcelain insulators. The overhead power wires are used for carrier current signalling between the front and rear locomotives of long freight trains.



The transmitter and receiver are contained in a single cabinet. On the left is a rear view of the panel, while an external view of the instrument is seen on the right.

Under steam-operating conditions this is accomplished by the rear locomotive allowing the throttle to remain partly open, thus picking up some of the slack of the train. When the forward locomotive starts, the motion of the train becomes evident to the engine-driver in the rear; he has simply to increase throttle opening.

Obviously with electric propulsion it would be uneconomical to follow the

Wireless and the Railway.—
same procedure. Furthermore, the air whistles on electric locomotives do not carry as well as steam whistles on steam locomotives. Thus, the goods trains on the Virginian railway being approximately one mile in length, it is often impossible to hear the whistle from one end of the train to the other.

In an attempt to solve the problem, it was decided to experiment with a carrier-current signalling system, and two transmitters and receivers were constructed. The early experiments showed that a railway carrier-current system must be extremely ruggedly built to withstand the vibration encountered. Accordingly, both the transmitter and receiver were redesigned. The ensuing tests were so successful that permission was sought and obtained from the Virginian Railway to give the apparatus a practical test on their electric locomotives.

The System in Operation.

Both transmitter and receiver are mounted in steel boxes, and all components are very rigidly made. The particular outfit used was primarily designed for both Morse and telephony, but Morse signalling is preferred, so that the apparatus now installed does not provide for telephony.

To the cab roof of the locomotive a small signalling box is attached, out of which box hangs a rope similar to the ordinary whistle cord.

The third unit of the installation is a motor generator furnishing the high-voltage output for the plate supply to the transmitting vacuum tubes. It is driven either from a storage battery or from an external source of power.

The transmitter and receiver are connected at will to an aerial mounted on insulators above the locomotive, and close to the trolley wire. In the experimental installation it is possible to operate the equipment from one end of the cab only, but in finished installations an operating box and loud-speaker would be installed in both ends of the cab.

The electrical circuits used are very similar to those employed in regular communication. The transmitter consists of a 50-watt master oscillator valve operating two 50-watt power amplifying valves in parallel. The signalling is effected by a remotely controlled relay. The receiver consists of the necessary tuned circuits with a detector and two low-frequency amplifying valves. The H.T. batteries are self-contained, and the filaments are operated from alternating current.

In operation all that is necessary when the driver wishes to signal is to pull down the signalling cord halfway. This starts the motor generator and sends high-frequency current out over the system. On pulling the rope all the way down the ourput is modulated by a 500-cycle modulator, producing a note in the loud-speaker at the other end of the train. By using a code of signals similar to that used for whistling, any message can be transmitted. Furthermore, the signal can be acknowledged, and communication carried on in the opposite direction.

The advantages of this system are obvious, particularly by reason of the fact that the only equipment needed is that on the locomotives. It is probable that any other communicating system would involve equipping all the rolling stock.

INTERFERENCE WITH RADIO RECEPTION BY STREET CARS.

VERY shortly after the introduction of broadcasting it was found in almost all German towns, that very unpleasant interference with radio reception was caused by the electric tramways. The reason for such interference was investigated as long ago as two years by F. Eppen, who found that the weak current used for lighting the cars was the cause of the interference. During the daytime, therefore, the interference did not generally occur, nor was it produced in the evening except when the intensity of the current was less than about 1 or 2 amperes. This limit of current intensity depended further upon the metals which touch each other at the current brushes of the car, and the conditions were specially unfavourable in the case of those cars with brush contacts of aluminium. Carbon brushes, however, are advantageous, and for this reason the cars of the tramways at Frankfurt-a.-M., for example, have had carbon sliding contacts fitted on their current brushes, with the result that the interference with reception caused by the trams has since totally disappeared.

In Berlin also numerous attempts have been made in order to determine how the interference caused by electric trams could best be eliminated. The cars of the Berlin tramways have been fitted with roller contacts, which, in general, give rise to less interference than do the sliding contacts. Another method adopted was the insertion of a large condenser of a capacity of about 30 mfd. between the brushes and the earth connection. This method has been applied to about twenty-two cars of a Berlin system, and is said to have been found satisfactory. With trials at other towns where the cars have not roller, but sliding, contacts, it was found, however, that the condensers were not of much use, and the plan is now seriously entertained of fitting all the current brushes with carbon sliding contacts, which has the added advantage that the supply wire is not worn nearly so much as is the case with the metal current brushes. H. K.

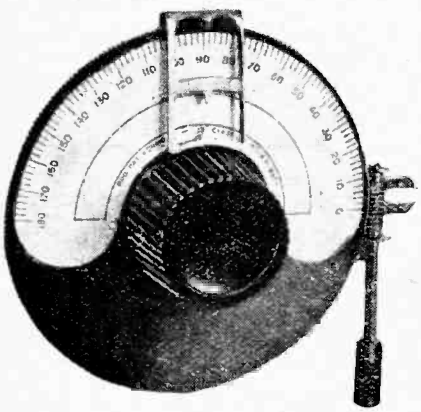
GERMAN BROADCAST LISTENERS.

THE number of German broadcast subscribers increased again considerably on December 1st. The total number of listeners-in subscribing on December 1st was 966,804, an increase in November of 53,028, *i.e.*, 1,768 new subscribers daily. The greatest increase is shown by Berlin with 23,257 new subscribers, so that the Berlin transmitting zone now includes 417,749 listeners. The Münster-Dortmund-Elberfeld transmitting zone has secured 10,613 new subscribers, and has now a total of 71,798 listeners-in; and Hamburg has 5,393 new subscribers (total for "Hamburg-Bremen-Hanover, 118,618). Nearly as great an increase is shown by Breslau with 4,920 new listeners, who come chiefly within the range of the newly opened Upper Silesian transmitting station at Gleiwitz.

A Review of the Latest Products of the Manufacturers.

THE FORMO DIAL.

A reduction gearing of 200 to 1 is obtained by means of a worm drive operating on the toothed edge of a nickel-plated brass disc in the new Formo instrument dial.



Tuning positions can be recorded on the Formo fine tuning dial.

The dial, which is slightly larger in diameter than the usual size, is provided with a white circle divided into 180°, and by means of an indicating plate tuning positions can be recorded. A grub screw attaches the dial to the instrument spindle, and a useful feature is the provision of a liner for the hole so that the dial can be used with either threaded or plain spindles.

○○○○

TUDORADIO A.C. MAINS UNIT.

The listener whose house is wired with A.C. supply usually regards himself as unfortunate inasmuch as the mains are unsuitable either for battery charging or supplying the plate potential for operating the receiving set. With regard to using A.C. mains for H.T. supply, the Tudoradio Co., Ltd., Tudor Works, Park Royal, London, N.W.10, have designed a unit which if connected up by means of a socket to the lighting circuit will provide at its three output terminals a suitable voltage for operating both detector and amplifying valves.

The experimenter has already devoted much attention to producing rectifying apparatus that will perform this duty satisfactorily, and it is generally admitted that single wave rectification on a 50-cycle supply is unsatisfactory and produces a hum on the transmission which is difficult to remove. One was therefore naturally a little prejudiced when testing this unit. A four-valve set consisting of a high-frequency amplifier, detector and two optional L.F. stages was used for the test in conjunction with a loud-speaker using the average aerial for reception at a distance of some fourteen miles from a broadcasting station. It was with some surprise that it was found that not only could the set be used with H.F. and detector valves, but that both of the low-frequency amplifiers could be brought into operation without an appreciable hum being discernible.

Tudoradio A.C. unit for deriving H.T. supply from A.C. mains.

Loud-speaker reception from a local station can be carried out with the unit, whilst with distant signals where the strength is inclined to be weak it was noticed that a slight hum did exist. A.C. hum, if present, is readily observed when using telephone receivers, and using the receiver as a three-valve set connected to a pair of telephones deriving H.T. from the unit, distant stations could be listened to with practically the same ease as when a dry cell battery supplied the H.T. potential.

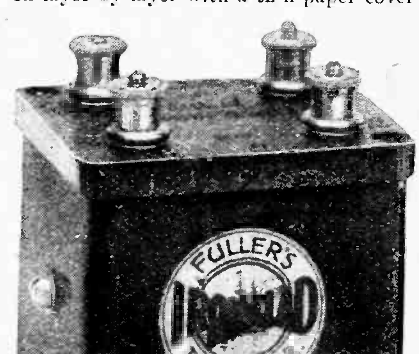
The design of the unit follows standard practice, and consists of a transformer with two secondaries for providing plate potential and filament heating current for the rectifier valve. A choke coil is in series with the output, and is bridged with a bank of condensers forming a smoothing or filter circuit. The valve recommended by the makers is the B.T.H. B6 with grid and plate pins bridged.

○○○○

THE SPARTA L.F. INTERVALVE TRANSFORMER.

The design of the Sparta Ironclad intervalve transformer manufactured by Fuller's United Electric Works, Ltd., Woodland Works, Chadwell Heath, Essex, departs from the more usual practice of adopting a core made up from stampings. In this instance the centre core, which is about ½in. in diameter, is built up with moderately fine soft iron wire of a suitable length so that when inserted into a cast-iron box a closed magnetic circuit is produced.

The winding is very carefully wound on layer by layer with a thin paper cover-



Sparta intervalve transformer. The magnetic circuit is closed through the cast-iron screening box.

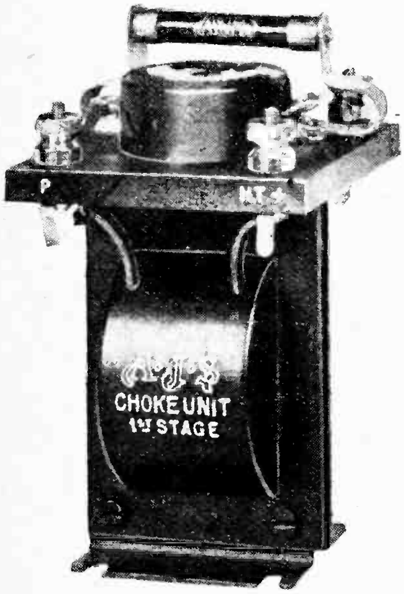
ing between each layer. The winding is not impregnated with wax or other insulating material, which would have the effect of increasing its capacity excepting at the ends, so that the entire spool is sealed and rendered impervious to moisture. Enamelled wire is used for winding, though the ends are terminated with a number of turns of fine silk wire inserted probably for the purpose of preventing breakdown of the end turns when connected in a circuit carrying radio frequency currents.

This component is compact, can be easily mounted in a set, and may be relied upon to give good performance.

○○○○

A.J.S. CHOKE AMPLIFYING UNIT.

The choke coupled unit of A. J. Stevens & Co. (1914) Ltd., Walsall Street, Wolverhampton, is designed so that it can easily replace transformer coupling without modifying the existing layout of the components of a receiver. The additional apparatus, consisting of coupling condenser and grid leak, are mounted on an ebonite panel, secured to



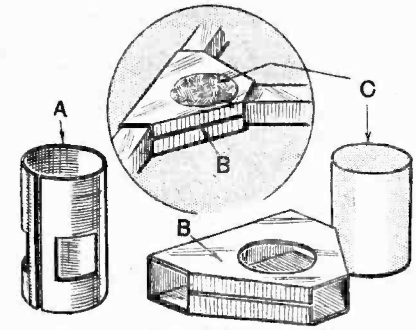
The A.J.S. choke coupling unit, type A1 is fitted with a condenser bridging the winding of the choke coil, coupling condenser and grid leak. Connections are made to four terminals so that the unit can replace a transformer.

the top of the iron core choke, and four terminals are provided so that the unit can be connected in circuit in exactly the same way as an intervalve transformer.

The choke coil consists of a spool of wire, liberal in size, set up around a core, in the manner adopted in intervalve transformer construction. A special choke coupling unit is supplied for use between a detector valve and the first note magnifier, fitted with a by-pass condenser bridging the choke winding. Mica is employed as a dielectric. The grid leak, which is mounted in clips, is shown to have a value of 2 megohms.

THE SOLCLIP CONNECTOR.

To produce a reliable junction in instrument wiring in the form of a "T" joint necessitates the bending of one of the wires into "L" formation to increase the area of contact. Joints of this sort rather detract from the appearance of the instru-



An enlarged view of the "Solclip" connector. (A) is a small brass cylinder to facilitate the soldering of square wire to the stem of a terminal. Another type is shown in (B) for making a "T" joint, while (C) is the small plug of solder which, when heated, exactly fills the joint.

ment wiring, and some experimenters therefore prefer to merely touch the wires in contact, bonding them together by a liberal application of solder. Such a joint is, however, liable to break when subject to vibration, while the solder after a while becomes brittle.

Messrs. Cooke & Whitfield Wireless, Ltd., of Birmingham, are placing on the market under the name of "Solclip" small brass connectors which are manufactured by Dale, Forty & Co., Ltd., and suitable for holding together "T" joints. To simplify soldering, small pellets of solder are supplied with the connectors, together with a tin of Fluxite. A solder pellet is inserted in a hole in the clip, and when heated just fills the joint.

Another type of "Solclip" is also produced for securing a connecting wire to the threaded stem of a terminal.

○○○○

THE SANGAMO CONDENSER.

The Sangamo condenser is moulded in Bakelite, completely excluding moisture and protecting the plates from damage. A section of the condenser is shown in the accompanying illustration, and it will be seen that the plates are completely bedded in the insulating material.

Screwed terminals are provided on both sides of the condenser so that several connections can be brought together, or alternatively the screws can be removed and a stiff wire passed right through the threaded hole, good contact being ensured by a touch with the soldering iron.

The attractive appearance presented by

A section through the Sangamo condenser.

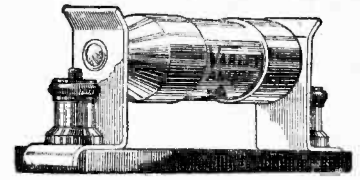
the clean brown Bakelite moulding recommends the use of this condenser apart from its reliability. No means are provided, however, for securing it to panel or baseboard, but it can be supported quite well on the wiring. Sangamo condensers are a product of the British Sangamo Co., Ltd., Ponders End, Middlesex.

○○○○

WIRE-WOUND ANODE RESISTANCE

The Varley Magnet Co., of Woolwich, S.E.18, have recently produced within the standard dimensions of the usual clip-in anode resistance, a series of wire-wound resistances suitable for use in resistance-capacity coupled circuits.

The winding is arranged as a spool consisting of a number of single layers with



The Varley wire wound anode resistance.

waxed paper insulation and the resistance wire is silk covered. This anode resistance is suitable for use in resistance-coupled low-frequency amplifiers, and is obtainable in resistance values up to 100,000 ohms. It is suppl ed complete with an ebonite base piece, nickel plated clips and terminals.

CATALOGUES RECEIVED.

"Falk, Stadelmann and Co., Ltd." (83-93, Farringdon Road, London, E.C.1). 68-page catalogue of Efesca components and Efescaphone receiving sets.

○○○○

"Fuller's United Electric Works, Ltd." (Woodland Works, Chadwell Heath, Essex). Catalogue 315 E, relating to Sparta radio accessories.

○○○○

"J. H. Taylor and Co." (Macaulay Street, Huddersfield). "Reliability" Wireless Guide No. 2, a price list of wireless apparatus by reliable makers.

○○○○

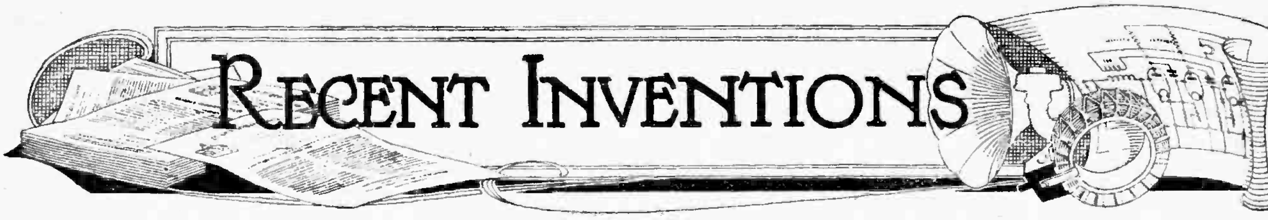
"Goswell Engineering Co., Ltd." 95-98, White Lion Street, London, N.1). Leaflet describing the Quality electric soldering set.

○○○○

"Seagull, Limited." (Regent House, Kingsway, W.C.2.) Catalogues of "Seagull" components, including the choke capacity coupling and the low-loss tuner.

○○○○

"Rotax (Motor Accessories), Ltd." (Rotax Works, Willesden Junction, N.W.10.) Art catalogue descriptive of "Rotax" wireless broadcast receiving equipment, dry batteries, and accumulators.

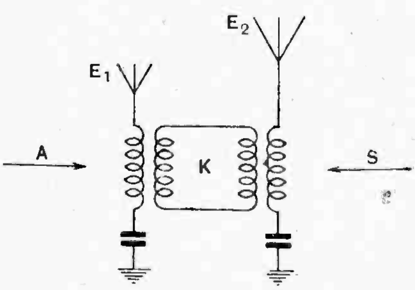


Brain Waves of the Wireless Engineer.

Aerial System.
(No. 221,825.)

Application date: Sept. 11th, 1924.
Convention date (Germany): Sept. 11th, 1923.

The Telefunken Company describe in the above patent specification an antenna system comprising a receiving antenna proper and one or more shielding antennæ of larger dimensions than the receiving antenna erected between the receiving antenna and the direction or directions from which it is desired to eliminate disturbances and coupled to the receiving antenna. The distance between the receiving antenna and the screening antenna or antennæ is made less than a quarter of a wavelength, so that the whole system may be erected upon a comparatively small piece of ground.



Directional aerial system. (No. 221,825.)

The arrow A represents the direction from which it is desired to receive the signals, while disturbances coming from the direction of the arrow S are to be eliminated. E_1 is the receiving antenna and E_2 the screening antenna, which is closely tuned to the same wavelength as E_1 and is also substantially similar to, but larger than, E_1. K is an aperiodic circuit coupling E_2 to E_1.

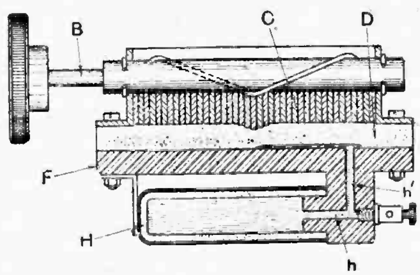
○○○○

Variable Condenser.
(No. 241,806.)

Application date October 25th, 1924.

Mr. J. A. Williams describes in the above patent specification a variable condenser in which mercury is maintained under pressure in a compartment of large surface area and very small volume formed between a pad of rubber D and a base of non-conducting material F covered with mica to form the dielectric, the mercury being forced therefrom to vary the capacity by varying the pressure on the upper surface of the pad D. The fixed plate of the condenser consists of a thin sheet of metal foil, carried on the upper surface of the base F.

The mercury is contained in a vessel



Variable condenser with mercury electrode.

H of resilient material which communicates with the compartment beneath the rubber pad D through passages h, h^1. The pressure over the upper surface of the pad D is varied by rotating the spindle B, which acts on a series of plates C resting on the rubber pad.

○○○○

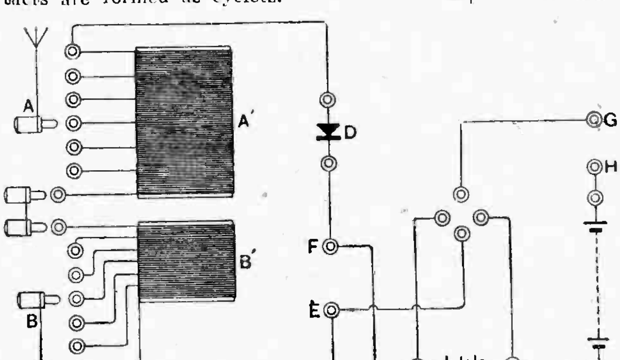
Tapped Coil Crystal Receiver with Optional Valve Amplifier.
(No. 241,656.)

Application date August 18th, 1924.

Mr. J. Gaunt describes in the above patent specification a tapped coil crystal receiver adapted to be used without low-frequency amplification by using terminals E F or with amplification by using terminals G H.

The set is tuned by plugs attached to the aerial A and earth B. The coils A^1, B^1 are separate, and a loading coil may be inserted between the terminal sockets.

The terminals, tappings and valve contacts are formed as eyelets.



Crystal receiver and amplifier.

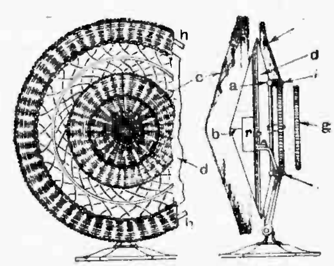
Hornless Loud-speaker.
(No. 242,362.)

Application date August 11th, 1924.

The Western Electric Co., Ltd., describe in the above patent specification a modification of their well-known "Kone" loud-speaker, consisting of an acoustic device comprising a large direct-acting vibratory member whose mass per unit area increases progressively from the point of application of the actuating force.

A large direct-acting double conical diaphragm d, one side of which is truncated and open, or closed, is secured to an annular member a in any suitable manner.

To the apex of the conical diaphragm is connected the receiver unit r by a rod b. The casing for the vibratory system



"Kone" loud-speaker modification.

is preferably made of wicker and for convenience is made in three parts, a frame f, a cover c, and a rear cover g. The frame portion f is preferably woven over rings h and i, leaving a central opening in the rear, which is closed by the portion g, held in place by spring clips. The basket-like cover c is preferably conical in shape.

Double cone diaphragms from 9in. to 4½ft. in diameter, constructed as herein described, have been found to give excellent results.

A practicable size, however, is one having a diameter of about 18in. and an insert approximately 9in. in diameter, the insert being made of thin glazed drawing paper and the other portion of the face and the truncated member of blotting paper. The actual materials to be used, however, are not so important.

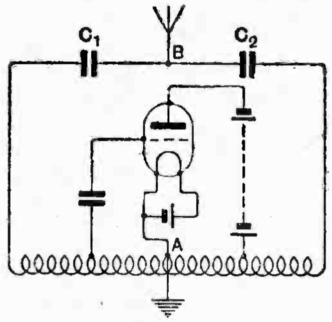
The central portion should be made as light and stiff as possible, the lighter and stiffer the better.

○○○○

High-Frequency Signalling System.
(No. 241,417.)

Application date Dec. 17th, 1924.

Dr. Marten Johann Huizinga describes in the above patent specification an improved high-frequency signalling system for wireless or line telephony or telegraphy of the type in which there is no carrier-wave radiated at intervals between signals, that is, during the time that the high-frequency current is not modulated, no wave is radiated, or only a very feeble one. According to the invention, a radiating circuit is connected to two model points in a local oscillating circuit, or to two points at which the voltage is always the same in magnitude and phase.



Suppression of carrier wave in intervals between signals or speech. (No. 241,417.)

Energy is radiated only when the frequency of the oscillations of the local circuit, or both, are modulated.

As shown in one example, oscillations are produced by a thermionic valve connected to three points of the coil that forms a closed circuit with the condensers C_1 and C_2.

These two condensers are connected together and form a push-pull-condenser microphone. To this end a movable diaphragm that vibrates with the speech waves is interposed between the two rigid plates, so that on opposite sides of the movable diaphragm condensers are formed the capacity of which is either reduced or increased, whilst the capacity of the other is increased or reduced.

Owing thereto, the total capacity in the closed circuit remains the same, therefore the frequency of the circuit is not altered.

Calls Heard.
Extracts from Readers' Logs.

London, S.W.10.

(October, November, December, 1925.)
Great Britain: 2CC, 2FK, 2FM, 2FU, 2GY, 2JJ, 2JU, 2LZ (R/T), 2QB, 2TA, 2VS, 2VL, 2XV, 2ZF, 5FT, 5HX, 5KU, 5SI, 5WV, 5XO, 5YI, 6IZ, 6VP, 6YU, 6ZM. U.S.A.: 2KG, 2BL, 2AGQ, 1RD, 1CMX, 1AIR, 8ALF, 8ALY, 9DYY, WQO, WIR, WIZ. France: 8DK, 8FP, 8GW, 8GZ, 8JC, 8NA, 8RZ, 8AIX, 8PKX, 8YOR. Holland: PB3, 2PZ, OEA, OEZ, OKS, PCLL, PCUU. Italy: IAS, IAU, IBW, IMT, IRG (R/T). Miscellaneous: B K5, B 2K, B 6G, SMYV, SMTN, SMUI, POF, 8LDR, 8CAX, 8ZB, 8MB, 7XX, LSI, CS.O.K.I, EAR.21, BZ.IBD, BZ.1MC, BZ.5AB, CBY, CRP.
(0-v-1. 15ft. indoor aerial.)
J. B. Kaye (5BU).

West Norwood, S.E.27.

Great Britain: 2AEY, 2AKG, 2BL, 2DA, 2EC, 2FM, 2GU, 2JB, 2JP, 2QB, 2QV, 2TO, 2XV, 2ZB, 5BY, 5DK, 5EC, 5GS, 5HG, 5HJ, 5HX, 5KO, 5KU, 5LF, 5MO, 5RQ, 5RZ, 5SI, 5SK, 5SZ, 5WQ, 6DO, 6ER, 6FA, 6FQ, 6IZ, 6JB, 6LJ, 6PG, 6RW, 6SU, 6TD, 6UZ, 6VP, 6XG, 6YC, 6YQ, 6YU, 6YV. G.I.: 5NJ, 6MU. Irish Free State: 11B. France: 7VX, 8CA, 8GI, 8JD, 8JR, 8DK, 8DUCH, 8JC, 8IL, 8MMP, 8PEP, 8PKX, 8PM, 8RZ, 8SST, 8TH, 8TOK, 8XH, 8Z3. Germany: KPL, K7, I8, L4, W4. Norway: 1A, 4X. Finland: 2CO, 2ND, 2NX, 5NF. Belgium: C2, E9, G6, K2, L9, S2, U3, V2, W3. Holland: 0CZ, 0GG, 0PX, 2PZ, 12BB. Denmark: 7ZM. Switzerland: 9AD, 9BR, 9KD, 9RNA. Yugoslavia: 7XX. Spain: E-1BH. Various: GB1, GB2, P-1AB.
L. H. Thomas (6QB).

London, N.10.

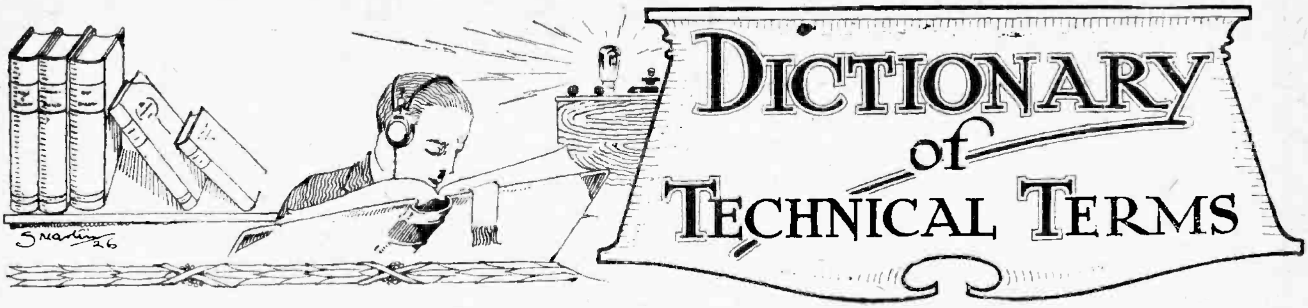
Great Britain: 2AU, 2BL, 2BM, 2BAV, 2CA, 2GG, 2GW, 2GY, 2GZ, 2IV, 2JJ, 2JU, 2KG, 2MI, 2OC, 2OM, 2ON, 2QC, 2RK, 2SO, 2ST, 2SV, 2SZ, 2UA, 2UV, 2VL, 2VO, 2VR, 2VS, 2VW, 2VX, 2WS, 2XO, 2XV, 2ZA, 2ZX, 5AR, 5BY, 5CB, 5CF, 5CP, 5CT, 5GW, 5HT, 5IS, 5NJ, 5OW, 5OX, 5OY, 5PD, 5QV, 5SO, 5SR, 5TV, 5TR, 5UL, 5UV, 5VP, 5WX, 5XW, 5XY, 5YK, 5YM, 5ZG, 6BF, 6BO, 6CT, 6DA, 6FK, 6GW, 6HY, 6JJ, 6JV, 6KA, 6LL, 6OP, 6PL, 6PT, 6PU, 6TX, 6UO, 6VX, 6WG, 6WQ, 6XR, 6YG, 6YJ, 6YK, 6YQ, 6YS, 6YT, 6YU, 6YV, 6YW. France: 8AE, 8BF, 8BGM, 8BN, 8BO, 8CH, 8CT, 8DK, 8EI, 8EU, 8FN, 8GB, 8HG, 8HU, 8IK, 8IL, 8JN, 8TOK, 8UOU, 8VO, 8VW, 8VX, 8WAL, 8YNB, 8ZB, 8ZEB. Spain: EAR1, EAR2, EAR6, EAR9, EAR21, EAR22. Italy: 1AS, 1FP, 1GB, 1GW, 1MT, 1NO, 1RG, 3TR, 4AS. Sweden: SMRG, SMTN, SMUI, SMUK, SMVY, SMWF, SMXU, SMYY, SMZS. Norway: LA1A, NW4X. Denmark: 7BJ, 7EC, 7QF, 7ZM. Belgium: K4, E9, 4KR, B7, J22, K14, 4YZ. Germany: K4, Y4, Y5, Z7. Holland: OFL, OWC, OZM. Finland: 2NCA, 2NCB, 2NM, 2NN, 3NO, 3NU. Egypt: 1BH, 3JJ, 3OO. Yugo-Slavia: 7XX, 7XZ. Others: A3, CB8, WX5M, G4HA, GFUO, GFUP.
J. Hum.
(0-v-0, 0-v-1.)

Lichfield.

(November 29th to December 31st.)
Great Britain: 6AH, 6YU, 6JW, 5YI (all telephony). U.S.A.: 1CKP, 1CMP, 1SW, 1AXA, 1SI, 1CH, 1ZA, 1YB, 1BGQ, 1AOI, 1CMX, 1AYA, 1BVL, 1AAP, 1AMD, 1GA, 2XE, 2AKY, 2AFO, 2CKL, 2EM, 2MK, 2BIR, 2CVJ, 3YX, 3BSS, 3BZ, 3PY, 3BVA, 4JE, 4BV, 4IZ, 4RR, 5ACL, 5ZAI, 8DGP, 8DGL, 8BZK, 8AUL, 8DFR, 8BWW, 8ALY, 8DTO, 8DIA, 8DEM, 9DQU, 9EJI, 9FF, 9BAZ, 9ZA, 9AVJ, 9EGH, 9ADO, 9BHT, 9DNG. Canada: 1DD, 1DQ, 1AR. Australia: 3AK, 3BD, 3BM, 2CM, 2BB, 3LM, 3YX, 5BG. South Africa: A6N, A3E, A4Z. Philippines: 1HR, 1FN, NAJD, NAJI. French Indo-China: 8LBT, 8QQ. New Zealand: 2AC, 2XA. Mexico: 1AA. Brazil: 5AA. Argentine: FH4. Scandinavia: SMXU, SMZZ, SMUV, SMZS, SMUI, SMVJ, 5NB, 2NX, 2NN, 2CO, LA1A, LA4X, SGT, SKA. Various: GFUP, NTT, GHA, EIBH, IDH, PC7, LX1, DA, 4AV, NEQQ, I2BB, LS1, EGEH, BER, SCS, DTBT, NDX, EA2.
G. S. Samways.

Dublin.

(December 7th to January 4th.)
Australia: 3XO, 6AG. New Zealand: 4AR, 4AV. Japan: 1PP. Honolulu: 6BUC. South Africa: A4Z, A6N. Canada: 1DQ, 2BG, 3KP. Brazil: 1AB. Porto Rico: 4JE. Palestine: 6ZK. U.S.A.: 1AAP, 1ACI, 1ACW, 1AEI, 1AGQ, 1AGS, 1AIU, 1AJO, 1AMF, 1ATJ, 1ATV, 1AWB, 1BAD, 1BDH, 1BIG, 1BGC, 1BS, 1BXF, 1BXH, 1BYX, 1BZ, 1CAB, 1CAW, 1CI, 1CKP, 1CMP, 1CMX, 1CO, 1COE, 1GR, 1HJ, 1II, 1SW, 1XM, 2AAN, 2ACP, 2ACS, 2ACY, 2AJQ, 2ANP, 2BL, 2BW, 2BWA, 2BXJ, 2CRB, 2CUB, 2CXL, 2CYX, 2HH, 2KG, 2KR, 2KU, 2MK, 2MU, 2QU, 2RW, 2TP, 2UK, 2XQ, 2ZT, 3AQL, 3AUV, 3BMZ, 3BTA, 3BWT, 3BVA, 3CEL, 3DH, 3HG, 3JO, 3JW, 3LJ, 3LW, 3PS, 3SK, 3TE, 3ZR, 3ZM, 3AVK, 4ES, 4FA, 4RM, 5ACL, 5AFD, 5AGN, 5ALZ, 5ATT, 5FC, 5JF, 5MI, 5VA, 5YD, 5ZAI, 6CGV, 6OI, 7GR, 7UZ, 8AC, 8ADE, 8AFQ, 8ALS, 8ALU, 8AME, 8BAU, 8BD, 8BDC, 8BI, 8BKM, 8BPL, 8BWW, 8CNX, 8DAA, 8DAN, 8DGJ, 8JO, 8UL, 9AZL, 9BFP, 9BHI, 9BHT, 9BNA, 9BUP, 9BVH, 9BZI, 9CIP, 9DBB, 9DZ, 9EJI, 9XI, 9ZT. Madeira: P3FZ. Russia: RCRL, RRP. Morocco: 1ZV, AIN, MAROC. Unknown: 3EX, EGEH, FT1, ZSF2, L6C, SP, L1JW.
D. M. and D. F. O'Dwyer.
(0-v-1. 25 to 50 metres.

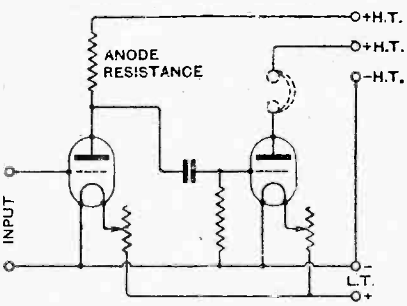


Definitions of Terms and Expressions commonly used in Wireless Telegraphy and Telephony.

This section is being continued week by week and will form an authoritative work of reference.

Resistance-Capacity Coupling. A method of connecting the *three-electrode valves* of a *resistance amplifier* in cascade by means of resistances. A high resistance of the same order as the internal impedance of the valve is connected between the positive terminal of the *high-tension battery* and the plate of each valve. The signal oscillations which have been amplified by any one valve flow through the plate resistance of that valve, and in consequence an oscillating *potential* is set up across the resistance. This oscillating potential is applied to the grid of the next valve in the series through the medium of a grid condenser, which allows the oscillations to pass but prevents the H.T. voltage from reaching the grid. A *grid leak* is connected between the grid and the negative end of the filament in order that the grid shall not accumulate too large a *negative charge* and render the valve inoperative.

A coupling of this kind is particularly suitable for *low-frequency amplification*, as it gives equal amplification



Resistance-capacity coupled valves.

for all audio-frequencies and is thus conducive to distortionless amplification. It is also suitable for high-frequency amplification for the longer wavelengths, *i.e.*, from 1,000 metres upwards. It does not give good amplification at short wavelengths because a large proportion of the signal oscillation is by-passed over the resistance by the inter-electrode capacity of the valves. On account of the *potential drop* across the resistance higher *plate voltage* supply is necessary than with other types of coupling.

Resistance Drop. The *potential drop* in a circuit, due to the resistance, which occurs when a current flows. This is given by the product of the current and the resistance.

Resistance Loss. See I^2R loss.

Resistivity. See SPECIFIC RESISTANCE.

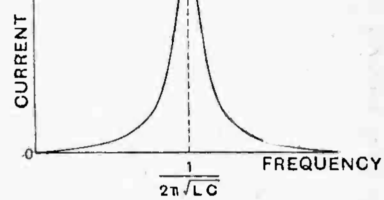
Resistor. A conductor having considerable *resistance* introduced into a circuit for the purpose of adding resistance.

Resonance (in electric circuits). Resonance is said to occur in an electric circuit when an *alternating potential* whose frequency is equal to the *natural frequency* of the circuit is applied to its ends. Resonance can only occur in a circuit which possesses both inductance and capacity, and "complete resonance" is said to take place when the frequency is such that the *inductive reactance* is exactly equal to the *capacity reactance*. Since these two quantities are opposite in sense (the former represents a lagging current and the latter a leading current), the resultant *reactance* of a circuit in complete resonance is zero, and therefore the current drawn from the supply is *in phase* with the voltage.

If f is the frequency, L the inductance in henries, and C is the capacity in farads, then the inductive reactance is $2\pi f L$ ohms, and the capacity reactance is $1/2\pi f C$ ohms, and, since these are equal when complete resonance occurs, the frequency of resonance is given by $f = \dfrac{1}{2\pi\sqrt{LC}}$ cycles per second, which is the *natural frequency* of the circuit. A circuit which has L and C adjusted to give resonance at a certain frequency is said to be *tuned* to that frequency. Wireless communication is based upon this property of electric circuits.

The properties of a circuit tuned to resonance depend on whether the inductance and capacity are connected in *series* or in *parallel*. For series connection the impedance of the circuit is a minimum when adjusted to resonance, being equal to the *ohmic resistance* R, whereas for parallel connection of the inductance and capacity the impedance is a maximum when the circuit is adjusted to resonance, being equal to L/CR, where R is the resistance of the inductive portion, the condenser being assumed to have negligible resistance. See REJECTOR CIRCUIT.

Resonance Curve. A graph showing the relation between current and frequency in a circuit of fixed inductance and capacity, a constant voltage at varying frequency (or wavelength) being applied to the ends of the circuit. For a *series* circuit the current reaches a maximum value at the frequency of



Typical resonance curve of a series circuit at constant voltage.

resonance, and for a parallel circuit it reaches a minimum value at the frequency of resonance. The sharper the peak shown at the point of resonance the more selective is the circuit for wireless tuning purposes. See RESONANCE.

Resonating Circuit. See OSCILLATING CIRCUIT.

Retroaction. See REACTION.

Retroactive Circuit. See REGENERATIVE CIRCUIT.

R.F. Abbreviation for *radio-frequency*.

Rheostat. A variable resistance for controlling the current in a circuit, *e.g.*, filament rheostat.

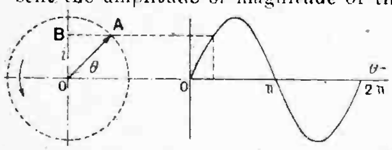
R.M.S. Abbreviation for *root-mean-square*.

Root-mean-square Value. The *effective value* of an alternating current, voltage, etc., based on the average heating value or energy value of an alternating current. See ALTERNATING CURRENT.

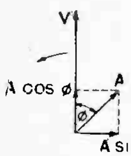
Rotary Converter. An electrical machine with a rotating armature for converting alternating current into direct current or *vice versa*. The armature is similar to that of an ordinary D.C.

Dictionary of Technical Terms.—
dynamo or motor, but carries *slip rings* as well as a *commutator,* both slip rings and commutator being connected to the same winding. The machine is run as an A.C. synchronous motor, being supplied with A.C. through the slip rings, and D.C. is drawn from the commutator (or *vice versa*).

Rotating Vectors. A rotating vector is a straight line which rotates with constant angular velocity about one end. Such a straight line can be made to represent fully an alternating current or voltage which obeys the sine law. The vector rotates about its end at a speed equal to the frequency of the alternating quantity, and the length of the vector is drawn to some scale to represent the amplitude or magnitude of the



(Above) Sine curve developed from a rotating vector OA. OB = instantaneous value of the current.



(Left) Current vector OA lagging behind voltage vector OV by an angle ϕ.

current or voltage. The projection of the vector on a vertical straight line then represents the instantaneous value of the current or voltage at any instant, and the angle which the vector makes with the horizontal straight line represents the *phase angle* of the alternating quantity at that instant. The vector makes one complete revolution for each cycle of the alternating current.

The current and voltage in a circuit can be fully represented both as regards their magnitudes and their phase relation by two rotating vectors, one representing the current and the other representing the voltage. The lengths of these vectors may be drawn to some scale to represent the *effective values* of the respective alternating quantities the angle between them being equal to the angle of *phase difference* between the current and voltage. If V and A are the lengths of the voltage and current vectors respectively, and ϕ is the angle between them, the *power* in the circuit is VA cos ϕ, watts; but A cos ϕ is that component of the current vector which is *in phase* with the voltage vector, and is therefore called the *power component* of the current. The other component, A sin ϕ, out of phase with the voltage by 90° (in quadrature), does not represent any power, and is called the *wattless component*.

Alternating voltages, etc., which are to be added together must always be added vectorially, *i.e.*, by vectors. See Vector Sum and Vector Difference.

S

Saturation (magnetic). The condition which occurs in iron, etc., when magnetised to such an extent that further increase in the *magnetising force* H does not make any appreciable difference to the flux density produced in the iron. Saturation point is that point on the *B-H curve* where the slope suddenly becomes less steep as the value of H is increased. See B-H Curve.

Saturation Current (of a valve). As the anode voltage of a thermionic valve is increased the anode current or plate current increases also up to a certain limiting value, beyond which it ceases to increase for further increase of anode voltage. This limiting value is called the "saturation current" and sometimes in the case of *hard valves* the "emission."

Saturation Curve. See B-H Curve.

S.C.C. Abbreviation for *single cotton covered*.

Screened Aerial. An aerial beneath which is spread a network of wires to act as a *counterpoise*.

Screening Effect. A sheet of metal placed between two pieces of apparatus, where one or both of them carry oscillating currents, will prevent one from affecting the other inductively on account of the eddy currents set up in the screen. If the screen is earthed it will also prevent any electrostatic interaction between the two pieces of apparatus. See also Magnetic Screen.

Secondary Battery. A battery of accumulators or *secondary cells*.

Secondary Cell. A cell in which suitable electrodes are immersed in an electrolyte so that an *electromotive force* is exerted and a potential difference is set up between the electrodes. The special feature of a secondary cell is that when it has been discharged and the chemical changes in the cell have been completed, the cell can be recharged electrically by driving a current the reverse way through the cell and so reconverting the chemicals to their original state. The lead-acid accumulator is the most common example of a secondary cell. Sometimes called a "storage cell." Compare Primary Cell *or* Secondary Emission.

Secondary Electrons or **Secondary Emission.** *Electrons* which are given off by the anode or plate of a *thermionic valve* when the ordinary stream of electrons from the filament (known as "primary electrons") strike it with a sufficiently high velocity. The resultant plate current is given by the difference between the primary electrons and the secondary electrons. See Dynatron and Kenotron.

Secondary Winding. That winding of a *transformer* which gives out electrical energy. This is quite independent of whether the voltage across it is greater or less than that across the other (primary) winding.

Selectivity (of a wireless receiver). The degree to which a receiver is capable of selecting one particular wavelength to the exclusion of others; sometimes referred to as "sharpness of tuning." A receiver in which the degree of selectivity is low is said to have "flat tuning" or to be "flatly tuned." The degree of selectivity depends upon the sharpness of the *resonance curve* of the tuned circuit: the lower the *decrement* of the oscillatory circuit the sharper is the tuning. Selectivity is greatly increased by having more than one tuned circuit. See Intermediate Circuit.

Selenium Cell. A small cell made up of selenium and used for wireless transmission of photographs, etc. The resistance of the cell varies according to the amount of light falling upon it, so that variations of light intensity can be converted into corresponding variations of current in a circuit.

Self-Capacity (of coils). Electrostatic capacity exists between the consecutive turns of all inductance coils used for wireless tuning purposes and also between the various layers where multilayer coils are used. This is correctly called the "distributed capacity" of the coil, but its effect is in some respects similar to that of a concentrated capacity connected across the ends of the coil, for instance, a coil without a condenser connected across it is tuned to a definite wavelength called the *natural wavelength* of the coil. The self-capacity of the coil is defined as the equivalent concentrated capacity which would give the same wavelength when connected across a coil of equal inductance but without any distributed capacity.

The self-capacity or distributed capacity itself does not account for any loss of energy in a coil. The losses which usually occur in coils of high self-capacity are due to *dielectric losses* in the insulation between the turns and layers of the coil.

Self-Heterodyne. See Endodyne.

HIDDEN ADVERTISEMENTS COMPETITION.

The "Wireless World" Hidden Advertisements Competition, which is proving extremely popular among our readers, will be continued weekly until further notice. Below are given the solution and the names of the prizewinners in the competition of January 6th, 1926.

Clue No.	Name of Advertiser.	Page
1	Bowyer-Lowe Co., Ltd.	23
2	Seagull, Ltd.	iii
3	General Radio Co., Ltd.	30
4	Mullard Wireless Service Co.	7
5	Edison Swan Electric Co., Ltd.	18
6	S. A. Lamplugh, Ltd.	25

The prizewinners are as follow:—

J. W. Robinson, Jun., Manchester	£5
T. R. Caldicott, Bath	£2
M. H. Raphael, Paris	£1

Ten shillings each to the following four:

F. Blackburn, Burnley.
F. J. Yarnall, Bloxwich.
J. Purdie, Glasgow.
H. J. Holmes, Watford.

"The Wireless World" Information Department Conducts a Free Service of Replies to Readers' Queries.

Questions should be concisely worded, and headed "Information Department." Each separate question must be accompanied by a stamped addressed envelope for postal reply.

A Simple Method of Improving Loud-speaker Quality.

I was very interested in the circuit given in your December 2nd issue for obtaining alternative grid and anode rectification, but I wish to build a 1-v-1 receiver, employing a plug-in H.F. transformer, and desire, if possible, to include a simple switching arrangement for alternative grid or anode rectification, and should be glad to know if it is possible to do this when using an H.F. transformer. H. S. K.

It is perfectly feasible to include the switching arrangement you suggest when using an H.F. transformer, and the circuit actually becomes very simple indeed, far more so than when using any other form of H.F. coupling, since auxiliary apparatus such as H.F. chokes, etc., are unnecessary, and an existing receiver employing an H.F. transformer can be converted at the cost of a single-pole switch and a few minutes' work with the soldering iron. The circuit which we illustrate in Fig. 1 is quite self-explanatory. With regard to the value of negative grid bias necessary to cause the valve to act as an anode rectifier, this depends on the characteristics of the particular detector valve used, and it is well to provide oneself with a 9-volt tapped grid bias battery. It is suggested that grid rectification be used when tuning in distant stations, whilst on the local or high-powered stations a very marked increase in the quality given by the loud-speaker will be obtained by changing over to anode rectification.

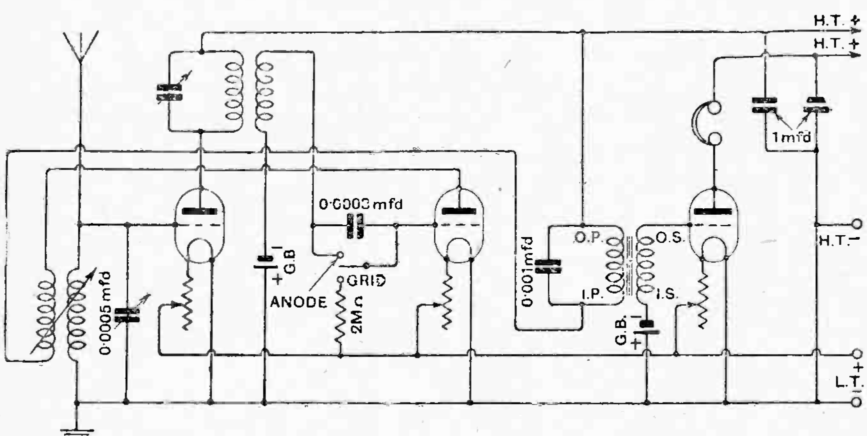


Fig. 1.—Circuit connections for obtaining grid or anode rectification.

oooo

Causes of Flat Tuning.

Why is it that the selectivity of a single-valve receiver employing anode rectification is greater than when grid rectification is employed, and the selectivity of either of these arrangements is greater than obtainable with a crystal receiver? D.A.G.

In the case of a valve employing "bottom bend" or anode rectification, a negative bias is placed on the grid in order to bring the operating point on the sharpest portion of lower curve of the grid volts—anode current characteristic curve. One of the "by-products" of this negative bias on the grid is that all grid current (which is, of course, the cause of flat tuning in the grid coil of a valve employing grid rectification) is effectively stopped, and so sharp tuning results. In the case of a crystal receiver or of a crystal rectifier connected to an H.F. amplifier, it must be remembered that a crystal connected in series with a pair of telephones, or the primary of a low frequency transformer, is shunted directly across a tuning coil and actually draws energy from the coil in the form of a current passing through crystal and telephones, and this withdrawal of energy "damps down" the oscillations set in the coil by incoming signals, and any interference with the free oscillation of a tuning system in this matter has a considerable effect in flattening tuning. In the case of a valve rectifier, the damping produced by grid current can be counteracted by the judicious stimulation of oscillations by a careful use of the reaction coil.

oooo

Selective Three-valve Circuit.

I wish to build a three-valve receiver employing one H.F. stage, but in order to improve selectivity desire to employ a loose-coupled aerial circuit. I presume, however, that in order to ensure stability I shall have to control the grid of the H.F. valve by means of a potentiometer, and your advice in this respect would be greatly appreciated. G. J. H.

In the case of the conventional receiver employing an H.F. stage plus reaction, it will be found that in most cases a direct-coupled aerial circuit is employed, and it is usually only the damping effect of the aerial which "holds down" the receiver and prevents it from bursting into uncontrollable oscillation. This is really an inefficient arrangement, since it prevents us using a coupled aerial circuit in order to improve our selectivity. Many readers get over the difficulty by employing a loose-coupled aerial circuit, and bring about stability by using a potentiometer to give a slight positive bias to the grid of the H.F. valve, thus introducing damping into the grid circuit. Whilst this certainly stabilises the receiver, it is a most inefficient method, since in most cases it reduces the efficiency of the H.F. stage so much that the valve is practically a passenger, and better results could be obtained by dispensing with it altogether. In addition, the fact of grid current being permitted to flow in the grid circuit of the H.F. valve flattens the tuning of this circuit and incidentally rejoices the heart of the manufacturer of H.T. batteries. The correct method of setting to work is to eliminate the cause of the instability by neutralising the stray capacities associated with the H.F. valve, rather than to employ such doubtful palliatives as potentiometer control. The circuit which we illustrate in Fig. 2 will, if correctly set up, prove to be a remarkably efficient and selective arrangement, since we obtain selective tuning both in our aerial circuit and in the coupling between the H.F. and detector valves. If it is desired to cut down the number of controls, an aperiodic aerial coil, of which there are quite a number on the market, may be used instead of tuning the aerial circuit. In the circuit which we illustrate

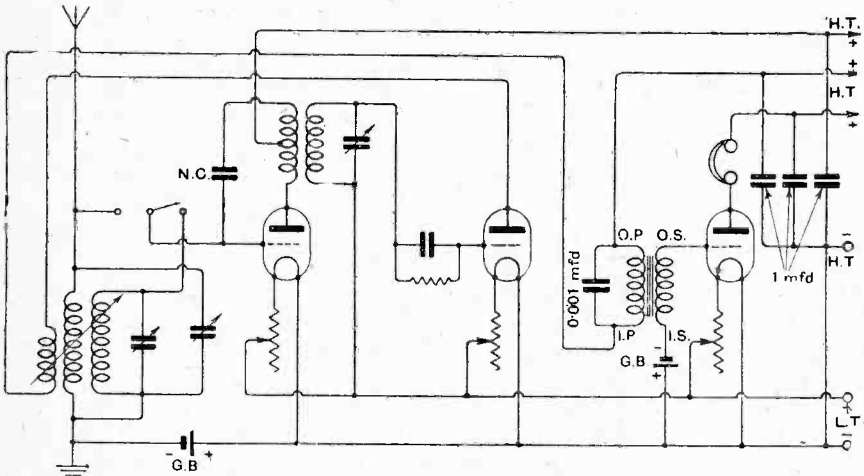


Fig. 2.—Selective three-valve circuit.

a single switch is incorporated for giving optional direct or loose coupling. With regard to the construction of the H.F. transformer, it is recommended that the details given on page 532 of our October 21st issue be closely followed out.

○○○○

Methods of Measuring Capacity.

I have recently been given a fixed variable condenser designed for shunting across the output of a receiver. I am told that this is an ex-Government instrument and it is marked in "Admiralty units." Can you explain what is meant by an Admiralty unit? B.F.H.

An "Admiralty unit," otherwise known as a "jar," represents the capacity of a Leyden jar of certain standard dimensions. One jar is approximately equal to 0.001 mfd. Thus, the 0.0005 mfd. variable condenser used almost universally to-day in wireless receivers might be described as having a capacity of half a jar.

○○○○

Anode Current.

I shall be pleased if you can answer the following query in order to settle an argument between myself and a friend. The query is as to the nature of the current flowing through the loud-speaker windings; is it D.C. or A.C.? J. S. T.

Since we know that the current flowing through the loud-speaker windings is constantly varying, not only in amplitude but also in frequency, the latter ranging from a few hundreds to several thousand complete cycles per second, it might appear at first sight that the answer was obvious, namely, that the A.C. or varying frequency was flowing through the loud-speaker windings. Since the loud-speaker is connected in the plate circuit of the final valve, this would mean that A.C. was flowing through the filament—anode path of the valve, but since we know that the correct definition of an alternating current is a current having its *direction of flow* and magnitude constantly changed, this would mean that during half of each complete cycle electrons would be flowing from the highly positive plate to the filament, which we know is impossible. The actual explanation is, of course, that the current flowing in the loud-speaker windings is a pulsating current, the definition of this latter being a current which, although rising and falling (not necessarily regularly), always remains on one side of the zero line, *and never reverses its direction*. This holds true only when actual music or speech is being impressed on the carrier wave of the transmitting station during the time that the microphone is in operation, the pulses varying both in amplitude and frequency in sympathy with the volume and pitch of the sound picked up by the microphone. During the time when there is silence in the studio, or when no transmission is being picked up by the aerial, the pulsating current gives place to the steady D.C. anode current passing through the output valve and loud-speaker, upon which, of course, the pulsations are super-imposed when actual speech or music is being radiated by the broadcasting station to which the receiver is attuned. In the case of a loud-speaker coupled to a receiver through the intermediary of an output transformer or choke filter circuit, no current flows through the loud-speaker windings when no actual transmission is taking place, whilst pulsating current commences to flow only when the microphone gets into action.

○○○○

Loud-speaker Resonance.

I have just completed a four-valve receiver, using 0.06 ampere dull emitter valves throughout, and whilst results are eminently satisfactory when using the loud-speaker on a long extension lead in another room, I find that if the loud-speaker is placed on the same table as the set, it commences to emit a soft moaning sound which speedily builds up into a wild shrieking, and all my efforts to correct the trouble have proved unavailing, and I am writing to ask if you can assist me in tracing this very disquietening trouble to its lair. P.H.R.

This trouble is one concerning which readers are constantly puzzled, and it is easily traced and remedied. The primary cause is that the type of valves you mention have a very thin and fragile filament, which is easily set into mechanical vibration by accidental jolting, this giving rise to the familiar "microphonic" noises associated with dull emitters. When the loud-speaker is placed near the set the sound waves from it, by striking the glass envelope of the valves, set the filaments into mechanical vibration, which, by producing a sympathetic variation in the plate current, causes a low howl to be emitted by the loud-speaker. This howl, by causing fresh sound waves to strike on the valves, is again repeated back to the loud-speaker *via* the sympathetic plate current variation, and gradually a roar builds up, which only ceases when the loud-speaker is moved to a sufficient distance from the receiver to prevent the sound waves agitating the valves. The phenomenon is analogous to the shrieking set up by holding the earpiece of a post office telephone close to the microphone, which is technically known as "blasting."

The best remedy when valves are mounted on the panel is to use anti-microphonic valve holders. In modern receivers where valves are enclosed inside the cabinet the trouble is less prevalent, but from all points of view it is desirable to use special valve holders with the type of dull emitters you mention.

"Heath Robinson" style of overhead system. The amount of interference caused by induction to a large number of wireless listeners is simply appalling. 5XX can just be received through the mush, and the reception of short wave stations is quite out of the question. The proprietors of the concern simply ignore all requests to abate the nuisance, which could be done quite easily at the cost of a few shillings.

There is little doubt that the only way of dealing with this form of nuisance is by legislation, and there is a sufficient majority of wireless listeners now to warrant this. G-2LZ.

Essex.

THE WORK OF THE AMATEUR.

Sir,—With reference to the letter in your issue of December 30th from "A.S.C.," is it not time that a stop was put to the cant which is being written concerning the value of the work carried on by the average wireless amateur? It is agreed that a small percentage of so-called amateurs (in reality professionals, or practically so) can do good work and should receive encouragement, but on the other hand, well over 90 per cent. of the home constructors are incapable of accurately observing the results of the most elementary experiments. Their only object in constructing sets is to be able to receive broadcast programmes at the minimum expense, as "A.S.C." so guilelessly points out. That they are robbing the genuine experimenter of his just reward is apparently no concern of theirs.

With reference to Captain Eckersley's "Don't do it!" plea, may I point out to "A.S.C." that Captain Eckersley has repeatedly suggested the remedy for "oscillation." Allow a factor of safety. If two valves will just do the trick with the assistance of critical reaction and a worried look, use a third valve and avoid the necessity for oscillation and face massage.

C. W. B.

THE "HOME MAKER."

Sir,—Evidently Mr. Eckersley does not believe in following the advice he so kindly gives to others, for only a few weeks ago he was writing about a wonderful set he constructed for his father-in-law. My advice to Mr. Eckersley is, Practise what you preach. W. F. BEAMISH.

Wallington.

Sir,—I venture to endorse your excellent article and "C.H.S.'s" letter in the January 6th issue of *The Wireless World* on what Captain Eckersley says about home makers.

My own experience is this:—Starting with a crystal set (factory-made), I was bitten by the "radio bug" and lured on by cleverly worded advertisements (which, I am bound to say, were nearly always justified as regards the quality of the article advertised), and I now find myself in possession of—

(1) A moderately efficient four-valve set (home-made) and all necessary adjuncts.

(2) Variable hook-up set for experiments.

(3) A large boxful of odd parts.

This, I find, has cost me about £60, of which £55 was spent on British-made goods.

I don't know how much a factory-made set would have cost, but it seems to me that the manufacturers haven't much to grumble at. If they have, why do they sell separate parts?

Geneva. G. D. M.

CLICKS FROM ELECRIC CLOCK MOVEMENTS.

Sir,—In your last issue, on your "Readers' Problems" page, you reply to a reader who complains of a click emitted by his loud-speaker every time his electric master clock operates. This "unusual cause of interference" was of interest to me, because I have a similar installation and have experienced exactly the same difficulty.

In an endeavour to cure the trouble I connected the largest fixed condenser I had (1 mfd.) across the clock terminals, and this materially improved matters.

My clock leads are ordinary bell wire, not sheathed and earthed. R. G. M.

Birmingham.

L.F. TRANSFORMER IMPEDANCES.

Sir,—Now that more is known concerning the matching of the impedances of the valves and the transformers in L.F. amplifiers for maximum results, surely it is time that manufacturers gave the impedance at a definite frequency of the primary and secondary in their advertisements.

Four to one, or 3 to 1, conveys nothing really, since one make of the latter ratio could easily be more efficient in every way than a 4 or 6 to 1 of another make, due to more suitable impedances for the valve being used. E. BOTTOMLEY.

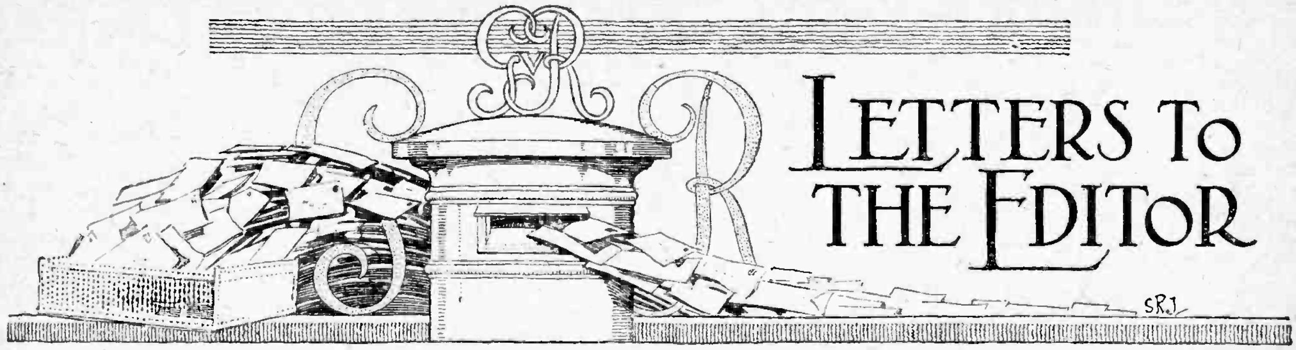
Manchester.

Prominent personalities in Russian amateur wireless. The photograph shows the actual laboratory in which Professor A. S. Popoff conducted his early experiments.

RADIO RESEARCH IN RUSSIA.

Amid all the vicissitudes in which Russia has been involved during recent years, research work in wireless has been carried on with astonishing persistency. The amateur's position was never stronger than it is to-day, interesting evidence of which is afforded by the thriving state of the radio societies. The accompanying photograph was taken recently in the laboratory of the "Aeroradiochemistry" Club at Kronstadt, and shows several celebrities in Russian wireless affairs. On the extreme left is Mr. D. N. Rybkin, who was the associate of Prof. A. S. Popoff when that noted research worker was experimenting with wireless nearly thirty years ago. Next to him is Mr. P. M. Lukyanoff, President of the Radio Section. Nearer the camera are Mr. O. Banyevitch, Director of the Laboratory, and Mr. Sokoloff, his assistant.

The College conducts regular courses in wireless and has a membership numbering about 9,500. A wireless museum has been opened.



LETTERS TO THE EDITOR

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

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

"A PROPRIETARY NAME."

Sir,—In reference to the paragraph headed as above, in your issue of December 30th, we submit that your information is both incorrect and misleading.

There can be no proprietary right to the word "Leclanché," which has been an accepted electrical term for upwards of 30 years, used in a descriptive sense.

Reference to an early catalogue of ours dated 1899, and to subsequent issues, reveals the constant and general use of this word.

Will you kindly give the same prominence in your journal to this statement of ours that has been given to that of which we complain?

H. CLIFFORD PALMER, Manager Publicity Organisation,
The General Electric Co., Ltd.
London, W.C.2.

Sir,—In the issue of *The Wireless World* for December 30th it is noted you specify the word "Leclanché" as applied to cells and batteries is the proprietary trade mark of Messrs. Ripaults, Ltd. We shall be glad to learn as to whether or not this claim is really valid, since the term "Leclanché" as applied to manganese carbon cells has been in common use since the introduction of this type of element about the year A.D. 1868, and we shall be glad to hear from you *re* this.

F. H. HOLYDAY,
Manager Plant and Battery Dept.,
The Edison Swan Electric Co., Ltd.
Ponders End, Middlesex.

MICA COUPLING CONDENSERS.

Sir,—We observe that your correspondent, Mr. W. D. Braid, in speaking of mica coupling condensers of 0.15 mfd. capacity approximately, expresses himself as dissatisfied with British manufacturers and their prices.

We would like to draw your correspondent's attention to the fact that we are always prepared to quote and supply condensers of any value and we can assure him that there is no need to apply to importers of American condensers. We feel sure that he will appreciate that the ease in obtaining an article from the retailer is naturally in proportion to the demand. THE TELEGRAPH CONDENSER CO., LTD.
Kew Gardens, Surrey. pp. H. W. COLE.

Sir,—Your correspondent, Mr. W. D. Braid, who bemoans his inability to obtain large mica-dielectric condensers, presumably for use in constructing a resistance- or choke-coupled L.F. amplifier, should turn his attention to the method recently described by Dr. Kröncke in *The Wireless World*.[1] He would find that high-capacity condensers are by no means necessary, while these amplifiers compare more than favourably, from every point of view, with the more conventional types. The low initial and upkeep cost is a great point in their favour.

C. B. OTWAY.

[1] *The Wireless World*, Sept. 23rd, 1925.

INTERFERENCE FROM MAINS AND GENERATORS.

Sir,—On a recent Saturday I helped a friend to install a four-valve receiving set in his home in a little country town known as Settle, in the West Riding of Yorkshire. On trying out the set we found that reception was absolutely spoilt owing to the activities of an electric lighting plant about 75 yards from the house. When we started to make the set we did not expect to cut out this plant absolutely, but we really did not think that it would so seriously affect reception. The sound in both headphones and loud-speaker resembled the exhaust of a gas-engine and was regular and continuous.

After trying out the set thoroughly we went to the houses of one or two people who had receiving sets in the vicinity and there discovered that the same conditions had to be contended with, and were informed that various attempts had been made to obviate the nuisance but without any appreciable success.

The town of Sedburgh has about 2,600 inhabitants, and as far as I could make out there are only about 18 receiving sets in the place, and the reason for this is that people are afraid to go to the expense of buying a set when reception is practically impossible. Perhaps I ought to say "clear" reception, as on the set I helped to install reception was loud, but was ruined by the beat of the engine.

I should be extremely obliged if you or your readers would suggest some method by which I could improve matters on the receiver, or, alternatively, whether the B.B.C. have power to force the owner of the electric lighting plant to improve the same so as to meet present-day conditions.

Settle. A. GRAHAM.

Sir,—A neighbour recently installed a small rotary rectifier for battery charging, and I find that when the machine is running reception on the waveband 70 to 30 is rendered quite impossible. Signals are obliterated by a low-frequency buzz and London experimenters may judge its intensity for it blots out the powerful signals from the Post Office station at Dollis Hill. The reception of KDKA is out of question when the battery charger is in operation. There is no interference on the broadcast band of wavelengths, but on the termination of broadcasting, when I switch over to my short-wave set, my neighbour switches on the machine and usually keeps it running all night.

Can the Post Office step in and help me by exercising their recently acquired powers with regard to the control of ether waves whether or not they are used as a means of communication?

Perhaps some of your readers can suggest a method of eliminating this form of interference. G. M. G.
London, N.

Sir,—The paragraph "The Dynamo Nuisance," on p. 26 of the January 6th issue of *The Wireless World*, is interesting to sufferers from this form of perpetual "interference factory," and I am very pleased to see that you have brought up this subject.

In our little village here there is a "rag time" supply of electricity purveyed to the consumers by means of a real

The Wireless World AND RADIO REVIEW (13th Year of Publication)

No. 337. WEDNESDAY, JANUARY 27TH, 1926. VOL. XVIII. No. 4.

Assistant Editor: F. H. HAYNES. Editor: HUGH S. POCOCK. Assistant Editor: W. JAMES.

Editorial Offices: 139-40, FLEET STREET, LONDON, E.C.4 - Telephone: City 4011 (3 lines).
Advertising and Publishing Offices: DORSET HOUSE, TUDOR STREET, LONDON, E.C.4. - Telephone: City 2847 (13 lines).
Telegrams: "Ethaworld, Fleet, London."

COVENTRY: Hertford Street. *Telegrams:* "Cyclist Coventry." *Telephone:* 10 Coventry.
BIRMINGHAM: Guildhall Buildings, Navigation Street. *Telegrams:* "Autopress, Birmingham." *Telephone:* 2970 and 2971 Midland.
MANCHESTER: 199, Deansgate. *Telegrams:* "Iliffe, Manchester." *Telephone:* 8970 and 8971 City.

Subscription Rates: Home, £1 1s. 8d.; Canada, £1 1s. 8d.; other countries abroad, £1 3s. 10d. per annum.

AN UNEXPLORED FIELD.

WHAT has become of the amateur of the "good old days," as we sometimes hear them referred to, who found all the pleasure in wireless which he desired without the aid of broadcasting?

To-day we believe that, apart from the transmitters, there are not many who listen in to Morse in preference to telephony, and yet for the inquisitive mind there is often a much greater variety and interest in identifying the source of the multitude of Morse signals which can be heard at any time of the day or night. Only recently we were talking to a reader who informed us that he derived comparatively little pleasure from listening in to broadcasting since he had taken the trouble to learn to read the Morse code, and that it was now only with difficulty that he could be persuaded to give up the set from time to time so that others could listen to broadcasting.

The Interest of Morse Reception.

Many people to-day regard Morse transmissions, and especially spark, as merely a necessary evil, disturbing from time to time, and all too frequently, the enjoyment of the broadcast transmissions. But when it is remembered that broadcasting represents only a small proportion of the total traffic of the ether available to be tapped by the listener, it is surely apparent that there is much of interest which the average listener ignores merely because he does not undertake the small initial effort required to learn the Morse code.

With the decline of interest in Morse reception another source of enjoyment has also disappeared. At one time the recording of Morse signals with various forms of recorder was a branch of wireless which was always popular. To-day, however, broadcasting seems to have eclipsed or smothered the former interests, not, we believe, because they are any less fascinating in themselves than they were, but rather because they were swept aside when the avalanche of broadcasting began, and have since been forgotten.

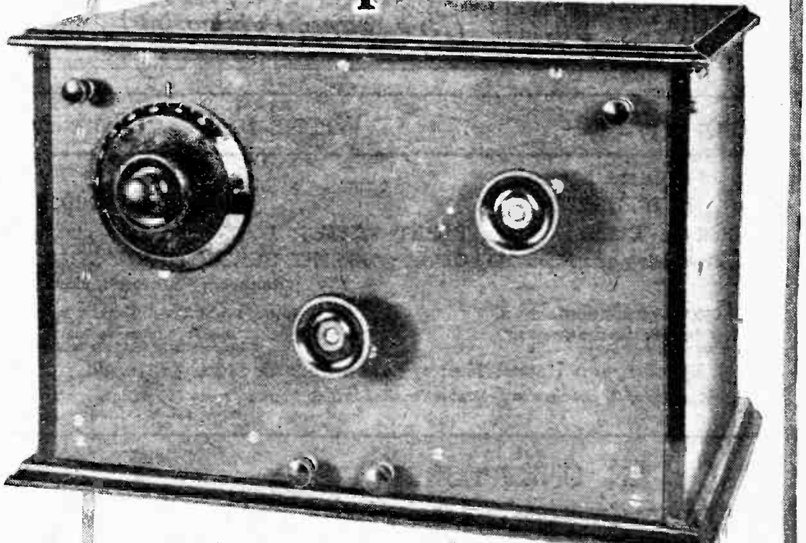
We believe that an occasional hour spent in the occupation of learning the Morse code would never be regretted, and that it would be a means of enhancing the fascination of wireless in the minds of a very large number of listeners.

CONTENTS.

EVIDENCE OF THE RADIO SOCIETY.

ON Wednesday, January 20th, evidence was submitted by the Radio Society of Great Britain before the Broadcasting Committee. The particular point which was stressed in the evidence was the need for an occasional quiet period to enable experimenters to carry on investigations or special transmissions without being swamped by the power of a local broadcasting station. We consider that such a request is very reasonable, provided that the period chosen is one least likely to restrict the interests of the general listener. It should be remembered that, because the experimenter is a minority, this is a reason for special consideration to be given to his case, especially as no previous opportunity has occurred for voicing his views.

An Easily Built Loud Speaker Set.



DETECTOR and ONE NOTE MAGNIFIER.

A Simple Receiver with Two Tuning Controls.

By A. J. EDGEWOOD.

IN the design of this two-valve loud-speaker set an endeavour has been made to incorporate, without unnecessary complication, several outstanding features in the equipment, which will in every way provide good reproduction in conjunction with a range of reception likely to meet the requirements of the home constructor. Although the combination will work efficiently with most types of valves, the best results are obtained by means of a six-volt filament heating accumulator with Marconi D.E.8 H.F. and D.E.5 valves, the object of using these valves being to obtain the maximum sensitivity from a range point of view and to provide an output capable of operating a loud-speaker without the slightest trace of harshness.

Arrangement of the Circuit.

The circuit is composed of a detector and one low-frequency magnifier, with reaction upon the aerial circuit, and tuning is performed by means of a Sterling square-law condenser of 0.0005 mfd. with a single plate control which shunts the inductance of a complete inductance and reaction unit. The inductance and reaction unit, which is a Sterling accessory, does not necessitate the usual type of coil holder with the interchanging of plug-in coils. Higher and lower wavelengths than the usual main B.B.C. band can be obtained by a novel fixing, the combined inductance and reaction units being interchangeable.

Grid condenser and leak rectification is used, but the grid leak is connected between the grid of the detector and a screw on the connection strip in order that the grid leak return may be connected by means of a flexible connection to either positive 2, 4, or 6 volts on the filament heating battery. Seeing that the action of the grid leak and condenser depends chiefly upon grid current, the adjustment of the normal potential of the grid in the manner just described enables one to get the best out of the detector. As the positive bias of the detector valve depends on the value of the grid leak and the voltage to which its return end is connected, different values should in all cases be tried if the very utmost is required from the set. The method of connecting the grid circuit is indicated in Fig. 1, which gives the theoretical connections of the receiver.

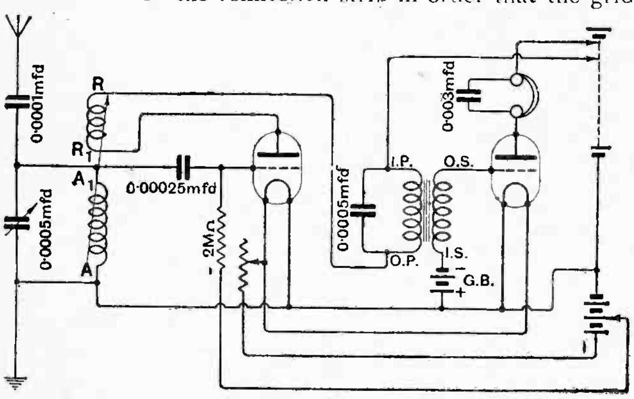


Fig. 1.—Theoretical connections of the receiver.

It will be noticed that a single filament rheostat is employed for regulating the voltage applied to both the detector and low-frequency magnifying valves.

Coupling the anode of the detector to the L.F. valve is a Marconiphone "Ideal Junior" transformer with a fixed condenser of 0.0005 mfd. connected across the primary winding. This condenser acts as a by-pass for the high-frequency currents flowing in the anode circuit of the detector and is necessary because reaction from the detector is used.

It must be observed that the transformer terminal connections should be as follows: O.P. to anode of detector through the reaction unit, I.P. to + H.T., O.S. to grid of L.F. valve, and I.S. to the negative connection of the grid bias battery.

Two H.T. battery values are used, and it is suggested that a maximum of 120 volts be employed for the L.F. valve, and about 80 volts for the detector. If a tapped H.T. battery is used the detector voltage can be varied for best results. A Marconi D.E.5 valve working with

An Easily Built Loud-Speaker Set.—

an anode voltage of 120 should have a grid bias of negative 7.5 volts, with 100 volts, negative 6 volts, and with 80 volts, negative 3 volts.

A control of volume can be obtained by varying the reaction adjustment, or an adjustable damping resistance having a maximum value of about 500,000 ohms may be shunted across the transformer secondary terminals. The latter component can be mounted on the panel if found necessary, but one was not included in the receiver illustrated, as it was not found essential.

It will be seen from the diagram that a fixed condenser of 0.003 mfd. is connected across the loud-speaker terminals of the receiver; this is not an essential component, and it will no doubt be found that with some loud-speakers better results will be obtained without this condenser, or perhaps with a condenser of different value.

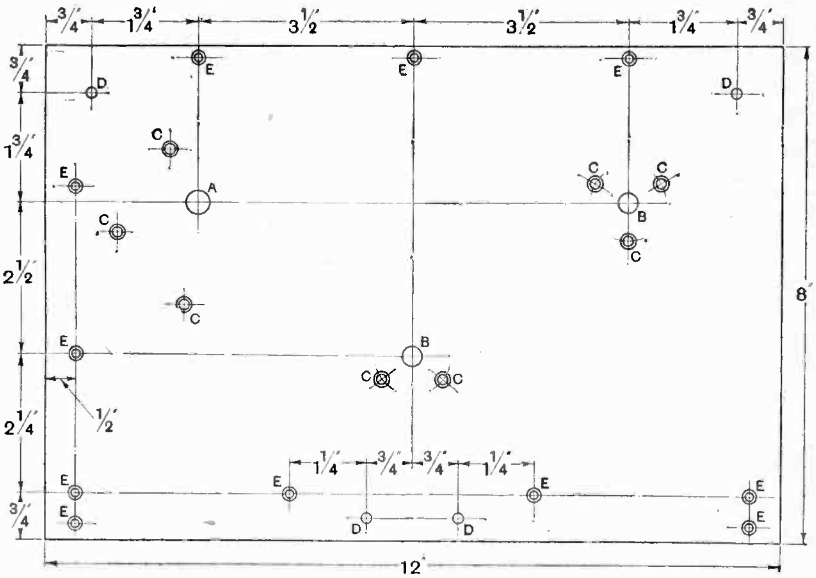


Fig. 2.—Details of the front ebonite panel. A, 3/8in.; B, 5/16in.; C, 5/32in. and countersunk for No. 4 B.A. screws; D, 5/32in.; E, 1/8in. and countersunk for No. 4 wood screws.

Construction of the Receiver.

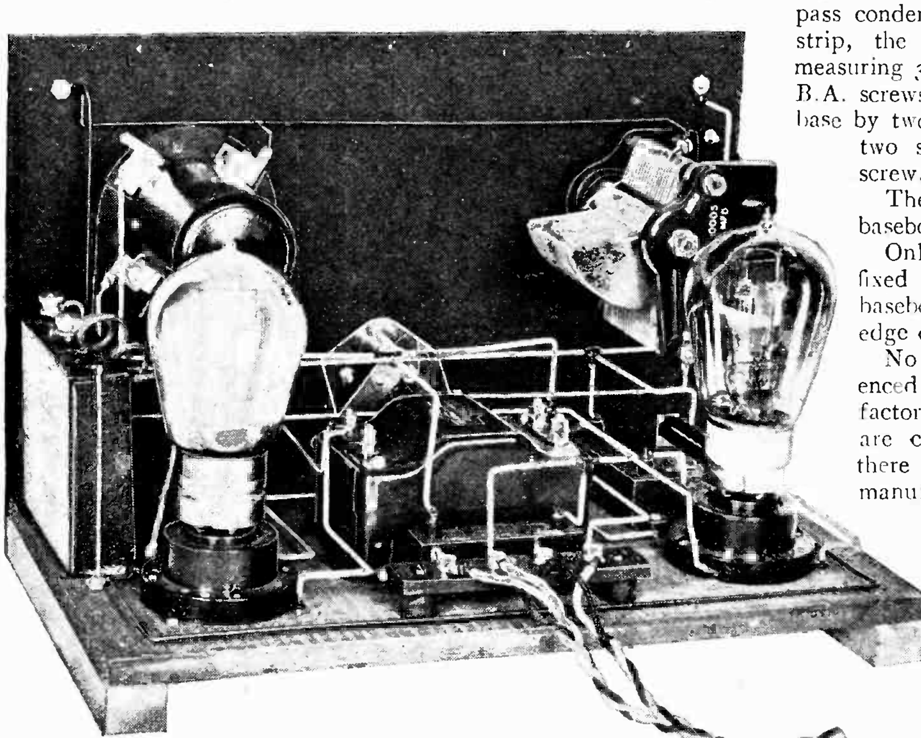
The receiver is an easy one to build. Mounted on the ebonite front panel is the tuning condenser, the filament rheostat, inductance-reaction unit, aerial, earth, and loud-speaker terminals, and on the back of the panel, just below the aerial terminal, the fixed aerial condenser of 0.0001 mfd. These parts are arranged in the positions shown in Fig. 2, which gives all the necessary details as to the size and position of the fixing and clearing holes.

Three-quarters of an inch from the bottom edge of the panel is screwed a baseboard of wood measuring 12in. × $7\frac{1}{4}$in. × $\frac{3}{8}$in., which is provided with two battens, $7\frac{1}{4}$in × $\frac{3}{4}$in. × $\frac{5}{8}$in., as shown. On the upper surface of this baseboard is mounted the valve holders, grid condenser and leak, intervalve transformer, transformer by-pass condenser, grid battery, and connection strip, the latter being a piece of ebonite measuring $3\frac{5}{8}$in. × $\frac{3}{4}$in. × $\frac{5}{16}$in., with five No. 2 B.A. screws. This strip is raised above the base by two pieces of ebonite $\frac{3}{8}$in. thick, and two soldering tags are fixed by each screw.

The arrangement of the parts on the baseboard is illustrated in Fig. 3.

Only one component, the 0.003 mfd. fixed condenser, is mounted below the baseboard, and this is screwed to the edge of the right-hand batten.

No difficulty at all should be experienced in mounting the parts in a satisfactory manner, provided the drawings are carefully followed, for, although there is ample room, and parts of other manufacture may be substituted in cases where it is thought absolutely necessary to do so, the set is so arranged that the wiring can easily be done. It should be noted that if for any reason a different make of transformer is included in the set, it ought to be of a type which will work well with the D.E.8 H.F. valve, which it is recommended should be used for the detector.



Appearance of the set without the cabinet. The valve on the right hand side is the detector, and that on the left the L.F. magnifier. It should be noted that the grid bias connection as described in the text was not fitted when this illustration was taken.

LIST OF COMPONENTS.

1 Ebonite panel, 12in. × 8in. × 5/16in.
1 Piece of ebonite, 3⅝in. × ¾in. × 5/16in.
1 Baseboard, 12in. × 7¼in. × ⅜in., with battens.
1 Fixed condenser, 0·0001 mfd. (Sterling Telephone and Electric Co., Ltd.).
1 Fixed condenser, 0·0003 mfd. (Sterling Telephone and Electric Co., Ltd.).
1 Fixed condenser, 0·003 mfd. (Sterling Telephone and Electric Co., Ltd.).
1 L.F. transformer, Junior Ideal (Marconiphone Co., Ltd.).
1 Anode reaction unit and adaptor, type D (Sterling Telephone and Electric Co., Ltd.).
1 Variable condenser with vernier, 0·0005 mfd. (Sterling Telephone and Electric Co., Ltd.).
2 Non Pong valve holders (Sterling Telephone and Electric Co., Ltd.).
1 2-megohm grid leak with holder (Sterling Telephone and Electric Co., Ltd.).
1 Rheostat (Sterling Telephone and Electric Co., Ltd.).
1 6-volt battery, G.E.C.
Glazite wire (London Electric Wire Co., Ltd.).
1 Cabinet (Compton Electrical and Radio Trades Supplies).
4 Terminals.
1 D.E.8 H.F. valve and 1 D.E.8 L.F. valve (Marconi).

Wiring Connections.

The wiring connections are given in Fig. 4, and in following them out it will be as well to make frequent reference to the illustrations, for a few of the wires are passed through holes in the baseboard on their way to the connection strip or other component. For instance, the wire connecting the return end of the grid leak passes through a hole in the baseboard by the side of the grid leak and runs along the underside of the base to a second hole placed just below the soldering tag on the connection strip, to which it is joined. The two wires for the loud-speaker are also run below the baseboard, as well as the two wires connecting the loud-speaker condenser. Wiring may be carried out with bare No. 18 tinned copper wire or with Glazite wire, all connections being soldered.

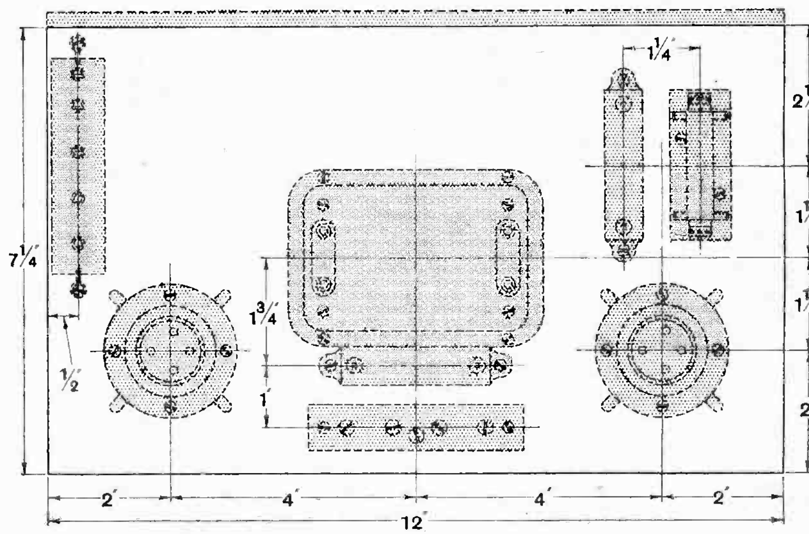


Fig. 3.—Arrangement of parts on the base, with details of their positions.

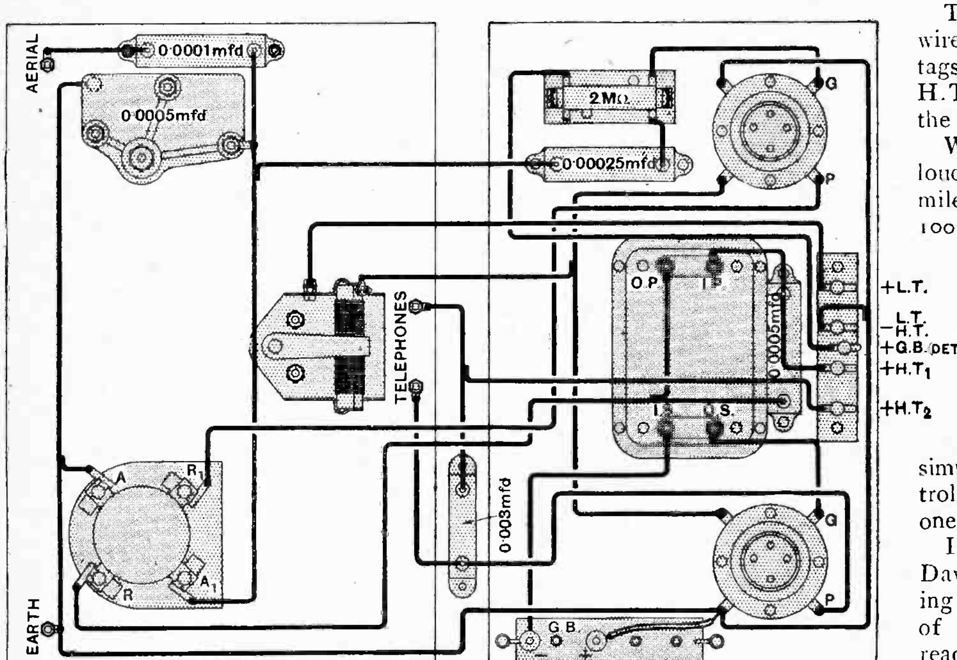


Fig. 4.—Wiring diagram. Some of the connecting wires are run beneath the baseboard, as explained in the text.

To finish off the set, flexible wires should be soldered to the tags on the connection strip for the H.T. and L.T. batteries, and for the grid bias.

With a good outdoor aerial a loud-speaker range of up to 40 miles from the main stations and 100 miles from Daventry is normally possible, and these distances will no doubt be exceeded in the majority of cases. The selectivity will, of course, not be anything out of the ordinary, as single circuit tuning is employed, but the advantages of a simple set having only two controls, one for aerial tuning and one for reaction, are many.

If the user proposes to receive Daventry as well as stations working on the main B.B.C. band, two of the combined inductance-reaction units will be required.

Finally, care should be taken to avoid continuous self-oscillation.

THE HARTLEY CIRCUIT.

Application to Short-Wave Reception and Tuned Anode H.F. Couplings.

By F. M. COLEBROOK, B.Sc., D.I.C., A.C.G.I.

THE fundamental type of oscillating circuit associated with the name of Hartley is illustrated in Fig. 1. A very good description of the circuit and its characteristics will be found in Van Der Bijl's book, "Thermionic Vacuum Tube" (McGraw-Hill). In particular it is there pointed out that, except in the case of valves of low amplification factor, the centre of the inductance is the most suitable tapping point for the connection to the filament. It will generally be found that this statement is confirmed by practice, though the condition is not very critical.

One minor disadvantage of the circuit as illustrated is the position of the high-tension battery. This not only prevents the possibility of having a common connection between the negative L.T. and H.T., which is usually a convenience in multi-valve arrangements, but it loads one end of the oscillating circuit with the capacity of the high-tension battery and thus raises the lower wavelength limit of the coil.

These difficulties can be obviated in most cases by adopting the alternative type of connection shown in Fig. 2. The suggestion that this shunt type of connection is essentially identical with the series connection shown in Fig. 1 is confirmed by the fact that if the coupling condenser C_1 in Fig. 2 is of sufficient magnitude to have a very small reactance at the frequency of operation, and if the high-frequency choke has an impedance high compared with the internal impedance of the valve, then the equations relating to the high-frequency components of the currents and potential differences in the two cases are identical.

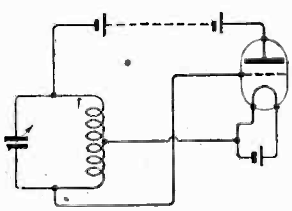


Fig. 1.—The Hartley circuit in its simplest form.

Reaction Control.

The fact that in either case the oscillatory circuit will be maintained in a state of oscillation shows that the valve can be regarded as an agent for the transfer of power into the oscillatory circuit in sufficient amount to cancel the dissipation of power on account of its resistance. In other words, the effect of the valve is to reduce to zero the effective resistance of the oscillatory circuit. It is therefore probable that by loosening the coupling between the valve and the oscillatory circuit a condition could be reached such that the power supplied by the valve is no longer sufficient to maintain the oscillations. Thus if the capacity C_1 is variable and is gradually decreased, the oscillations will decrease in amplitude and eventually stop. In this last condition, however, the effective resistance of the circuit from the point of view of a high-frequency E.M.F. induced in it will be considerably less than its actual resistance. Or, considering the process in the reverse way, an E.M.F. induced in the oscillatory circuit will give rise to a current in the circuit which will increase as the coupling condenser C_1 is increased, owing to the negative resistance or retroactive effect of the valve, until a point is reached when the effective resistance of the circuit has been reduced to zero, at which point continuous oscillations will occur. Thus the variable condenser is a means of controlling the reaction effect of the valve and is analogous to the control of the variable coupling of the more usual type of reaction coil.

Frame Aerial Reception.

The use of condenser reaction as described above is, of course, very generally known, and is applied to a great variety of circuits. The object of the above introduction is simply to delineate the essential character of the effect and to show its connection with the Hartley type of oscillating circuit. The object of the remainder of this article is to describe some applications of the Hartley circuit to reception. One of these, relating to high-frequency amplification, has not been described before as far as the writer is aware.

The first application is to a single-valve frame aerial circuit. The writer believes that this has already been described in some form in *The Wireless World*, so very little will be said about it now. The arrangement is shown in Fig. 3, and the chief points about it are as follows: The resistance of the frame aerial appears to be a very secondary consideration. The writer has introduced as much as 100 ohms in series with the coil without producing any very serious reduction in signal strength. The E.M.F. induced in the coil is proportional to the area-turns, and this product should therefore be made as large as possible. The limits in this direction are the inductance and self-capacity of the coil, *i.e.*, its natural wavelength. Both the inductance and the self-capacity can be reduced by having widely spaced turns, preferably of fairly thin wire. For the short-wave broadcast range a coil frame about 18in. square is a convenient size. The tuning condenser should be not more than about 250 micro-microfarads, and preferably less than 100. A vernier extension drive, or failing this, effective shielding of the condenser, is a great advantage. The reaction condenser can be conveniently made in the form of a single movable plate of the usual size and a single fixed plate. It is desirable that its minimum capacity should be as small as possible. A threaded spindle has the advantage of permitting a variation of the range of the condenser of which the maximum value need not be more than about 50 micro-microfarads.

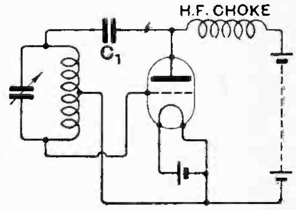


Fig. 2.—Circuit arrangement permitting a common negative connection between H.T. and L.T. batteries.

The Hartley Circuit.—

A choke is shown in the anode circuit, but this will not always be necessary. The impedance of the telephones appears to be quite sufficient in most cases. If a choke is used, it should preferably be of the disc type to be described later.

It is hardly necessary to point out that tuning is facilitated by oscillating the frame and then picking up

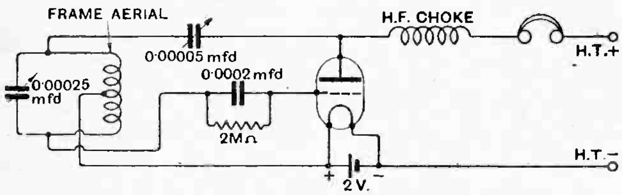


Fig. 3.—Practical frame aerial receiver employing the Hartley circuit.

the carrier wave of the station to be received. It will be found that the reaction condenser has a slight effect on the tuning, but never so much as to lose the signal, and the adjustment of the set is very simple. It will give quite comfortable telephone intensity up to distances of about 15 miles from a main station, and if desired low-frequency amplification can be added in the ordinary way. It might be mentioned that the same type of circuit can be used for the longer wave stations, such as Daventry.

Reception on Open Aerial.

Another application of the Hartley circuit is very similar in principle to the frame aerial circuit above, being, in fact, the adaptation of it to ordinary aerial reception. Any of the arrangements shown in Figs. 4, 5, or 6 can be used, the first two having the advantage of simplicity of operation combined with very good

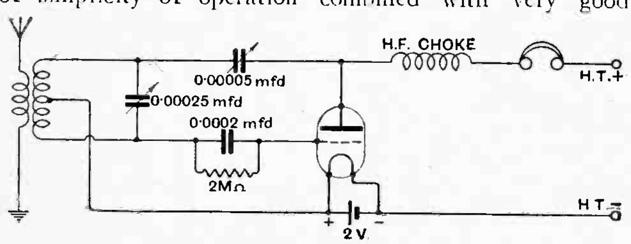


Fig. 4.—Aperiodic coupling to open aerial.

selectivity. It will be recognised that the arrangement of the secondary circuit is very similar to the various forms of the Reinartz circuit which have proved so popular.

The principal feature of the arrangement is the centre tapped coil constituting the secondary. These are not obtainable commercially in any very convenient form, as far as the writer is aware,[1] but can be very easily constructed. Alternatively, two of the ordinary plug-in coils can be mounted side by side and connected in series. Perhaps the simplest form of construction is to mount two basket coils side by side, the terminals and centre of the winding being carried down to three valve pins about an inch apart from each other. For the arrangement shown in Fig. 4 the coupling coil can consist of a similar basket having only a few turns, say, ten to fifteen.

The circuit of Fig. 5 has the advantage of needing only the one centre-tapped coil. The small series condenser, the chief requirement of which is that it should have a very small minimum capacity (not greater than, say, 15 micro-microfarads), is to be regarded not so much as a part of the tuning system as a variable coupling between the aerial circuit and the secondary. The smaller this condenser the smaller will be the effective signal E.M.F. operating in the secondary, but the amount of the aerial resistance introduced into the secondary will be correspondingly reduced, making it easier to obtain selectivity.

Application to H.F. Amplifiers.

Whichever of these alternative types of aerial coupling is used, the complete circuit will be found very easy to manipulate, the condenser reaction control being exceedingly smooth. The circuit should not be allowed to oscillate, for even if the aerial coupling is very loose there would be appreciable radiation.

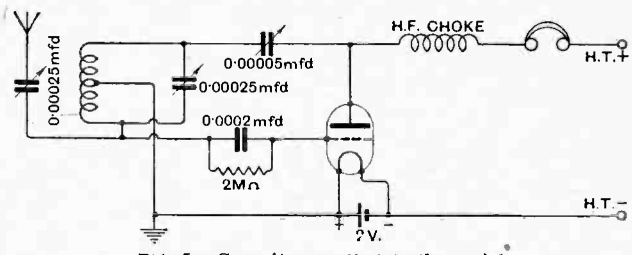


Fig. 5.—Capacity coupling to the aerial.

The addition of low-frequency amplification if desired would follow the usual lines and need not be described.

Finally, it will now be shown how the same general principle can be applied with great effect to tuned anode high-frequency amplification.

If either of the various input arrangements described above is followed directly by a tuned anode circuit or tuned transformer amplifying valve, the system will be exceedingly unstable, and the writer has not been able to find any really satisfactory method of stabilising it without sacrificing the advantage of fine control of input circuit reaction or reducing very considerably the effectiveness of the high-frequency stage. None of the usual neutrodyning systems seemed quite suitable for association with this rather sensitive input circuit. It was eventually found, however, that complete stability without apparent loss of effectiveness could be obtained by separating two tuned circuits by means of a single stage

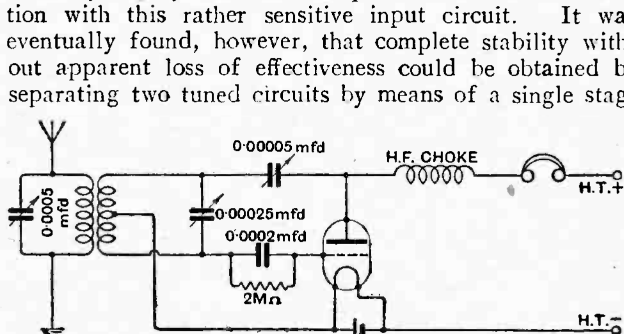


Fig. 6.—Loose-coupled tuned aerial circuit for maximum selectivity.

[1] Messrs. L. McMichael, Ltd., have recently produced an inductance with centre tap known as the "Dimic" coil.

The Hartley Circuit.—
of aperiodic or choke-coupled amplification. This feature of the circuit, which has formed the subject of a recent patent, is illustrated in Fig. 7. For its success however, it is essential that the choke coil used shall have a really high impedance, at least 50,000 ohms, at the frequencies of operation. An example of such a choke coil will be found in an article by Mr. P. K. Turner in *Experimental Wireless* for April, 1925. The chief requirement of any such choke is that its inductance shall be really high, *i.e.*, 500 millihenries or so, and, equally important, that its self-capacity shall be only a few micro-microfarads.

Practical Tuned Anode Circuits.

The circuit connected as in Fig. 7 is more than stable, so that appreciable condenser reaction can be used to increase both the input signal strength and selectivity. Even with a retroactive input circuit, however, the tuned anode stage remains perfectly stable, and both the effectiveness and the selectivity of the latter can be greatly increased by treating it in exactly the same way as the input circuit, *i.e.*, by connecting it in the shunt Hartley circuit manner with a variable condenser coupling to the anode of the next valve. The arrangement will now be as shown in Fig. 8. The same type of centre-tapped coil as used in the input circuit can be employed for the tuned anode stage, but it will be found that the reaction condenser will need a slightly larger maximum value than that used in the input circuit, say, about 100 micro-microfarads. The use of this reaction condenser gives a remarkable increase in the effectiveness of the tuned anode stage, increasing both the signal strength and, apparently, its selectivity. Moreover, it appears in practice, and is theoretically probable, that this increase

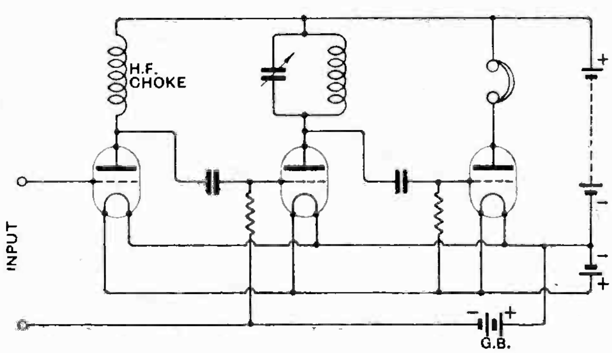


Fig. 7.—Aperiodic coupling introduced to stabilise H.F. amplifier.

in signal strength does not involve the same degree of reaction distortion as would be associated with a similar degree of reaction in the input circuit.

The operation of this three stage arrangement is naturally not quite so simple as that of any of those described above, but this characteristic is inherent in any circuit involving more than one tuned circuit. However, once the tuned anode circuit is calibrated approximately in wavelength the loss of simplicity is not appreciable. Some form of interrupted wavemeter oscillator is, of course, a very useful accessory for the operation of such circuits, but is not really necessary.

The manipulation of the set is fairly obvious, and does not require any full description. In general it is better to search with both reaction controls some way off instability. The station having been located, the tuned

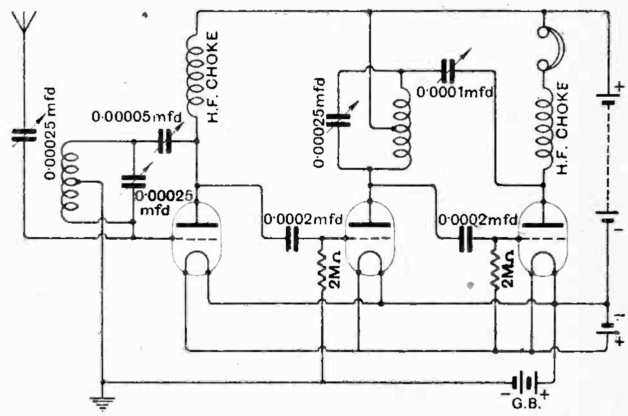


Fig. 8.—Practical H.F. amplifier, with Hartley circuit applied to the tuned anode coupling.

anode reaction can then be applied up to the limit at which distortion begins to be noticeable, after which a still further increase in signal strength can be obtained by using the input circuit reaction without appreciably affecting the quality.

In putting together any set embodying this principle it is well to adopt the usual precautions to avoid coupling between the coils of successive stages, and if, in addition, both the input circuits and tuned anode circuit coils can be made either toroidal or otherwise astatic with respect to external fields, the local interference due to direct pick-up in these components will be minimised.

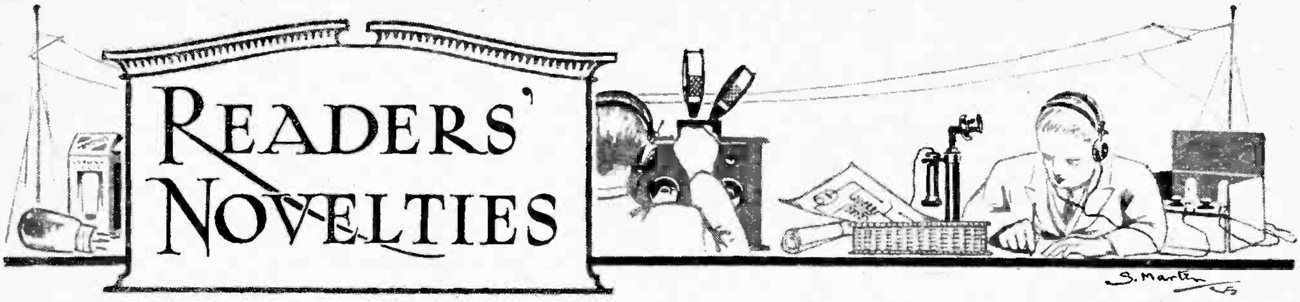
Results.

The writer has not spent much time in "touring Europe" with this receiving arrangement, but as an example of its sensitiveness it may be mentioned that Münster was received direct at Teddington on the same evening that the B.B.C. carried out its first international receiving experiment (but before they had started doing so) at very comfortable and clear telephone intensity without any low-frequency amplification at all, and without interference from Newcastle, which came in at about the same intensity at nominally six metres away. Speech could have been followed quite easily by anyone with an adequate knowledge of German.

WHO OWNS THE ETHER?

According to a Washington message, Senator Howell, of Nebraska, has introduced a Bill in the Upper House "re-affirming the use of the ether for radio communication or otherwise to be the inalienable possession of the people of the United States and their Government, and for other purposes."

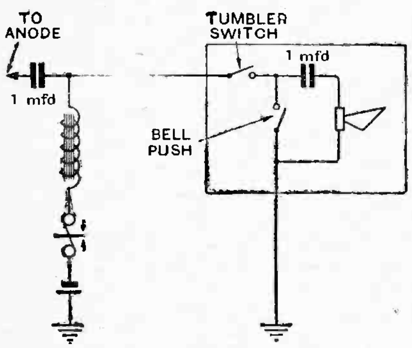
This bold, but vague, Bill has been referred to the Senate Committee on Inter-State Commerce.



A Section Devoted to New Ideas and Practical Devices.

REMOTE CONTROL.

The system of remote filament control illustrated in the diagram operates through the medium of a single line between the receiver and loud-speaker. A low-frequency choke coil is connected in the anode circuit and



Single line remote control system.

the variations of voltage set up at the anode of the valve are transferred to the loud-speaker lead through the medium of a 1 mfd. condenser. To the line side of this condenser is connected a local circuit joined to earth consisting of a L.F. choke of high inductance (an intervalve transformer with windings connected in series), a Weston or other sensitive relay, and a single dry cell. The loud-speaker unit includes a bell push, a tumbler switch, and an additional 1 mfd. feed condenser. An earth connection is provided so that when the bell push is pressed with the tumbler switch closed, a small current flows through the relay windings. The filament current is controlled through a second relay, which opens and closes the filament circuit alternately.

The tumbler switch is provided so that the loud-speaker may be switched off without disturbing other loud-speakers working off the same circuit. —V. H.

THE MAP SUPPLEMENT.

The utility of the map supplement of European broadcasting stations presented with the issue of this journal for December 9th, 1925, may be considerably extended in the following manner :—

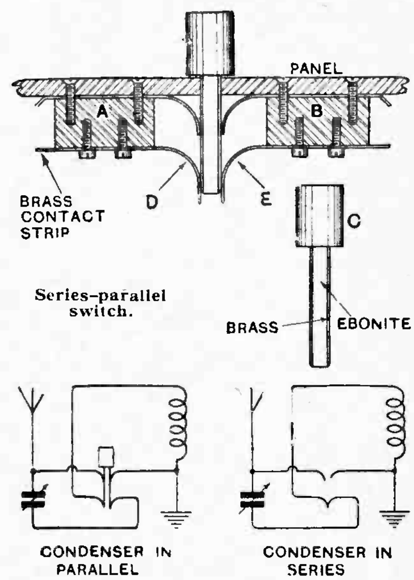
The map is pasted on a sheet of thick cardboard, and a narrow strip of thick cartridge paper or Bristol board is pivoted by means of a drawing pin to the point on the map occupied by the reader's home town. One edge of the strip is then graduated in miles by means of the scale at the foot of the map.

Then by rotating the strip the distance of any given station can be immediately read off. In order to avoid inaccuracies in measuring short distances it is advisable to pivot the strip as near as possible to the graduated edge.—A. C. B.

○○○○

SERIES-PARALLEL SWITCH.

A neat series-parallel switch for mounting below the receiver panel is shown in the diagram. Four spring strip contacts are screwed to the panel on both sides of insulating blocks A and B. The lower contacts D and E are adjusted, so that they join together when the shorting plug is withdrawn. The shorting plug itself is made of insulating material, the lower part being of square section. On opposite sides of the plug, brass contacts are fixed with short countersunk screws. The contacts must be insulated from each other, and the



Series-parallel switch.

securing screws must therefore be inserted alternately. The two circuit diagrams at the bottom of the figure show that the tuning condenser will be connected in parallel with the plug inserted and in series with the plug withdrawn.—B. V.

○○○○

WIRING HINT.

In wiring up receiving sets the exact length of wire required for connections of awkward shape may be estimated by using a length of lead fuse wire. The lead wire can be easily straightened if a mistake is made, and when the required shape has been found the wire can be pulled straight and a corresponding length of tinned copper connecting wire can be cut off and bent to the same shape, using the kinks in the lead wire to indicate the positions of the bends.—L. T. H.

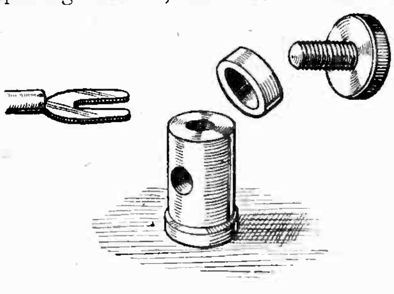
VALVES FOR IDEAS.

Readers are invited to submit brief details, with rough sketches, where necessary, of devices of experimental interest for inclusion in this section. A receiving valve will be despatched to every reader whose idea is accepted for publication.

Letters should be addressed to the Editor, "Wireless World and Radio Review," 139, Fleet Street, London, E.C.4, and marked "Ideas."

TELEPHONE TERMINALS.

Telephone leads provided with spade terminals can be fitted in ordinary telephone terminals by removing the screw and inserting a small brass spacing washer, such as is used in



Fitting spade tags to telephone type terminals.

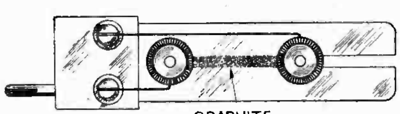
the construction of air-dielectric variable condensers. The spade is inserted between the top of the terminal pillar and the under side of the spacing washer. E. S.

oooo

RESISTANCE COUPLING.

In receivers incorporating H.F. valves with tuned anode coupling, it is quite a simple matter to try resistance-capacity coupling, say, on the Daventry wavelength.

Experimental resistances may be made by marking a graphite line between two terminals fitted on an



Experimental plug-in anode resistance.

ebonite basket coil holder. These will be found quite satisfactory for test purposes, since the anode current for H.F. amplification need not exceed 0.5 mA.

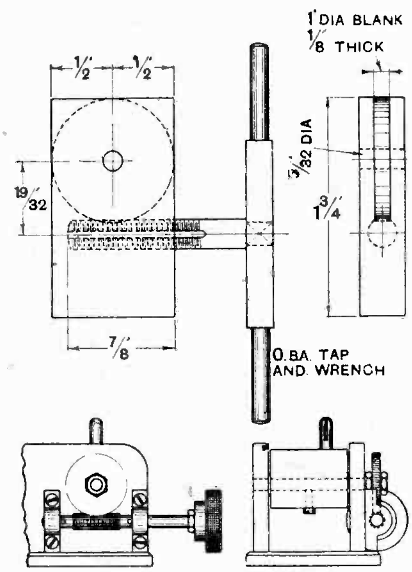
Before inserting the terminals, the ebonite in the vicinity of the holes should be well rubbed with graphite and tinfoil washers should be used to secure a large area of contact with the graphite film. P. A.

oooo

FORMING GEAR WHEELS.

Amateurs who take a pride in constructing their own components can cut their own worm wheels for geared vernier adjustments by means of the simple jig shown in plan and side elevation in the upper part of the diagram.

The jig should be cut from solid metal, for preference, but may be built up if there is any difficulty in obtaining metal ⅞in. in thickness. A clearance hole for a No. 0 B.A. tap is drilled laterally in one side of the block, the size of drill being carefully chosen to avoid side play when the tap is inserted. The hole is not drilled right through in order to provide a stop to take the thrust of the tap when the gear is being cut. A



Jig for cutting worm gear wheels and (below) method of fitting vernier movement to variable coil holder.

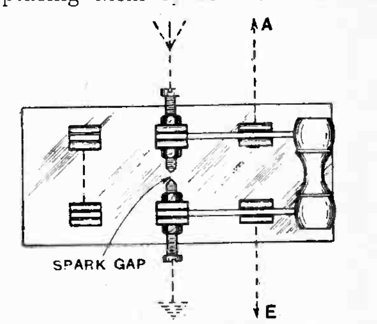
⅛in. slot is then cut for the wheel blank (1in. diameter) and a hole drilled for a bearing pin $\frac{19}{32}$in. from the centre line of the tap. It is advisable to use a bolt and nut for the pivot in order to pull the inside faces of the jig into close contact with the blank. It is then only necessary to insert a plug tap and turn it continuously in a clockwise direction until the wheel is formed.

The sketches in the lower part of the diagram show the finished gear wheel fitted to a two-coil holder, the worm wheel consisting of a length of No. 0 B.A. screwed rod with the thread turned off at each end to fit in brass bearings screwed to the side of the coil holder. J. C.

oooo

COMBINED EARTHING SWITCH AND SAFETY GAP.

A safety gap can be quite easily fitted to the usual D.P.D.T. earthing switch by abstracting the rivets pivoting the two knife contacts and replacing them by screws with lock-



Safety gap incorporated in D.P.D.T. earthing switch.

nuts fitted to each side of the bearing clips. The opposing ends of the screws are pointed to facilitate the passage of a spark should the aerial become charged during a thunderstorm.

The gap should be adjusted to about one millimetre. R. H.

oooo

CONDENSER DIALS.

Graduated scales for variable condensers, filament resistances, etc., fitted with knobs and pointers can be quite easily constructed in the following manner:—

Using a celluloid drawing protractor as a negative, prints are made on blue print or daylight photographic printing paper. In the case of the photographic paper it is advisable to burn the print slightly as this gives a more definite image. J. H.

HIDDEN ADVERTISEMENTS COMPETITION.

Below are given the results of "The Wireless World" Hidden Advertisements Competition for January 13th, 1926. It is regretted that a small error occurred in regard to the first example, which was taken from the advertisement of Messrs. H. Clarke & Co., on page 7. Owing to a printing slip, the comma after the bracket was omitted. The majority of competitors, however, were successful in identifying the advertisement.

The correct solution is as follows:

Clue No.	Name of Advertiser.	Page
1	H. Clarke & Co.	7
2	Dubilier Condenser Co. (1925) Ltd.	15
3	Pugh's Wireless	18
4	Paragon Rubber Mfg. Co., Ltd.	18
5	Ferranti, Ltd.	iv
6	Maywood Eng. & Elec. Mfg. Co., Ltd.	23

The following were the prizewinners:

Mrs. B. Judges, St. Albans	£5
Robert Anderson, Hebburn-on-Tyne	£2
D. J. F. Jackson, Keynsham, Somerset	£1

Ten shillings each to the following four:

David Duncan, Dundee.
C. G. Daft, Barnsley.
Will Smalley, London, N.16.
W. Whitmore, Settle, Yorks.

WIRELESS CIRCUITS

in Theory and Practice.

2.—Electromagnetic Effects and Self-Inductance.

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

WHENEVER a current flows through a circuit a magnetic field is set up in the neighbourhood of the conductors. Even when the current flows through a straight conductor, lines of magnetic force are produced in circles around the conductor, and it can easily be proved that the strength of the magnetic field at any point outside the conductor is directly proportional to the current in the conductor and inversely proportional to the distance from the conductor.

The strength or intensity of a magnetic field is measured in *lines per square centimetre*, and it is necessary at this point to consider exactly what is meant by one line of force. It is based on the force in dynes exerted between two concentrated magnetic poles, viz., unit pole is that which would exert a force of one dyne on an equal pole when the distance between them is one centimetre. Now unit field strength (one line per square centimetre) is that which would cause a force of one dyne to be exerted on a unit magnetic pole situated in the field.

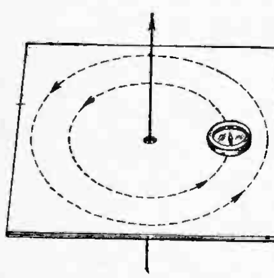


Fig. 1.—Magnetic field surrounding a straight conductor.

The magnetic effect of a straight conductor is not very powerful, and when it is desired to make use of the magnetic effects of a current, it is usual to wind the conductors in the form of a coil with a considerable number of turns. The magnetic effects are then concentrated into a small space through the centre of the coil, and a comparatively powerful field is produced. A coil of wire used in this way is sometimes called a solenoid, and in wireless work an *inductance coil* or *tuning coil*. We are directly concerned here with the properties of such a coil.

Electromagnetic Induction.

It can be shown experimentally that whenever the lines of magnetic force threading through the turns or convolutions of a circuit are changing in number, an electromotive force is *induced* in each of those turns, and the magnitude of this induced electromotive force is proportional to the rate at which the lines are changing. This is known as Faraday's Law of Induction.

For the present we shall assume that there is no iron or other magnetic material present in the magnetic field of the coil, so that the field strength produced is directly proportional to the current through the coil. Suppose that a total magnetic flux of ϕ lines threads through the whole of the turns N of the coil (see Fig. 2) when a current of I amperes flows through it; then the product ϕN is called the total number of ***line-linkages*** or ***flux-turns***. If some of the lines of force are not linked with all of the turns, the effective number of line-linkages will be less than ϕN.

The magnitude of the electromotive force induced in the coil when the flux is changing is one volt when the line-linkages are changing at the rate of 10^8, or one hundred million, per second,

i.e., induced E.M.F., in volts

$$= \frac{\text{change of line-linkages per sec.}}{10^8}$$

$$= \frac{N \times \text{change of } \phi \text{ per sec.}}{10^8}$$

Thus, if the flux changes from ϕ_1 to ϕ_2 in t seconds, the average rate of change will be $\frac{(\phi_2 - \phi_1)}{t}$ lines per second, and, therefore, the average induced E.M.F. during this time will be

$$\frac{N(\phi_2 - \phi_1)}{t \times 10^8} \text{ volts} \quad \ldots \quad (1)$$

It must be clearly understood that a magnetic field linked with a coil does not induce an electromotive force in that coil unless the strength of the field is varying. For instance, if a galvanometer is connected between the ends of a coil, as shown in Fig. 3, and a permanent magnet of the bar type is introduced into the end of the coil, it will be found that the galvanometer shows a deflection only when the magnet is *moving* into or out of the coil.

Self-Inductance.

Referring again to the coil of Fig. 2, where the field linked with the coil is produced by the current through the coil, we see that the flux or number of lines of force is directly proportional to the current, *i.e.*, $\frac{\phi}{I}$ = a constant, and therefore also $\frac{\phi N}{I}$ = a constant,

or $\phi N = I \times$ a constant.

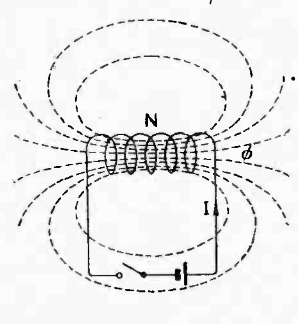


Fig 2.—Magnetic field surrounding a cylindrical coil.

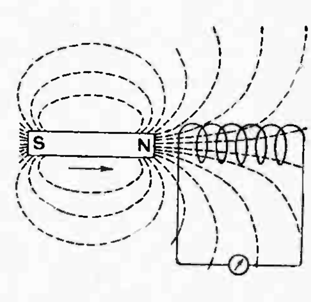


Fig. 3.—E.M.F. induced in a coil by moving magnetic lines of force.

Wireless Circuits in Theory and Practice.—

From this it follows that, whenever the current is changing in value, the line-linkages will be changing also, and hence we see by Faraday's Law that an electromotive force will be induced in the circuit when the current is varying, and that this E.M.F. will be proportional in magnitude to the rate at which the current is changing. This property of the electric circuit is called its *self-inductance*, and hence self-inductance may be defined as that property of an electric circuit in virtue of which an electromotive force is induced in it whenever the current is changing. From the foregoing it follows that in any circuit where a magnetic field is produced by a current through the circuit, inductance is present, and, conversely, a magnetic field is always produced when a current is passed through a circuit possessing self-inductance.

Practical Units of Inductance.

The practical unit of inductance is called the *henry*, and a circuit is said to have a self-inductance of one henry if 10^8 line-linkages are produced when a current of one ampere flows through the circuit. Thus in a coil or circuit where a current of I amperes produces a flux of ϕ lines linked with N turns, the inductance will be

$$L = \frac{\phi N}{I} \times 10^{-8} \text{ henries} \quad \ldots \quad (2)$$

This is a large unit, and the self-inductance of tuning coils, etc., is frequently expressed in *millihenries* (thousandths of a henry) or *microhenries* (millionths of a henry), and sometimes in absolute electromagnetic units or *centimetres*. A circuit has a self-inductance of one absolute unit if one line-linkage is produced when one absolute unit of current (equal to 10 amperes) flows through the circuit. The *dimensions* of inductance in terms of the fundamental units of length (L), mass (M), and time (T), work out to length alone, so that the symbol L is used to denote self-inductance and the absolute unit of inductance is the centimetre. We see then that the centimetre of inductance is 10^9 of a henry or one henry equals a thousand million centimetres, or one microhenry = 1,000 cms. The self-inductance (L) of a circuit in henries is called the *coefficient of self-induction* of the circuit.

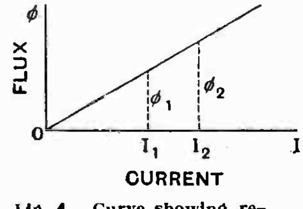


Fig. 4.—Curve showing relation between current and magnetic flux when no iron is present.

From equation (2) we have line-linkages $\phi N = LI \times 10^8$. Suppose, now, that the current is changing at a steady rate and increases from I_1 to I_2 in t seconds, and let the magnetic flux increase from ϕ_1 to ϕ_2 in the same time; then the rate of change of line-linkages during this time will be

$$\frac{\phi_2 N - \phi_1 N}{t} = \frac{(LI_2 \times 10^8) - (LI_1 \times 10^8)}{t}$$

or

$$\frac{N(\phi_2 - \phi_1)}{t} = \frac{L(I_2 - L_1) \times 10^8}{t}$$

Now by equation (1) above we see that the induced E.M.F. in volts is

$$\frac{N(\phi_2 - \phi_1)}{t \times 10^8} = \frac{L(I_2 - I_1) \times 10^8}{t \times 10^8}$$

$$= L\frac{(I_2 - I_1)}{t} \text{ volts}$$

$$= L \times (\text{rate of change of current}) \quad \ldots \quad (3).$$

Thus the self-induced voltage at any instant is given by the product of the self-inductance in henries and the rate of change of current in amperes per second. This is a very important relationship, and will be employed to a considerable extent as we proceed, especially in connection with alternating currents. We are now in a position to give another and perhaps a better definition of self-inductance; namely a circuit is said to have a self-inductance of one henry if one volt is induced in it when the current is changing at the rate of one ampere per second. It should be noted that there is no E.M.F induced in the circuit when the current has a steady value.

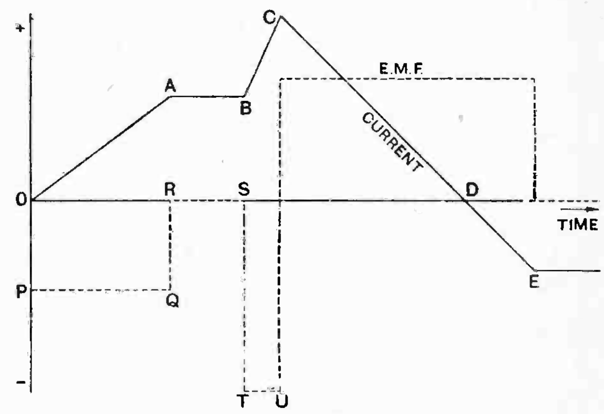


Fig. 5.—Diagram showing relation between rate of change of current and the E.M.F. induced in an inductive circuit.

Lenz's Law.

Lenz's law states that the E.M.F. of self-induction always acts in such a direction as to oppose the changing of the current. Thus if the current is changing from a negative to a more positive value, or increasing from zero to a positive value, the induced E.M.F. will be negative. In general, the induced voltage acts in the opposite direction to the E.M.F. which is causing the change of current. The accompanying diagram of Fig. 5 should make this clear. The full line represents a varying current, and the dotted line the induced E.M.F. When the current is increasing from zero at a steady rate, represented by OA on the curve, the induced E.M.F. is negative and has a steady value OP. From A to B, when the current is constant, there is no induced voltage. From B to C the slope is steeper than from O to A, and therefore the rate of change of current is greater, and the induced E.M.F., still negative, is higher than before. At C the current suddenly begins to decrease, with the result that the induced E.M.F. is now positive, acting so as to oppose the decrease of current. Even after the current passes through D and becomes negative, the induced

Wireless Circuits in Theory and Practice.—

E.M.F. remains the same, since it is dependent on the rate of change of current only, and not on the direction of the current. Because the induced E.M.F. always opposes any change in the current, it is usually written

$$e = -L \times (\text{rate of change of current}) \quad \ldots\ldots\ldots\ldots \quad (4).$$

The part played by inductance in an electric circuit is very similar to the part played by inertia or mass in mechanics, and for this reason self-inductance is often referred to as "electrical inertia."

Energy Stored in a Magnetic Field.

Suppose that we have a coil of inductance L henries and that we increase the current at a steady rate from zero to I amps in t seconds. The rate of change of current will be I/t amperes per second, and the induced E.M.F. during this time will be, by equation (4),

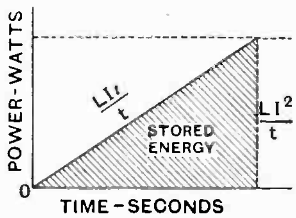


Fig. 6.—Energy stored in a magnetic field.

$$e = -L \times \frac{I}{t} \text{ volts.}$$

Energy is being used up in driving the current against this opposing E.M.F., and if i is the value of the current at any particular instant, the power at that instant $= e \times i = -\frac{LI}{t} \times i$ watts, i.e., the power is directly proportional to the current, the negative sign simply meaning that the coil is absorbing energy and not giving it out. Henceforward the *minus* sign is omitted. The energy so absorbed is stored in the magnetic field.

Fig. 6 is a power diagram for the case under consideration plotted to a time base. It will be noticed that, as the current increases from zero to a maximum value represented by the dotted line, the power increases proportionately from zero to $\frac{LI}{t} \times I$, that is, to $\frac{LI^2}{t}$ watts. Hence the average value of the power during the interval of t seconds will be $\frac{1}{2}\frac{LI^2}{t}$ watts. Now the total energy put into the magnetic field during this time is equal to the average power × time,

$$i.e., \text{ energy} = \frac{LI^2}{2t} \times t$$

$$= \tfrac{1}{2}LI^2 \text{ watt-seconds or } \textit{joules}.$$

The shaded area under the power curve represents the stored energy. The method which we have used here for finding the stored energy is based on the assumption that the current increases at a steady rate, but, no matter how the current builds up from zero to I, the stored energy will always be the same, just as in mechanics the work done in lifting a weight through a given height is quite independent of the time taken to lift it. The energy $\frac{1}{2}LI^2$ stored in the field is again given back to the electric circuit when the current falls to zero and the field collapses.

UNITED STATES SHORT-WAVE MILITARY SET.

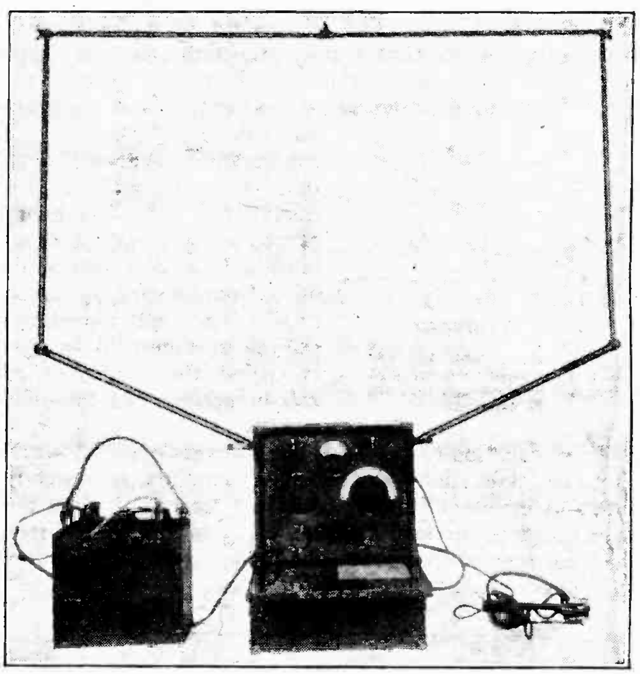
TAKING a lesson from the experience gained in trench communication during the Great War, American Army radio engineers have endeavoured to develop a reliable portable short-wave outfit for inter-trench communication.

The entire receiving-sending apparatus is placed within a waterproof container. The extra equipment consists of the filament battery and the telephone receivers. The collapsible loop-antenna is located within the cabinet when folded and closed.

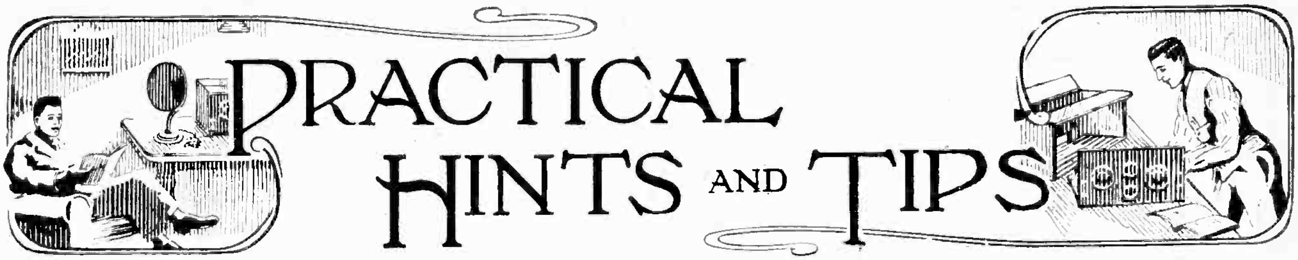
The operation of the outfit is extremely simple. When the cover is thrown open the collapsible key springs forward, thus completing its part of the circuit. Plugs allow of the instantaneous connection of both battery and telephones, while the loop may be set up in a few seconds. For rigidity and to ensure constant frequency on the low waves, the loop aerial is made of bronze tubing, sections of which are screwed together in the shape shown.

The set has a wavelength range of from 74 to 14 meters. Plate potential for the transmitter is supplied by the receiving batteries. A consistent range of from 2 to 15 miles is stated to have been attained. The directional effects of the loop, combined with the very sharp tuning obtainable, render interception of the signals difficult, ensuring some degree of secrecy.

The complete outfit may be carried, set up, and operated entirely by a single individual, though two men are ordinarily assigned to the set. Extra batteries and spare parts are included in the equipment.



Portable short-wave transmitter and receiver of the United States Army. High-tension supply is derived from dry cells, and the loop aerial is used for both transmission and reception. The normal working range is only a few miles.



A Section Mainly for the New Reader.

SIMPLIFYING THE REINARTZ CIRCUIT.

The popularity of the " Reinartz " circuit is almost certainly due to the fact that it gives a good degree of selectivity without complicated tuning adjustments, and also permits of very fine control of reaction. The latter point is probably the more important, as the sensitivity of a valve detector is increased to an enormous extent when fullest possible use is made of reaction, but if this adjustment cannot be carried to the critical point at which self-oscillation is just about to commence, the full benefit of regeneration will not be obtained.

Another reason for the success obtained by many readers with this type of circuit is that the necessary coil may be easily wound in a very efficient manner by even the beginner without any elaborate workshop equipment. The circuit as originally described had a separate reaction winding connected direct to the plate and tightly coupled to the aerial-grid coil, the variable condenser (which controls the amount of plate current fed back to the grid circuit) being inserted between one end of this winding and the lower end of the aerial coil. A slight modification of this circuit using a coil of even simpler construction is shown in Fig. 1. A continuous single-layer winding is tapped off to form aerial, grid, and reaction coils. The grid section may have 65 turns of No. 20 or 22 D.C.C. wire, the aerial section some 15 turns of the same wire, with about 30 turns of reaction winding. Finer wire (about No. 30) may well be used for this latter winding, as by its use the overall length of the coil may be reduced.

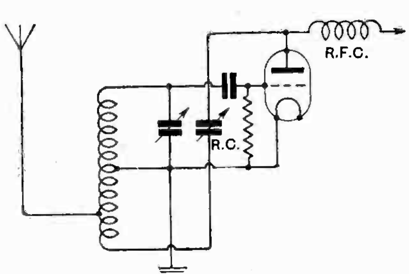


Fig. 1.—A simplified "Reinartz" receiver.

Arrangements such as this, having an aerial circuit not separately tuned are not particularly efficient on the long waves, and in any case the provision of facilities for interchanging the complete coil will introduce complications from the constructional point of view. It would seem more convenient to increase the wavelength of the receiver by plugging in an interchangeable coil in the grid circuit. At the same time, unfortunately, it will be necessary to arrange for an increase in the number of turns in the aerial circuit, thus introducing another slight complication. This may most easily be overcome by adopting the scheme of connections shown in Fig. 2; this arrangement is readily applicable to sets constructed on the American principle, with a vertical panel and horizontal baseboard. The cylindrical short-wave coil is mounted vertically on the base, while the sockets for the loading coil are fitted to the panel in such a way that the two coils are tightly coupled. Sockets for an extra reaction coil are mounted immediately above those for the loading coil.

When receiving on the normal broadcast waveband these coil sockets are short-circuited, and the aerial is connected to the terminal marked A_1. For long waves, appropriate coils are inserted in the sockets, and the aerial is moved to A_2; the short-wave grid coil then acts as an aerial winding, and is tightly coupled to the loading coil.

Assuming that the tuning and reaction condensers have maximum capacities of, respectively, 0.0005 and 0.0002 mfd., a standard 250-turn loading coil in the grid circuit will be suitable for the reception of Daventry, while the extra reaction coil will have 75 or 100 turns.

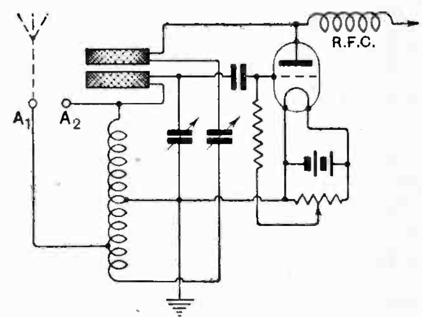


Fig. 2.—Adapting a "Reinartz" receiver for long waves.

The H.F. choke should have a high inductance with minimum self-capacity, and to avoid casual couplings with other coils its dimensions should be reduced as much as possible. A suitable choke consists of about 600 turns of No. 42 D.S.C. wire on a former of $1\frac{1}{4}$in. diameter.

Referring to Fig. 2, it will be noticed that the grid leak is connected to the slider of a potentiometer, the winding of which is across the L.T. battery. This is a convenient method of applying the correct voltage to the grid for most efficient rectification, and also helps in obtaining conditions giving the smoothest possible control of reaction.

○○○○

ACCUMULATOR CHARGING.

Many amateurs who have a direct current electric supply are apt to neglect the possibilities of charging their accumulators by inserting them in series with the household circuits. It should be stated at once that to attempt to do so by setting up a lamp or other resistance board for this purpose is an extremely wasteful and inefficient practice, for the difference in voltage between the mains and the cells to be charged is so great that an altogether excessive amount of energy is wasted in heating up whatever kind of resistance happens to be used, and any advantages which might arise are more than offset by the high cost.

If, however, arrangements can be made to connect the accumulator battery in series with a part, or even all, of the house supply, the charging current will cost nothing, while the operation of the majority of electrical appliances will not be adversely affected by the slight reduction of voltage due to the back E.M.F. of, say, a six-volt accumulator.

Connection with the mains may most easily be picked up at a fuse box, and a few measurements made with an ammeter (taking care, when the measurements are made, to see that the normal number of lights, etc., are in operation) will show which circuit will be most suitable, taking into account the charging rate of the cells. A sound and well-insulated connection should be made, and a non-reversible plug fitted in a convenient position.

The polarity may be determined by the use of pole-finding paper, or the ends of the two leads from the plug may be immersed in a glass of water; the one from which bubbles are given off most freely will be the negative, and should, of course, be connected to the negative terminal of the accumulator.

Due to the somewhat irregular nature of the charge which will be delivered to the accumulator, this should not be run down to its limit, and it will generally be advisable to have a duplicate, so that one may be charging while the other is being used.

The above remarks do not apply to high tension accumulators; the low charging rate of these batteries naturally renders impossible this method of charging. Due to their higher voltage, it is, as a rule, quite permissible to set up a special charging circuit, with a lamp rated at from 20 to 60 watts or more in series as a regulating resistance, the actual choice of lamp depending on the charging rate of the battery. Care should be taken not to connect the charging circuit in the wrong direction, even momentarily, as the combined voltages may, in the case of a large battery, be sufficient to burn out the lamp filament.

GRID BIAS ON H.F. AMPLIFIERS.

The need for the application of a negative bias to the grids of low-frequency amplifying valves is generally appreciated, but in many cases the rule has not been applied to H.F. amplifiers. Possibly this is because in some circuits valves performing this operation require a certain amount of positive bias for stability, but, now that methods of ensuring stability by balancing or neutralising are in fairly common use, the saving of anode current consumption resulting from the application of negative bias cannot be ignored.

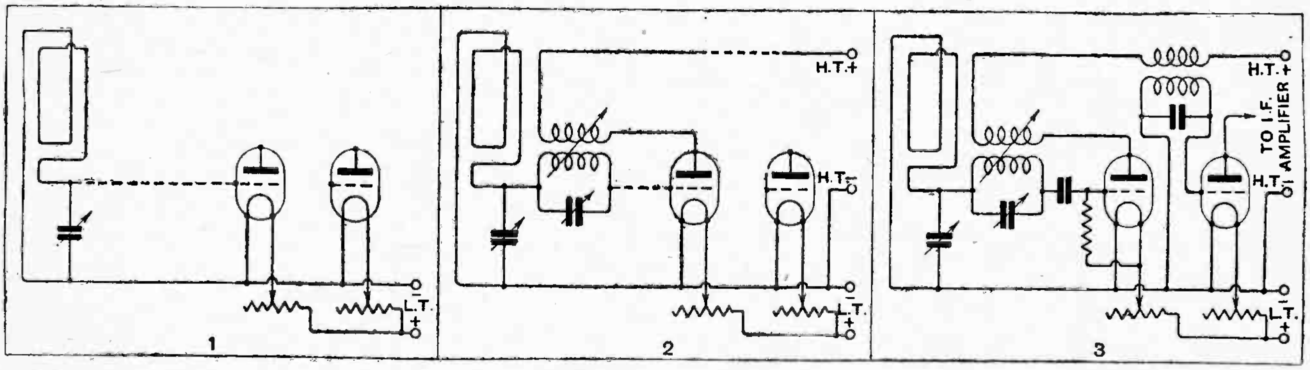
In neutrodyne receivers having two stages of high-frequency amplification it is usual to employ low-impedance valves, with some 60 volts on the plates. A consideration of the curves of some typical valves of this class will show that a reduction of as much as five milliamperes will result from suitable biasing of two amplifying valves.

Moreover, as the flow of grid currents will be prevented, the damping of the receiver as a whole will be reduced, and a distinct improvement in selectivity will often be noticed when attention is paid to this matter.

DISSECTED DIAGRAMS.

No. 15.—A Harmonic Superheterodyne.

For the benefit of readers who find difficulty in reading circuit diagrams we are giving weekly a series of sketches showing how the complete circuits of typical receivers are built up step by step. Below are shown the connections of the combined detector-oscillator of a superheterodyne operating on the second harmonic principle.



Two valves, with filaments connected across the L.T. battery; filament control rheostats are inserted. The frame aerial, tuned by a variable condenser to the wavelength of the desired signal, is connected between grid and filament of the first valve, which operates as a combined detector and oscillator.

A circuit which may be tuned by a variable condenser to a wavelength roughly double that of the incoming oscillations is inserted in series with the grid of this valve. In the plate circuit is connected a reaction coil, variably coupled to the grid inductance. A leaky grid condenser—

—is inserted for rectification. In the plate circuit is connected the primary of a transformer tuned to the beat frequency. The secondary is connected between grid and filament of the first valve of an intermediate frequency amplifier, which may be of the type shown in "Dissected Diagrams," No. 14b.

SHORT-WAVE OBSERVATIONS.

Effect of Wavelength on Daily Variations of Signal Strength.

By R. W. P. COLLINGS.

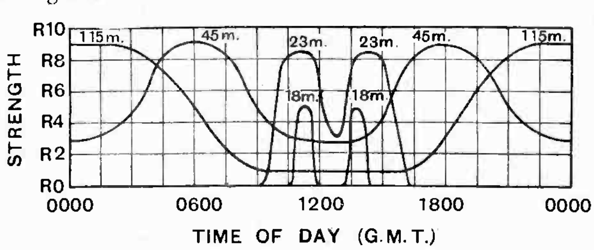
DURING September, 1925, a series of somewhat lengthy tests were carried out from a short-wave experimental station situated in Cornwall, with a view to determining the effects of the time of day and of distance on the strength of received signals on wavelengths between 15 metres and 100 metres.

The methods adopted were very simple and did not involve the use of apparatus for the accurate measurement of signal strength. Strength was recorded merely by the use of the old " R " scale, and so there was considerable liability to error. However, this system was sufficiently accurate for the purpose, in that signals were either very loud, very weak, or inaudible. The purpose of the tests was to show that wherever short-wave transmission is to take place between two stations, the actual wavelength to be employed to obtain greatest efficiency must be chosen having regard both to the time of day and to the distance between the stations.

For this purpose, a transmitter was set up to work on wavelengths of 115, 45, 23, and 18 metres. A constant input was obtained on all wavelengths, and the actual efficiency at the various wavelengths was kept as nearly constant as possible. The power used was 18 watts, obtained from a 400-volt battery of accumulators.

Range Covered by the Tests.

Owing to difficulties in obtaining co-operation from distant stations, definite tests could only be carried out for one distance—350 miles. The results obtained over this distance are best shown by a series of curves in the figure.



Average daily variations of signal during September, 1925

This curve is intended only to show an average of results, as the actual strengths varied from day to day. These variations were of two distinct types :—

(*a*) Those in which strength on all wavelengths either decreased or increased simultaneously.

(*b*) Those in which the wavelength giving loudest signals at any given moment changed either upwards or downwards.

This may be illustrated by a few examples. In case (*a*) it is found that signals are not up to normal strength on any wavelength, but that the relative efficiency of different wavelengths is normal. In case (*b*) it is found perhaps that the 18-metre wave can be used for a longer period both morning and afternoon, and that the actual strengths of signals is greater than normal. It is possible that on some days the 18-metre curves would approximate to those shown for 23 metres in the figure. On such an occasion, the 23-metre curve would be found to aproximate more closely to the normal 45-metre than to its own curve. Again, it would also be possible under these circumstances to establish communication on a lower wavelength than is normally possible. For instance, a 15-metre curve might be obtained similar to that shown above for the 23-metre wave.

Transatlantic Tests.

In the tests, unfortunately, complete results could not be obtained for any other distance than 350 miles. However, some observations were made for a distance of 600 miles. These were such as to indicate that the mid-day characteristics shown by the 350-mile tests, were less marked. In fact, the mid-day falling off in strength could not definitely be observed in the limited tests carried out. At the same time, lower wavelengths could be employed with advantage as compared with the 350-mile tests. It was found that the 18-metre wavelength gave appreciably better results than the 23-metre wave, but only beween 11.00 and 14.00 G.M.T.

During November and December a certain amount of transatlantic work was carried out from this station using wavelengths of 15-25 metres. The tests were very limited, however, as no American station seemed available for this work except on Sundays. A further limitation was due to the inability to make rapid changes of wavelength. The transmitters on the American side did not seem to be available for operation outside the 18-21-metre band, and receivers were not generally in use tuning below 16 metres. A power of 15 watts (input) was used for this work by the station in Cornwall, this giving a signal strength in Eastern U.S.A. varying from R2 to R7, averaging R4.

Long Distance Daylight Transmissions.

Only on one Sunday during these two months did communication fail to take place. Signal strength varied from day to day, and also variations in the efficiency of the various wavelengths were observed. On those occasions on which American signals were weak, the British station's signals were inaudible on 23 metres, and very weak on 20 metres. When American signals were loud, the 23-metre wave could be used by the British station giving signals sometimes louder than those on 20 metres. Again, on the occasions on which American signals were very weak, only those stations operating below 20 metres could be read, and only when conditions were " good " could American stations above 22 metres be heard.

Short-wave Observations.—

These results would indicate that successful daylight transmission over distances of 2,500-3,500 miles can only be obtained by adjusting the wavelength between the limits of 15 to 25 metres, according to conditions. On those days on which no 20-metre signals can be heard, it is probable that the use of 15 metres would result in successful communication.

These last remarks apply only to transatlantic communication between 11.00 and 21.00 G.M.T., and are based on results during November and December.

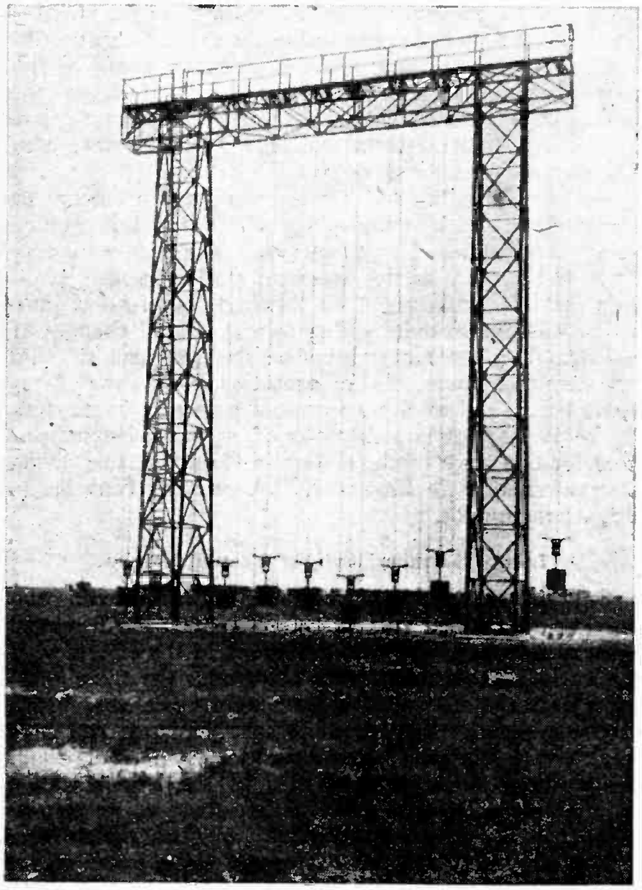
Some other interesting facts concerning this long-distance 20-metre work are obtained by comparing 20-metre conditions with 40-metre conditions during the same 24 hours. It has been found possible during November and December to obtain two-way communication with the U.S.A. on 40 metres, sometimes as early as 19.30 G.M.T. On these occasions 20-metre signals have been very loud between the hours of 16.00 and 21.00 G.M.T., and inaudible between 12.00 and 16.00 G.M.T.

On other occasions 40-metre signals have not been loud enough to effect two-way working until after 23.30 G.M.T. Under these circumstances, signals on 20 metres have been weak, but their strongest period has been at 20.00 G.M.T. and not, as is usual, at about 17.00 G.M.T.

In conclusion, some warning is necessary with regard to the results given above for the 350-mile tests. These were only obtained by continuous tests, which had to be made at irregular hours. They involve considerable possibilities of error, and should be looked upon more as results to be expected from serious experimental investigation. The writer hopes that they will be taken not as final, but as some guide for the serious experimenter who has time to probe further into the study of these short wavelengths.

The same theory is true of the later observations concerning 20-metre and 40-metre work. It is expected that large numbers of amateurs will have other views and have made tests themselves showing different results. If this is the case, it is the writer's earnest hope that they will not remain silent. He will therefore be glad to receive any observations on the subject matter of this short article.

HIGH POWER IN ARGENTINA.

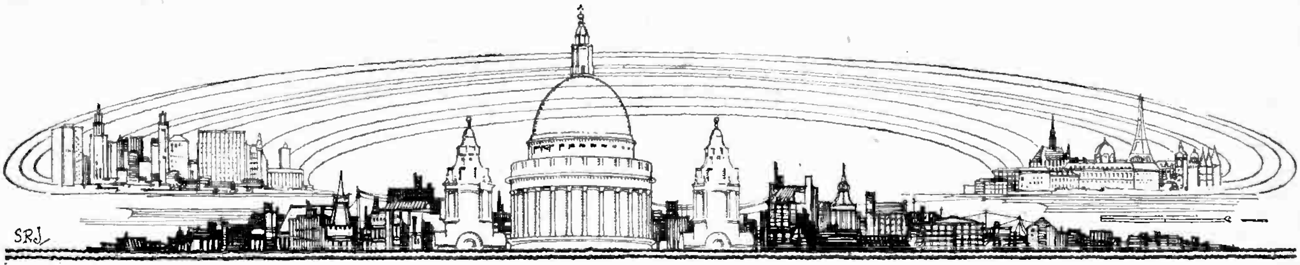


The aerial counterweights for maintaining an even tension on the wires at all temperatures.

THE accompanying photographs depict the antenna system of the Monte Grande Transoceanic Wireless Station, owned by the Republic of Argentina. This powerful station, which is still quite new, will be remembered for its pioneer work in conjunction with Nauen, in the use of short waves for long-distance commercial traffic.

One of the massive stay wire anchorages.

Three important firms were engaged simultaneously in the construction of the Monte Grande Station, viz., the British Marconi Company, the Audio Corporation of America, and the German Telefunken Company. Regular communication is maintained with Bordeaux and St. Assise, in France; Carnarvon, in Great Britain; Rocky Point, near New York; and Nauen, near Berlin.



CURRENT TOPICS

Events of the Week in Brief Review.

WORKHOUSE WIRELESS DANGER.

Commenting last week on the installation of a wireless receiver in the Narborough Workhouse, a member of the Board of Guardians deplored the possibility that the new attraction might lead to an influx of interested inmates!

o o o o

DECEMBER INCREASE IN LICENCES.

Probably owing to Christmas gifts of broadcast receivers, a marked increase occurred in the number of wireless licences taken out during December. The actual number was 69,593, which compares favourably with the monthly average of 40,000 or 50,000. The total number of licences now held is 1,644,325.

o o o o

BROADCAST "PIRACY."

A novel prosecution is to take place shortly in America on a question of broadcast wavelengths. According to a Central News message the U.S. Government is to institute proceedings against the Zenith Radio Corporation, Chicago, for broadcasting on a wavelength allotted to Canada but hitherto unused.

Readers may remember that the Zenith Corporation owns WJAZ, the broadcasting station with the "temperamental" studio.

o o o o

VISITORS' DAY.

The staff of the Cardiff Broadcasting station were kept busy last Saturday week, when 150 members of the Bristol branch of the Wireless League paid a visit to the studio and transmitting rooms. This was probably the largest public party ever to visit a B.B.C. station in one afternoon.

o o o o

REPLY TO WIRELESS STRIKERS.

In reply to an application by the Wireless Operators' Union for a Court of Enquiry into the strike of marine wireless operators, the Minister of Labour has stated that the facts of the dispute are widely known, and it is not considered that a case has arisen for the appointment of such a Court. Further, it is felt that the dispute is one which must be settled by negotiation.

According to the Marconi Company, three-fourths of the total number of ships coming under the compulsory wireless law still have wireless operators on board.

"WHERE IGNORANCE IS . . ."

"Sometimes we get as many as 200 or 300 valves returned in one day as 'duds,'" a wireless expert is reported to have declared in the North London Police Court last week. He explained that public ignorance was to blame. The returned valves were examined, found efficient and put back into stock.

o o o o

THE BELLS OF COPENHAGEN.

The bell tower of the Copenhagen Town Hall has now been fitted with a microphone, and every Sunday evening at 5 p.m. (G.M.T.) listeners to the Copenhagen station (340 metres) can hear the chimes striking six o'clock.

o o o o

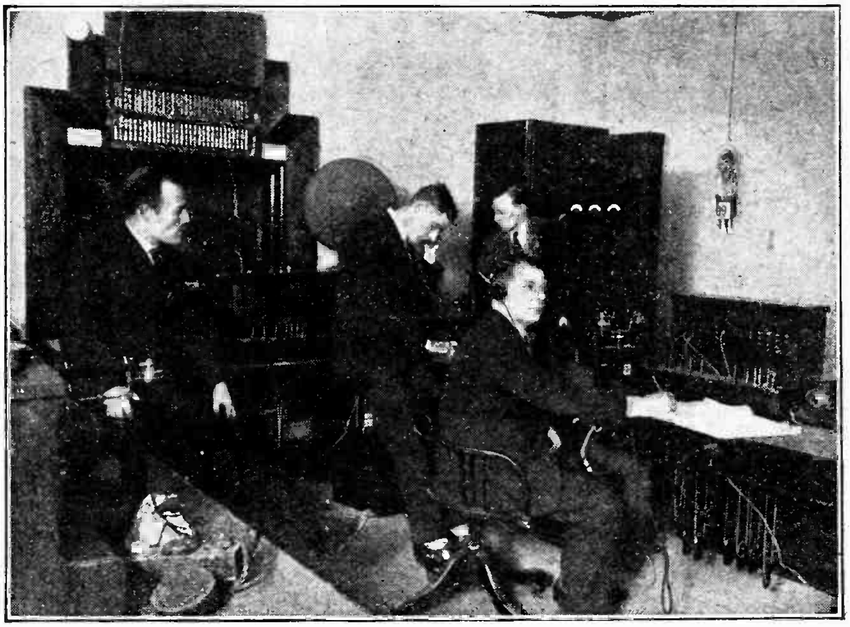
WIRELESS BUSINESS IN THE U.S.A.

An interesting estimate from America places the wireless industry to-day as twelfth in the big manufacturing businesses of that country. Three years ago wireless was 34th.

EXPERIMENTAL BROADCAST TRANSMISSIONS.

It is at present too early to collate results of the experimental transmissions which are taking place this week between European and American broadcasting stations.

The American stations opened operations on Sunday evening last, or, in terms of G.M.T., early on Monday morning, transmitting from 12 midnight to 4 a.m. These times are being adhered to nightly for one week. The British and Continental stations participating are transmitting daily from 4 to 5 a.m. (G.M.T.), and, by arrangement with the International Radiotelephony Bureau at Geneva, special steps have been taken to prevent "clashing" of times and wavelengths. The principal British broadcasting stations, including Daventry, are taking part, and among the Continental stations engaged are Vienna, Berlin, Munich, Radio Toulouse, Hamburg, Madrid, Prague and Brussels.



BIRMINGHAM GETS BUSY. An interesting glimpse in the modulating room adjoining the new studio at 5IT. Mr. Cooper, the Engineer-in-Charge, is seen controlling the modulation during the transmission of the first item.

NEW EUROPEAN WIRELESS SERVICE.

A new Marconi commercial wireless service has been opened between Austria and Spain.

oooo

NEW USE FOR THE LOUD-SPEAKER.

The "theatre-telephone" service in Paris, subscribers to which can "listen-in" to performances in the leading theatres, is reported to be gaining in popularity owing to the advent of the loud-speaker. Actually the service has been in existence for 30 years, but the necessity for headphones has limited its appeal.

oooo

WIRELESS AT BRITISH INDUSTRIES FAIR.

Arrangements are nearly completed in connection with the British Industries Fair, the London section of which will be held at the White City from February 15th to 26th.

Wireless apparatus will have a good representation, and we note from a plan sent us by the Department of Overseas Trade that the Uxbridge Road entrance should be used by visitors to the wireless, scientific and optical instruments section.

The public will be admitted to the Fair each evening from 5 to 8 p.m., and from 1 to 8 p.m. on Saturday, February 20th.

oooo

A GROAN FROM AMERICA.

Dr. Charles Gray Shaw, professor of philosophy at New York University, has uttered a lament regarding the seven "deadly values" in the world of to-day. Among these he classes wireless.

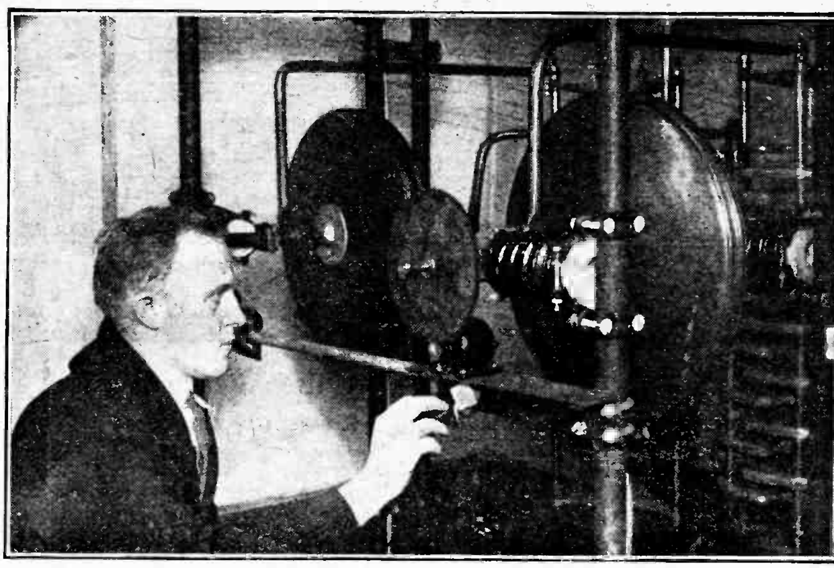
According to the New York correspondent of the *Daily Express*, Dr. Shaw expressed himself thus: "We revere radio and have set up a million altars to it for no other reason than to listen-in on the most commonplace entertainment at the greatest distance. Another age would have hesitated to annihilate space and time the way we grind them up with our machines, but we enjoy the idea of overcoming the natural limits of human life."

It would appear that the learned doctor is unfamiliar with modern progress in the design of transformer, choke and resistance-capacity coupled amplifiers. Or, possibly, his grid battery has run down.

oooo

SCHOOLS BROADCAST ESSAY COMPETITION.

Frederick Pridmore, a 13-year-old schoolboy, of the Elstow Council School, Bedfordshire, has won the honour of broadcasting a prize essay from 2LO or 5XX. Master Pridmore is the winner of the Essay Competition organised by the Schools Section of the Radio Society of Great Britain, a competition for which entries were received from schools throughout the United Kingdom and the Irish Free State. Mr. J. C. Stobart, Director of Education of the B.B.C., kindly acted as judge. The prize of £5 was offered by the Society for the best essay on: "The Uses of Broadcast Lessons."



THE LAST WORD IN VERNIER CONTROL. This photograph, taken recently in the transmitting room of the 50 kW. broadcasting station, WJZ, at Bound Brook, N.J., shows the two variable air condensers used for fine tuning. Note the small electric motor which operates the condensers.

The second and third places were secured respectively by Ronald Tomlin (aged 13), of Central London District Schools, Hanwell, and Muriel Hart (aged 14), a home student, of 5, Convent Gardens, Ealing. Mildred Alford (aged 13), of the Bicester C. of E. Schools, was very highly commended; while the following were also highly commended:—Charles Keep (aged 13), Elstow Council School, Beds.; A. Cudby (aged 14), Polehampton Boys' School; Gladys Luxton (aged 14). Alfred Sutton Central School, Reading; Claude Molcher (aged 10), Roade Council School, Northants; Elsie Pouney (aged 13), Bounds Green Girls' School, New Southgate; E. Powell (aged 11), Downham Market Boys' School, Norfolk. The following received special mention:—Oscar Clayton (aged 8), Fawbert and Barnard School, Harlow; Nora Pope (aged 8), St. Charles R.C. School.

oooo

FUTURE BROADCASTING POLICY.

Two important questions affecting broadcasting policy were raised by Brig.-Gen. Sir Capel Holden, giving evidence on behalf of the Radio Society of Great Britain before the Broadcast Committee at the House of Lords on Wednesday last. The Society considered that the following features in the constitution of the B.B.C. were anomalous:—(1) That there is no representation on the directorate of the public, who supply all the revenue, and (2) that the directorate consists solely of representatives of manufacturing interests. The Society held strongly that broadcasting should not be entrusted to a private limited liability company.

Sir Capel also urged the claims of the Society for silent periods, when the cessation of broadcasting would permit of experiments by members.

On Thursday the point of view of the listening public was put forward by Mr. Filson Young, who urged more original methods in the presentation of broadcast programmes, and Lieut.-Commander Kenworthy, M.P., of the Radio Association. As a result of a referendum, said Commander Kenworthy, 95 per cent. of the members of the Radio Association approved the present system of broadcasting. The Association advocated better research facilities for B.B.C. engineers.

oooo

FOR THE WIRELESS TRADER.

We have just received a copy of the 1926 edition of that useful reference book, "The Wireless Trader Year Book and Diary," which contains a wealth of information of the utmost value to all connected with the industry.

Produced by the Trader Publishing Co., Ltd., 139-140, Fleet Street, London, E.C.4, the Year Book is priced at 5s. 6d. (7s. 6d. overseas).

oooo

SPEECH AMPLIFIER DESIGN.

In the footnote on page 45 of our issue of January 13th the last sentence should read: "With pure A.C. the maximum inductance at 50 cycles exceeds 300 henries."

oooo

BEAM v. CABLE IN INDIA.

Within six months it is expected that the beam station now under construction at Kirkee, near Poona, will begin its experimental transmissions. Five steel masts, each 280ft. high, are to be erected in a line pointing directly to Skegness, where the reciprocal station is now being built.

With the new station it should be possible to transmit at the rate of 1,000 words per minute, which compares very favourably with the average cable speed of 40 words per minute.

PIONEERS OF WIRELESS.

By ELLISON HAWKS, F.R.A.S.

4.—Ampère.

AT about the same time that Volta was experimenting, Ampère, a young French scientist, was also studying electricity, and his work was destined to have a marked effect on scientific progress.

Andre Marie Ampère was born at Poleymieux, near Lyons, on January 22nd, 1775. At an early age he showed a wonderful talent for calculation, and we are told that he worked out arithmetical problems with pebbles even before he had been taught his figures! In his youth he had no tutor, but was assisted in his studies by his father, who procured for him the necessary books.

Studies in Physics.

In 1789 the French Revolution broke out, and the ideals of the Revolutionaries filled young Ampère with enthusiasm. He received a rude shock, however, when his father was put to death by the Revolutionaries, and the tragedy made a deep and melancholy impression on him.

For almost a year young Ampère remained in a state of stupor, not even recognising the places where he had been brought up. Gradually he recovered his normal spirits, however, chiefly through reading some verses of Horace's *Ode to Licinius*. As soon as he felt able to do so, he endeavoured to find solace in a study of botany. From 1794 to 1797 he immersed himself in literature, and having devoured all the Latin poets turned his attention to Greek. He followed literature with a study of science and art, but seemed unable to plan out any definite line of work until at last he decided to devote himself exclusively to physics.

In the meantime (in 1799) he had married Mlle. Julie Carron,[1] a circumstance that necessitated him choosing a profession. He decided on a scientific career, and in 1801 became Professor of Chemistry and Physics at Bourg. In the following year, at the age of 27, he published a mathematical paper.

In 1804 Ampère's wife died, and in the same year he became Professor of Mathematics at Lyons. In his youth he had always shown a considerable interest in mathematical subjects, and in his later years remarked that he knew as much about mathematics when he was eighteen years of age as at any time afterwards. In 1805 he entered the Polytechnique at Paris, and in 1809 attained the high post of Professor of Mathematical Analysis and Mechanics. In 1814 he became a member of the Academy of Sciences and Professor of Physics in the College of France. Subsequently he enjoyed numerous distinctions, including the Legion of Honour and Fellowship of the Royal Societies of London and Edinburgh.

It was during a tour of inspection in 1836 that Ampère, worn out by toil but still in full possession of his mental faculties, fell ill at Roanne. He endeavoured to continue with his tour, but, arriving at Marseilles, had to take to his bed. He died in the College of that town on the 10th of June, being sixty-one years of age.

Although Ampère's work was considerable, his fame as a pioneer of wireless is based more particularly on his application of the highest branches of mathematical analysis to electricity and magnetism. His study of electro-magnets and his researches in this connection largely prepared the way for Faraday's famous experiments, which we shall consider later.

Andre Marie Ampère.

As we have already learned, Oersted had discovered (in 1819) the effect of an electric current upon a magnetised needle. The Academy of Sciences did not hear of Oersted's experiments until September 11th, 1820, but immediately the discovery was announced Ampère began an investigation of electro-magnetism. Seven days later (on September 18th) he read a paper before the Academy, announcing that the voltaic pile itself affected the magnetic needle in the same manner as did the uniting wire. He showed that the effect was consistent with the theory that the electric current completes a circuit back to the pile from which it originated. He also advanced his brilliant theory that the magnetism of a magnet is due to molecular electric currents.

In a paper, *New Discoveries in Magnetism and Electricity*, Ampère suggested using the

[1] In the following year a son was born, and he subsequently became an intellectual literary man and a member of the Academy of Sciences.

Pioneers of Wireless.—

effect of an electric current upon a magnetised needle in order to transmit signals from one point to another. It is on this suggestion that the French base their claim that Ampère was the originator of the conception of the electric telegraph.

The question as to who invented the telegraph has, of course, been the subject of considerable discussion. Although Ampère suggested that the electric current might be used to transmit intelligence to a distance, it is a far cry from his discovery of the scientific principle to the completed system, operating on a commercial basis, of Morse. It is significant that Ampère made no attempt to patent his discovery.

Although a great savant, whose name is one of the most illustrious in French science, Ampère was remarkably candid and ingenuous. Possessed of a very modest fortune, he gave it freely to those in need and lavished it on the construction of new apparatus. In France his absent-mindedness was almost proverbial, and is well illustrated by an incident that occurred, during a meeting of the Academy. Ampère was reading a paper, and the members were listening to him with rapt attention. Suddenly there was an unusual disturbance and a general murmur spread over the meeting as a stranger, attired in a dark blue dress-coat, entered the hall. The stranger quelled the excitement with a sign, and taking a vacant seat on the platform listened undisturbed to the lecturer.

When he had read his paper, Ampère returned quietly to his place, not having noticed the stranger's entrance. Great was his astonishment, therefore, when he found the stranger occupying his seat. Too modest to say anything, Ampère walked round his seat and coughed once or twice, but the stranger did not take the hint. He then remarked to some of his colleagues that it was extraordinary that a stranger could enter and take another's place without apology or explanation. The only responses were quiet smiles, which so mystified Ampère that he overcame his timidity and addressed M. Geoffroy Saint-Hilaire, the President.

"Mr. President," said he, "I must point out to you that a stranger has taken my place and sits amongst us."

"You are mistaken, my dear colleague," replied the President; "the person to whom you allude is a member of the Academy of Sciences."

"Since when?" asked Ampère.

"Since the 5 Nivôse, year VI.," interjected the stranger.

"And in what section, sir?" inquired Ampère.

"In the Mechanics Section," responded the intruder.

"This is a little too much," cried Ampère, as he snatched up a list of members of the Institute. Turning to the date mentioned, he read:—"*Napoleon Bonaparte, Member of the Academy of Sciences, elected to the Mechanics Section on the 5 Nivôse year VI.*"

Ampère, very upset at not having recognised the Emperor, was profuse in his apologies. The Emperor was much amused by the occurrence, however, and genially replied: "There, sir, you see the inconvenience of your not consorting with your colleagues. I never see you at the Tuileries. However, I can easily compel you to come there, at least to bid me good day."

When the meeting terminated, the Emperor approached Ampère, and taking his hand said: "I shall expect you to dinner to-morrow. It will be at seven, and so that you will not take her for someone else, I will warn you now that I shall place you next to the Empress!"

The sequel to this incident is as strange as it was typical of the absent-mindedness of the great scientist, for on the following night the Imperial household did not sit down to table until eight o'clock. The Emperor had waited an hour for his colleague of the Academy, but Ampère had forgotten all about the invitation and was unconcernedly absorbed in his work!

TRADE NOTES.

"CHARGING FROM A.C. MAINS."

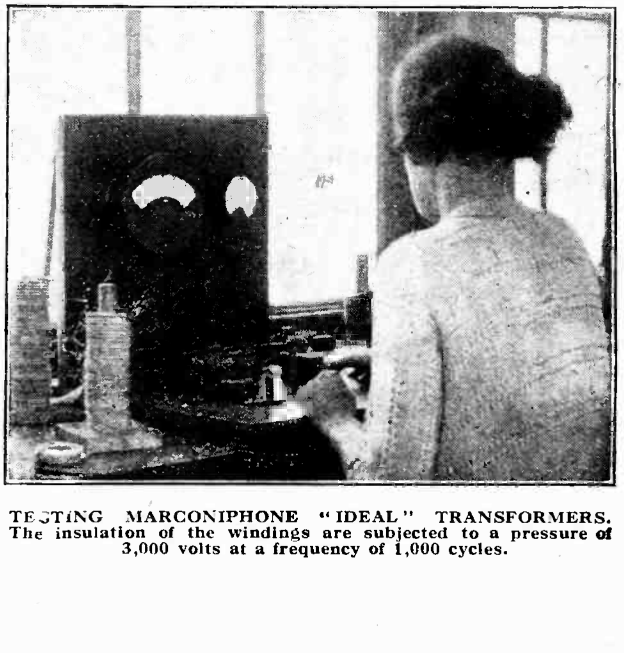
Readers of the article with the above title, by Prof. E. V. Appleton, in *The Wireless World* of December 30th will be interested to know that the Balkite Battery Charger mentioned in the last paragraph is only obtainable in Great Britain from the branches and agents of Burndept Wireless Limited. The idea is protected in this country.

The Balkite Battery Charger is shortly to be manufactured at the company's Willesden works.

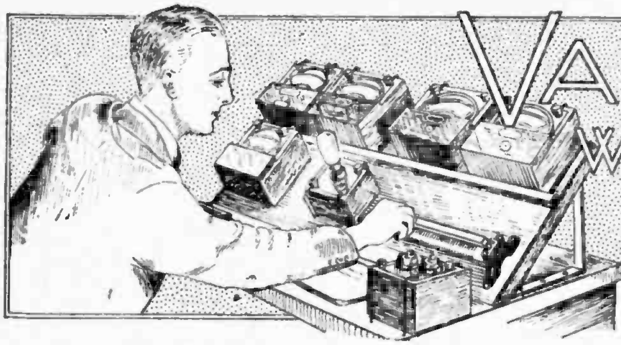
TRADE MARK FACTS.

From King's Patent Agency, Ltd., of 146A, Queen Victoria Street, E.C.4, we have received a fascinating little booklet about Trade Marks, containing extracts from a paper on the subject given before the Publicity Club of London by Mr. Benj. S. King.

A distinction is drawn between invented and "non-invented" trade marks; a good specimen of the former is "Osram," while the latter is well exemplified by "Monarch" as applied to typewriters. Mr. King's remarks are worthy of the attention of all wireless manufacturers who propose to benefit by the powerful appeal of a good trade mark.



TESTING MARCONIPHONE "IDEAL" TRANSFORMERS. The insulation of the windings are subjected to a pressure of 3,000 volts at a frequency of 1,000 cycles.



VALVES WE HAVE TESTED

Marconi and Osram D.E.2 Series.

THE D.E.2 valves are dull emitters designed for use with two-volt filament heating accumulators. It is said by the manufacturers that these valves incorporate all the good features of the well-known D.E.R. type valves, with the added advantages of lower filament current consumption and improved characteristics which provide special values most suitable for the H.F. detector and L.F. positions in the receiver.

H.F. and L.F. Models.

Two classes are provided, one being designated D.E.2, H.F., and the other D.E.2, L.F. D.E.2, H.F. is recommended for H.F. amplification and detection and for use in resistance or choke-coupled L.F. or H.F. stages, whilst the D.E.2, L.F. is designed for L.F. transformer-coupled stages, or for the output stage if telephones are employed.

Sample valves submitted by the Marconi and Osram Companies have been tested, with the results given in the accompanying tables. These figures compare fairly favourably with those given in the makers' catalogues, although it would appear that the manufacturers specify the amplification factors and anode impedances of their valves at a high anode voltage with the grid at approximately zero volts instead of with usual operating values as we do in our tests. The result of this, of course, is to show that the valve is not quite such a good one, judged by the ratio of the amplification factors and impedances, as one would be led to expect from the figures given by the makers. These remarks apply not only to the Marconi and Osram Companies, but we believe to all valve manufacturers, and we would suggest that the time has arrived when the public has the right to expect that actual values under operating conditions be given. That the makers appreciate the importance of grid bias is evident from the figures which they invariably give in the literature describing their products. Thus we are told that when the D.E.2, L.F. valve is used in a L.F. amplifier with an anode voltage of 80, the correct grid bias is negative 4.5 volts. Surely then we are entitled to be given the characteristics of the valve under these conditions, for the keen wireless amateur no longer chooses components and valves at random, but endeavours so to choose these things that they match and work well together. Typical instances where matching of parts is essential are when low- and high-frequency transformer couplings are used. Many manufacturers of transformers specify the anode impedance and amplification factor of the valves used with transformers of various ratios to give certain frequency-amplification characteristics, and these form in many instances the only guide the buyer has as to the amplification, and to a certain extent the quality, he will get.

D.E.2, H.F. Nominal rating, filament, 2 volts, 0·12 ampere; anode volts 120, maximum; amplification factor, 12; anode impedance, 45,000 ohms.

D.E.2, L.F. Nominal rating, filament, 2 volts, 0·12 ampere; anode volts 80, maximum; amplification factor, 7; anode impedance, 22,000 ohms.

The D.E.2, L.F. valve will be found suitable for the first stage of a transformer-coupled low-frequency amplifier, when a transformer of 2 or 3 to 1 ratio of good design may be used. This valve will also function fairly well in a transformer-coupled high-frequency amplifier, provided the ratio of the windings and the value of the tuning condenser is properly chosen.

MARCONI AND OSRAM VALVES.

D.E.2., H.F.

Filament characteristics. 1.8 volts. 0.12 ampere.
1.9 volts. 0.125 ampere.
2.0 volts. 0.13 ampere.
Total emission, 5.9 milliamperes.

Anode Volts.	Anode current at zero Grid Volts. Milliamperes.	Actual Anode Current. Milliamperes.	Grid Bias. Volts.	Amplification Factor.	Anode Impedance. Ohms.
40	0.64	0.4	—1	11.3	50,000
60	1.1	0.56	—2	11.5	44,600
80	1.57	0.71	—3	12.85	54,500
100	2.1	0.85	—4	12.5	45,000
120	2.75	1.11	—5	12.5	46,800

Valves we have Tested.—

D.E.2., L.F.

Filament characteristics.		
	1.8 volts.	0.122 ampere.
	1.9 volts.	0.127 ampere.
	2.0 volts.	0.132 ampere.

Total emission 5.7 milliamperes.

Anode Volts.	Anode Current at Zero Grid Volts. Milliamperes.	Actual Anode Current. Milliamperes.	Grid Bias. Volts.	Amplification Factor.	Anode Impedance. Ohms.
40	0.84	0.53	—1.5	8.65	45,000
60	1.53	0.78	—3	7.0	30,000
80	2.27	0.95	—5	7.5	31,200
100	3.06	1.14	—7	8.0	35,200

Taken with 2 volts on filament.

For tuned anode couplings, the H.F. valve will be found satisfactory, for it has a high impedance, and will not be so liable to oscillate as a circuit including a valve of similar amplification factor but lower impedance. Further, the tuning characteristics, which depend to some extent on the anode impedance, will be better, *i.e.*, tuning will be sharper than when a low-impedance valve, such as a D.E.8, L.F., is used.

To avoid overrunning D.E.2 valves, they should always be operated from a two-volt accumulator, and it is advisable to employ a 5-ohm rheostat in order that the valve may be heated to as low a temperature as is consistent with satisfactory operation.

NEWS FROM THE CLUBS.

Captain Eckersley at Hounslow.

The members of the Hounslow and District Wireless Society are looking forward with interest to a visit from Captain P. P. Eckersley, Chief Engineer of the B.B.C., who has kindly arranged to give a non-technical lecture on Friday, February 12th, his title being "Broadcasting from Within."

On the same evening the Marconiphone Co., Ltd., will demonstrate their "Straight Eight Receiver."

The meeting will be open to the public, a collection being made an behalf of the Hounslow Hospital Wireless Fund.

Hon. Secretary : Mr. Arthur J. Myland, 219 Hanworth Road, Hounslow.

oooo

A Constructional Course.

Great enthusiasm is being shown in connection with the inauguration of a practical course in wireless construction by the Croydon Wireless Society. This course, which is to be continued fortnightly until the summer, will alternate with the regular fortnightly Monday lectures. It will be helpful and informal, and is intended to bring members into closer contact for the purpose of mutual instruction and advice.

A single-valve Reinartz receiver is being built by several of the members under expert supervision, and will later be fitted with one or two low-frequency stages. When the sets at present under construction are completed an evening will be devoted to calibrating them against a standard wavemeter.

The Hon. Secretary of the Society is Mr. H. T. P. Gee, 51-52, Chancery Lane, W.C.2.

oooo

Liquid Air to Increase Signal Strength.

Mr. Allen S. Bremner, B.Sc., gave a fascinating lecture and demonstration on the subject of "Liquid Air" before the Muswell Hill and District Radio Society on January 13th. Although the majority of his remarks were not strictly applicable to wireless, the lecturer made the interesting observation that by immersing his aerial tuning coil in liquid air he had noticed a considerable increase in signal strength, due to decreased resistance.

Particulars of the Society's activities, together with a membership application, will be gladly forwarded by the Hon. Secretary, Mr. Gerald S. Sessions, 20, Grasmere Road, Muswell Hill, N.10.

oooo

Can a Reflex Set be Stable?

An outstanding feature of the meeting of the Lewisham and Bellingham Radio Society on January 12th was the demonstration by Mr. Riches of a two-valve reflex receiver. The demonstration was the outcome of a previous discussion in which several members had doubted the possibility of any reflex circuit being stable and constant in operation, while possessing good range and volume. Mr. Riches showed that, in regard to his particular receiver, he was fully justified in claiming that an efficient reflex set could be rendered stable.

oooo

Broadcasting Frequencies.

An important meeting for members of the Holy Trinity Radio Club (Barnsbury, N.1) will be held on Friday next, January 29th, when a member of the Engineering Staff of the B.B.C. will lecture on "Frequency in Relation to Broadcasting." The meeting will be held at the Parish Hall, Richmond Road, and will begin at 7.45 p.m. All interested in wireless are cordially invited.

A special effort is being made to increase the membership of the club. Particulars will be gladly forwarded by the Hon. Secretary, Mr. D. E. Stretton, 15, Thornhill Houses, Barnsbury, London, N.1.

oooo

New Headquarters.

We greatly regret that a mistake was made in these columns last week in referring to the move of the Ilford and District Radio Society to new and more comfortable headquarters. These, it should have been stated, are situated at the Wesleyan Institute, High Road, Ilford. By an unfortunate error, the society's original address was given in our last issue.

oooo

Wavelengths and Cycles Per Second.

One of the most interesting half-hour talks ever heard in the club room of the Ipswich and District Radio Society was given by Mr. Stanley Lewis on January 4th. The subject was "Wavelengths and Cycles per Second." Many obscure points were made clear by clever demonstration, and not a little of the success of the evening was due to Mr. Lewis's discreet use of the blackboard.

Before the close of the meeting an entertaining diversion was provided by one of the members who produced a two-valve receiver which competed successfully with the society's four-valve instrument in picking up most of the B.B.C. stations at good strength.

FORTHCOMING EVENTS.

WEDNESDAY, JANUARY 27th.

Radio Society of Great Britain.—General meeting. At 6 p.m. (tea at 5.30). At the Institution of Electrical Engineers, Savoy Place, W.C.2. Lecture, with demonstration: "Loud-speakers," by Dr. N. W. McLachlan, M.I.E.E.

Tottenham Wireless Society.—At 8 p.m. At 10, Bruce Grove. Lecture: "Distortion," by Mr. J. H. A. Whitehouse, of the B.B.C.

Muswell Hill and District Radio Society. At 8 p.m. At St. James' Schools, Fortis Green. Lantern lecture: "Mica Condensers for Transmitting and Receiving," by Mr. H. Andrewes, of the Dubilier Co.

FRIDAY, JANUARY 29th.

Sheffield and District Wireless Society. At 7.30 p.m. At the Department of Applied Science, St. George's Square. Lecture: "Power Transformers," by Mr. L. H. Crowther, A.M.I.E.E.

Bristol and District Radio Society.—At the Physics Lecture Theatre, Bristol University. Lecture: "Acoustics" (with experiments), by Prof. A. M. Tyndall, D.Sc.

Radio Experimental Society of Manchester.—Experimental evening.

Holy Trinity Radio Club (Barnsbury).—At 7.45 p.m. At the Parish Hall, Richmond Road. Lecture: "Frequencies in Relation to Broadcasting," by a B.B.C. Engineer.

MONDAY, FEBRUARY 1st.

Ipswich and District Radio Society.—Open night.

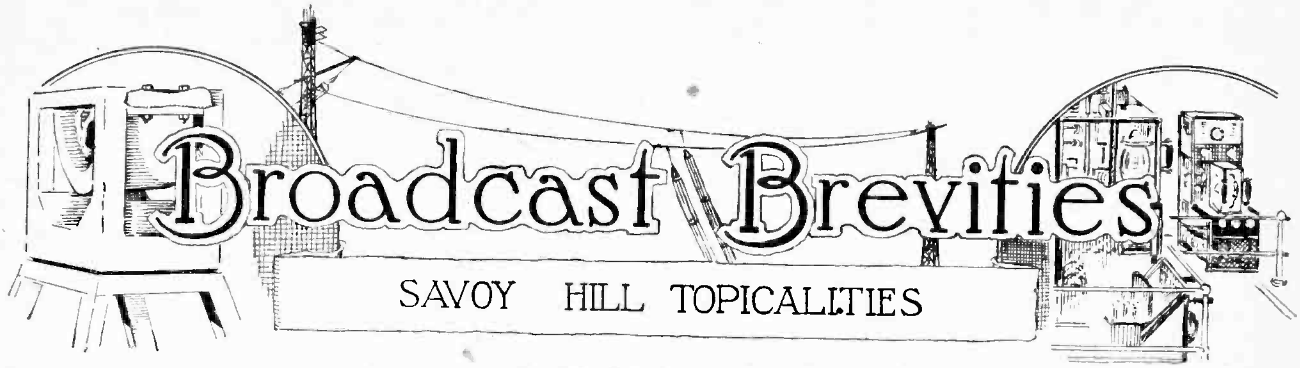
Swansea Radio Society.—Lecture by Mr. R. G. Isaacs, M.Sc.

TUESDAY, FEBRUARY 2nd.

Halifax Wireless Club.—Lecture: "Broadcasting" by Mr. H. Bishop, of the B.B.C.

WEDNESDAY, FEBRUARY 3rd.

Institution of Electrical Engineers (Wireless Section).—At 6 p.m. (refreshments at 5.30). At the Institution, Savoy Place, W.C.2. Lecture: "The Propagation of Electric Waves," by Mr. J. Hollingworth.



Broadcast Brevities

SAVOY HILL TOPICALITIES

By Our Special Correspondent.

Duplication of Wavelengths.

Our surmise of last week that Geneva would soon be experimenting, not on short wavelength transmissions—as was stated in a misleading report in a morning newspaper—but on the duplication and triplication of wavelengths, has already been shown to be accurate. As the outcome of a short conference held in Brussels a few days ago, it was decided to institute the Bournemouth station as a sort of keystone of transmissions from this country, operating on wavelengths of 250, 350, and 500 metres simultaneously with transmissions on the same wavelengths from *Petit Parisien*, Berlin, and Rome. The idea is to ascertain which, if any, stations in Europe can broadcast on the same wavelength without interference. If such economies in the waveband can be effected, the move will go a long way toward solving the European waveband problem.

oooo

Prince Henry.

Prince Henry will respond to the toast of "The Royal Family," to be proposed by Sir Warren Fisher, Secretary to the Treasury, at the Civil Service dinner which is to be held on February 12th. The Prime Minister will propose the toast of "His Majesty's Civil Service." All three speeches will be broadcast from 2LO.

oooo

Broadcast Humour.

The scare administered to listeners by Father Ronald Knox, in a burlesque entitled "Broadcasting the Barricades," which was relayed from Edinburgh recently, has greatly perturbed the B.B.C. officials. While the skit, in manuscript form, bore every indication of what it was intended to be, and while a greater proportion of humour is called for by a section of listeners, the incident showed the need of very careful discrimination in the choice of broadcast humour.

oooo

All Sorts and Conditions of Men.

Even in the narration of a funny story the point is often missed by the hearer, and the danger that listeners may fail to appreciate the subtleties of broadcast humour cannot be overlooked nor underestimated. It takes all sorts to make a world, and it is clear that the officials responsible for Father Knox's burlesque transmission did not pay due regard to that section of the listening world which regards its news bulletins as unequivocal fact.

oooo

Lyn Harding as Drake.

There are few more refreshing characters in history than Drake, and excerpts will be broadcast to-morrow (January 28th) from Louis N. Parker's play of that name. An excellent Drake has been secured in Mr. Lyn Harding, who created the part when the play was first produced at His Majesty's Theatre in 1912. Another well-known artist, Miss Edyth Goodall, will play Queen Elizabeth.

oooo

A Job for Capt. Eckersley.

Here is a ghost story which has not even the excuse of wireless to support it. A resident on a small and isolated farm in Shropshire heard music and voices outside the house in the middle of the night, and, being very puzzled, got out of bed to see who was disturbing his slumbers. There was no sign of anyone, but the singing continued long after he had returned to bed. On the following morning he found that the snow which had fallen overnight was undisturbed. The curious point about the story is that the information has been passed on to Captain Eckersley with a request that he will try and explain the mystery, seeing that the farmer concerned has no receiving set.

oooo

We Wonder.

A listener tells me that he proposes to attach an aerial to a century-old oak tree in his garden, and wonders whether this is likely to kill the tree.

oooo

He Didn't Want Much.

This reminds me of the unsophisticated candidate for broadcasting honours who recently offered his services to the B.B.C. for broadcasting anything in the way of song, from cradle songs to serenades, war songs, or dirges. He stated

2RN DUBLIN. The studio of the Irish Free State's first broadcasting station at Dublin. The new station is working on a wavelength of 390 metres and the quality of transmission is reported to be steadily improving.

that he would take in part payment a "first-class listening-in set, with full directions for putting up and for manipulation, plus a free licence for same." He added that he would prefer one "with twelve first-class quality headphones and would wish to be advised where best to rig aerials, and would need a long aerial of finest copper wire, with means of attaching same to ten or twelve trees." It would appear that the correspondent wants a telegraph line to his house and not a wireless aerial.

oooo

Good Reception from the Continent.

From time to time the engineers at Savoy Hill receive information from listeners in certain parts of the country as regards the ease with which foreign stations can be picked up, while British stations cannot be heard at all. The user of a two-valve set, installed near the Caledonian Canal, last week forwarded a long list of Continental stations which he had been able to receive, and remarked that he had at the same time succeeded in getting Glasgow only of all the British stations.

oooo

Bad for Valves.

The reason is that the Continental stations generally over-modulate—an expensive procedure so far as the life of valves and other transmitting apparatus is concerned. The B.B.C. engineers, on the other hand, in the interests of listeners as well as of their own transmitting plant, pay attention to the factor of safety, to ensure consistency in their transmissions, combined with unvarying quality. The aim of every broadcasting concern should be to give its nationals a consistent service rather than to indulge in the somewhat speculative pastime of bolstering up transmissions for the benefit of listeners abroad.

oooo

A New Type of Valve.

In connection with the question of modulation, an experiment was tried the other day at one of the provincial stations with a new type of valve to replace several low-power valves. So far from providing listeners with an improved level of consistency in reception, overmodulation was more pronounced than ever, and speech could even be detected on the anode, in small clouds.

oooo

A Record Week.

In these days of heterodyning and interference on the ether, the week January 7th to 14th may be counted as a red-letter week in broadcasting, for the B.B.C., in its weekly report to Geneva, was able to declare that seventeen of its stations were clear of heterodyne, a condition of things that has not been experienced for many months past.

oooo

Manchester Badly Heterodyned.

Manchester, on the other hand, was in a serious plight during the period mentioned, interference being concentrated on that station with especial intensity. Manchester's wavelength was lowered from 382 metres to 379 metres in an attempt to extricate its transmissions from those of Prague, Union Radio Madrid, Oslo, and Dublin. The situation between 350 metres and 400 metres is presenting Geneva with a difficult problem.

oooo

FUTURE FEATURES.

Sunday, January 31st.

London.—4.30 p.m., La Chauve Souris. 9.15 p.m., Schubert Programme.

Birmingham.—9.20 p.m., Mainly Concertos.

Bournemouth.—3.30 p.m., Wagner-Liszt Programme. 9.15 p.m., Instrumental Feature and Art Songs.

Cardiff.—9.15 p.m., "Out of the Depths."

Glasgow.—3.30 p.m., Orchestral Programme.

Monday, February 1st.

London.—8 p.m., Chamber Music.

Birmingham.—8 p.m., Classical Items.

Aberdeen.—8 p.m., Scottish Song, Music and Drama.

Glasgow.—8.30 p.m., Aspects of the East.

Belfast.—8.58 p.m., Instrumental Solos. 9.30 p.m., Two Scenes from Shakespeare.

Tuesday, February 2nd.

London.—8 p.m., An Operatic Evening.

Bournemouth.—8 p.m., Folk Lore in Song and Music.

Cardiff.—8 p.m., A Pageant of the West—(1) Cardiff.

Manchester.—8 p.m., "Daughters of Men" (Charles Klein).

Aberdeen.—8 p.m., English and Irish Music.

Wednesday, February 3rd.

London.—8 p.m., Mendelssohn Programme.

Birmingham.—7.30 p.m., Organ Recital by C. D. Cunningham (City Organist), relayed from the Town Hall.

Cardiff.—8 p.m., "Runes of the Hebrides."

Manchester and 5XX.—8 p.m., "John Peel" Programme.

Newcastle.—8 p.m., Mendelssohn Programme. 9.15 p.m., Opera.

Glasgow.—8 p.m., Symphony Concert.

Edinburgh.—8 p.m., A Mendelssohn Night.

Thursday, February 4th.

Birmingham.—8 p.m., Chamber Music Programme.

Manchester.—8 p.m., Lancashire Talent Series: A Contribution by Bury.

Friday, February 5th.

London.—9.30 p.m., Special Relay from the Continent.

Manchester.—8 p.m., A Popular Concert.

Belfast.—8 p.m., Portion of Concert by the Belfast Philharmonic Society relayed from the Ulster Hall.

Saturday, February 6th.

Newcastle.—8 p.m., The Hatton Colliery Prize Band.

Aberdeen.—9 p.m., Instrumental Programme.

oooo

Schoolboys to Broadcast.

Listeners heard, a few days before Christmas, the first of the public school concerts relayed from Marlborough College. By way of contrast, 2LO will broadcast, on February 16th, a cantata entitled "Youth and War," which is to be relayed from the Bermondsey Central School for Boys. The cantata is by Dr. Robert Jones, the headmaster of the school—which is something between the elementary and secondary school grades. The boys will demonstrate that tuneful voices are to be found in the purlieus of South London as well as in the open countryside.

oooo

What Station was That?

Need appears to exist for a stiffening-up of the regulations respecting the announcement of the identity of various stations during broadcasting. The complaint was made that many people tuned in half-way through a recent burlesque, and were unable to gather up the threads in a way that would have enabled them to follow the argument. It is equally important that, on tuning in, the listener should not be for long at a loss to know the name of the station to which he is listening. Call signs should be announced with unfailing regularity before each and every item.

oooo

Realism in Broadcasting.

Do listeners realise the amount of physical and mental effort that many artists put into their broadcast performances? In listening to that wonderful broadcast of "The Tell-tale Heart," one of Edgar Allan Poe's eerie tales, which was recited by Mr. Russell Thorndike from 2LO a week ago, we felt something of the dramatic intensity that the well-known actor put into the words; but we did not, perhaps, realise that he *acted* the part of the insane murderer just as if he were performing before a visible audience. At one point he pounded a wooden chair in front of him with such vehemence, to typify the beating of his victim's heart, that his knuckles were noticed at the end of the broadcast to be streaming with blood.

oooo

A Musical Dinner.

This evening (Wednesday) listeners are to have half an hour of George Graves, the inimitable Baron Popoff, in a broadcast from "The Merry Widow."

The first performance of York Bowen's Rhapsody for violin, 'cello, and piano will also be broadcast from the Annual Dinner of the Federation of British Music Industries. The speeches of Lord Hewart, Lord Chief Justice, and Mr. J. B. McEwen, Principal of the Royal Academy of Music, will also be broadcast from the same function.

SPEECH AMPLIFIER DESIGN.

Derivation of Transformer Characteristics.[1]

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

(Concluded from page 98 of previous issue.)

THIS subject has been treated experimentally and mathematically by various writers, but to save the reader the necessity of wading through the original papers a simple treatment is outlined below.

The chief object to be attained in getting the optimum of amplification from a valve is that only a minor portion of the alternating voltage shall be expended across the valve. This is equivalent to the valve impedance being negligible compared with that of the resistance or transformer primary in the anode circuit. It is, of course, the variation in the impedance of the "load" which prevents the amplitude-frequency characteristic being horizontal, *i.e.*, having an unvarying ordinate, or in mathematical language y = a constant.

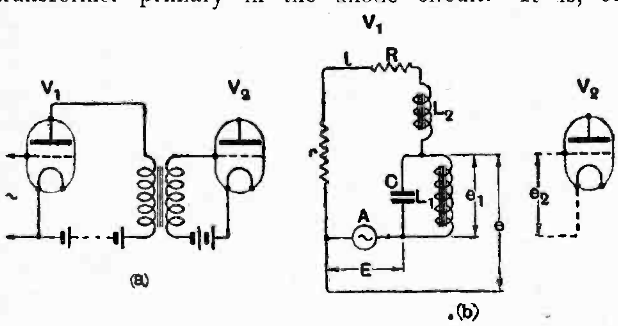


Fig. 13.—Equivalent circuit (b) of valve-transformer combination shown at (a). A = variable frequency alternator equivalent to signal; r = internal resistance of valve; C = equivalent capacity of transformer secondary referred to primary circuit; L_1 = inductance of primary, assumed constant; L_2 = equivalent leakage of transformer referred to primary; R = equivalent resistance of transformer referred to primary; E = m × voltage applied to grid of V_1 at any instant; e_1 = voltage across primary at any instant; e_2 = voltage across secondary = e_1 × transformer ratio; i = alternating current through r at any instant.

Transformer Resonance.

Let us turn our attention to Fig. 13 (b), in which is illustrated a circuit approximately equivalent to the valve circuit Fig. 13 (a). The alternator A will be assumed to generate a constant voltage at all frequencies, this being equivalent to a like voltage control of the valve as effected by a voltage between its grid and filament. The amplification from the grid of V_1 to that of V_2 is $\frac{e_1}{E} \times m \times$ transformer ratio, where m is the magnification factor of the valve. From this formula with the aid of Fig. 13 it will be seen that $\frac{e_1}{E}$ should be as near unity as possible, *i.e.*, e_1 should be much greater than e. Now, e is the vector sum of ri, Ri, and $\omega L_2 i$, where i is the alternating current flowing round the circuit. Expressed symbolically the numerical value of e is $i[(r+R)^2+\omega^2 L_2{}^2]^{\frac{1}{2}}$, where $\omega = 2\pi \times$ frequency. Also $e_1 = \omega L_2 i = \frac{i}{\omega C}$.

Taking phase into account it must be clear that at any instant the total voltage across r, R, L_1 and L_2, *i.e.*, $e + e_1$, cannot exceed E. Now, suppose the frequency is of such a value that the impedance of L_1 is very high compared with that of C. We may then consider L_1 to be removed (in an actual valve circuit L_1 will act as an anode feed choke). Moreover, at a suitable frequency L_2 and C will resonate, and their voltages will be equal *but opposite*. The voltage across them is $\omega L_2 i = \frac{i}{\omega C}$ (giving $\omega^2 L_2 C = 1$). Now, the maximum value of i is governed by the value of $(r+R)$. Thus the voltage across C and therefore across the primary of the transformer is controlled by $r+R$. Hence, with a transformer and a valve of low combined resistance, the current may be relatively large, thereby yielding a voltage on the primary several times greater than E, *i.e.*, when leakage resonance occurs.

For example, take a combined value of $r+R$ as 35,000 ohms, a value of L_2 as 2 henries, and C as 400 micro-microfarads. The resonance frequency would be in the neighbourhood of 6,000 cycles. At resonance the maximum current is given by $I = \frac{E}{R+r}$. Now, the voltage on C and therefore on L is $\frac{I}{\omega C} = \omega L_2 I = \frac{E}{\omega C(R+r)} = \frac{\omega L_2 E}{(R+r)}$ which is approximately equal to 2E (by insertion of numerical values).

Thus the effective amplification due to the valve and transformer is given at leakage resonance by the expression $\frac{\omega L_2}{R+r} . E . \frac{n_2}{n_1}$ where $n_1 n_2$ = turns.[2] The factor $\frac{\omega L_2}{R+r}$ is the outcome of the leakage.

Thus, if the transformation ratio were 2, and the valve magnification factor 7, the amplification at 6.000 would be $2 \times 2 \times 7 = 28$, or just double that on the horizontal portion of the characteristic. The curve of Fig. 2 (page

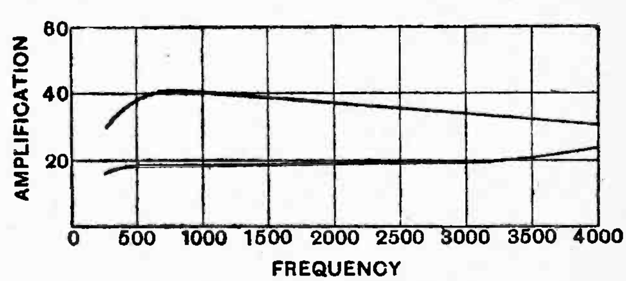


Fig. 14.—Curves of Marconiphone "Ideal" transformer. Upper curve with "R" valve, lower curve with D.E.3 valve.

[1] In all calculations the valve constants have been taken from data supplied by the valve manufacturers.

[2] $\left(\frac{E}{m}\right)$ is the voltage applied to grid of V_1 of Fig. 13. In the ordinary way the amplification is given by $\frac{kEn_2}{n_1}$ where k is about unity on the flat part of curve.

Speech Amplifier Design.—

45 of January 13th issue) ought now to have a definite meaning, and the gradual slope from 1,000 cycles upwards indicates that at some frequency a resonance point will be attained. Also, from the formula it will be evident that with any given transformer which shows a rising characteristic the rise can be reduced by augmenting $(r+R)$, *i.e.*, by using a higher impedance valve. This is illustrated in a concrete manner by the curves of Fig. 14, which show the characteristics of a 4 : 1 transformer with valves of high and of moderate impedance.

Amplification at Low Frequencies.

The upper curve of Fig. 14 shows a falling characteristic, and this is due chiefly to the alternating volt drop on the valve being of importance compared with that across the transformer primary. Although the primary inductive reactance is high, the capacity reactance is low, as an example will clearly show. Taking the valve resistance and primary of transformer as 40,000 ohms, L=25 henries and C=0.001 mfd., the reactances of L and C at 3,000 cycles are respectively 460,000 ohms and 55,000 ohms. Thus the transformation ratio will be—by calculation from these data—about 33, which is in close agreement with the value given in the upper curve of Fig. 14. This fall in amplification is due to the large internal resistance of the valve, which eliminates the resonance peak due to leakage. Having dealt with the rise and fall of the amplification curve above the normal resonance point (about 1,000 cycles in Fig. 14), there still remains the important lower frequencies where transformer curves fall away rapidly. Referring to the equivalent circuit of Fig. 13, capacity and leakage effects will be negligible below frequencies of the order of 300 cycles. The amplification is now

$$\frac{n_2}{n_1} \times \frac{\text{primary inductance}}{\text{primary resistance} + \text{valve resistance}}.$$

Let

ρ = internal resistance of valve,
r = effective resistance of transformer,
m = amplification factor of valve,
L = effective inductance of transformer primary (variable),
S = ratio of transformation $= \frac{n_2}{n_1}$.

Then amplification $= \dfrac{Sm}{\left[1+\left(\frac{\rho+r}{\omega L}\right)^2\right]^{\frac{1}{2}}}$ for low frequencies, *i.e.*, below 300 cycles.

Now Sm is sensibly constant, so that it is only necessary to consider $\left[1+\left(\frac{\rho+r}{\omega L}\right)^2\right]^{\frac{1}{2}}$. Taking some values approximating to an average transformer, let L = 15 henries, ρ=8,000 ohms (D.E.5 or D.E.8 L.F.), r= 3,000 ohms, $\omega = 2\pi f = 2\pi \times 256$ (middle C on piano), we get $\left[1+\left(\frac{\rho+r}{\omega L}\right)^2\right]^{\frac{1}{2}}$ is approximately equal to 1·1. At 128 cycles, an octave lower down the piano, the value is 1.35 at 64 cycles=2.05, and at 32 cycles=3.7. Table 1 shows the corresponding amplifications.

A glance at the figures shows that there is little amplification on the lower portion of the pianoforte scale. In fact, it would be a good plan to play notes equivalent to these frequencies on the piano to get a closer acquaintance with the importance of low tones. Using only one such transformer and a power valve the energy for equal volts on the grid of the detector at 64 cycles would be 0.28 of that at 512 cycles, thus giving a much reduced bass. But now consider two such transformers in cascade, *i.e.*, detector followed by two note magnifiers. The voltage amplification at 64 cycles is now $0.28 \times 0.49 = 0.14$, whilst the energy is 0.02 of the corresponding quantities at 512 cycles. There is no wonder that few people hear the low-toned instruments when we see these figures.[3] Of course, a good deal of low-tone boosting is done by grid leaks and reaction, so that the actual case is not so bad as the figures represent; but in general such boosting is offset by a lack of clearness and intelligibility. This is not always readily apparent unless a quick change over can be made to the other condition. Some calculations on the special transformer mentioned above may be of interest. Using the same formula and data as before, but taking L=225 henries and r=10,000 ohms, we get the following figures (see Tables 2 and 3) At 64 cycles with two of these high inductance transformers, the energy is not reduced perceptibly, whereas with the 15-henry type the reduction was $\frac{1}{0.02} = \frac{1}{50}$.

Put in another way, with two transformer primaries of 225 henries, the relative intensity of a note of 64 cycles would be fifty times that with one transformer of 15 henries.[4] This is not a plea for transformer coupling—far from it. Just as good results can be obtained with resistance coupling, the magnification being little inferior.

There is, however, an absence of variability of the characteristic unless additional devices are incorporated with the resistance coupling. It is possible, however, to augment the amplification far beyond that of a single stage of resistance coupling by using a D.E.5B valve with an m value of 20 and a ρ value of 30,000 ohms. The magnification is then 40 on the horizontal portion of the curve, whilst that at 64 cycles is $0.92 \times 40 = 37$.

Influence of the Internal Resistance of the Valve.

In the last section a simple mathematical argument was advanced to account for the shapes of amplification-frequency characteristics associated with transformer-coupled amplifiers. From what precedes, the following salient conclusions can be deduced : (1) A high-impedance valve of 40,000 ohms with a transformer of moderate inductance, say, 20 henries, is conducive to a lack of amplification of both upper and lower tones. (See Fig. 14, upper curve.)

(2) A low-impedance valve, on the other hand, is conducive to good amplification of the lower tones, but, in general, there is a tendency for the higher tones to be accentuated, due to an upward tilt of the characteristic. (Fig. 14, lower curve.)

[3] With a high impedance valve, say 22,000 ohms, the figures would be ludicrous.

[4] With two 15-henry transformers the ratio would be 2,500 : 1.

TABLE 1. (Sm = 28.)		
	Freq.	Ampln.
C	256	0.91
C_1	128	0.74
C_2	64	0.49
C_3	32	0.27

TABLE 2. (ρ = 20,000 ohms.)		
	Freq.	Ampln.
C	256	1.0
C_1	128	0.99
C_2	64	0.95
C_3	32	0.80

TABLE 3. (ρ = 8,000 ohms.)		
	Freq.	Ampln.
C	256	1.0
C_1	128	1.0
C_2	64	0.98
C_3	32	0.92

The next phase of the subject is to discuss the influence of high- and of low-impedance power valves on the loud-speaker, which will be assumed to have a D.C. resistance of 2,000 ohms. The conclusions will, in general, be valid for low-resistance instruments with a transformer. At a frequency of 50 cycles the major portion of the impedance of the loud-speaker is due to its resistance. To get the total impedance, the internal resistance of the valve must be added. Let the latter resistance be 10,000 ohms and the A.C. resistance of the speaker 2,000 ohms. The total is 12,000 ohms, and with any low-frequency alternating voltage E the current is E/12,000. Now replace the valve by one of 4,000 ohms internal resistance (D.E.5A). The total resistance at 50 cycles is now 6,000 ohms. Thus the alternating current will be E/6,000, or about *twice its former value*. Thus the low tones will be augmented in intensity. At frequencies of 1,000 cycles and upwards, the inductive reactance as well as the resistance of the loud-speaker must be taken into account. Assuming the inductance to be 3 henries and the effective resistance (at 1,000 cycles) 5,500 ohms, the inductive reactance $\omega L = 2\pi \times 1{,}000 \times 3 = 19{,}000$ ohms (approx.). With a valve of 10,000 ohms (ρ), the total resistance is 15,500 ohms. Thus the total impedance is $[(19{,}000)^2 + (15{,}500)^2]^{1/2} = 24{,}500$ ohms, and with an alternating voltage E the current is E/24,500. By using a valve of 4,000 ohms the total impedance is 21,200 ohms, and the current E/21,200. Thus the ratio of the currents with 4,000- and 10,000-ohm valves at 1,000 cycles is $\frac{24{,}500}{21{,}200} = 1.16$, as against a ratio of 2 : 1 at a frequency of 50 cycles. Hence the use of a low-impedance valve as against one of high impedance is to boost the low tones relative to the high ones, which are not increased very much. It will be appreciated, of course, that the low-impedance valve, owing to its smaller *m* value, necessitates augmented signals on its grid to give equal audibility with the high-impedance valve. Since the impedance (reactance and effective resistance) of the loud-speaker increases with the frequency, the current, for equal voltages applied to the power valve at all frequencies, will decrease with increase in frequency. There will probably be undulations due to mechanical resonance effects, *i.e.*, variation in motional impedance. Apart from varying the high- and low-frequency amplifier characteristics, there are three ways of boosting (relatively) the low-frequency tones by manipulating the *loud-speaker circuit*: (1) By using a low-impedance valve or several similar valves of moderate impedance in parallel, (2) by shunting the loud-speaker with a fixed or a variable condenser, (3) by connecting two or more loud-speakers in series. Method (1) is, of course, the best, since the higher tones are not reduced to the same extent as pertains in the other two arrangements. For example, (1) leaves the high tones intact, whereas the other method merely reduces the high tones and leaves the low ones much as they were, and the higher the tone the greater the reduction. Moreover, in practice the result is a muffling effect when methods (2) and (3) are used. It is seldom found necessary to reduce the low tones, but a suitable inductance or choke of low resistance shunted across the loud-speaker, a high-impedance valve, or a non-inductive resistance in series with the power valve will supply the necessary conditions. The effect of a resistance can readily be tested by including one's body—from hand to hand—in series with the loud-speaker. The reproduction will then sound squeaky. A word of warning is necessary concerning the above, or, in fact, any mode of boosting the low tones. There will be no audible alteration, and the experiments will therefore fail if the low tones are not of sufficient intensity before the boosting device is applied. For instance, suppose a double bass is inaudible on the loud-speaker with a valve of 8,000 ohms internal resistance. It is, indeed, too much to expect that this instrument will become appreciably audible by using a 4,000 ohm valve. Moreover, it will eliminate any possibility of misconception if we define the boosting of low tones as one which augments the aural perception of tones already audible. A great deal of boosting is requisite to render an inaudible tone comfortably audible.

Requirements for Average Loudness Level.

In general, I think that the majority of reproductions lack the *very* high and the *very* low tones. For general purposes in a private residence one can tolerate a good deal of the low tones, but the really high ones, *e.g.*, the extreme overtones from stringed instruments, are decidedly irritating (at normal strength), although it must be conceded that the reproduction is more natural when they are heard in full force. The desideratum is something with the sharp "edge" off, and, moreover, an absolute replica at original strength would in many cases of prolonged listening be physiologically undesirable. Stated in other words, the average listener wants a mellow tone from the loud-speaker. In a heavily draped room an instrument of the "edge" variety would doubtless be quite pleasing at some distance from it.

The question of loudness level has already been broached, and this is really an important point. It seems a reasonable hypothesis that, when listening to radio reproduction for hours at a time in a private residence, the intensity should be such that conversation is easy and listening effortless. Moreover, suppose we reproduce a military band or a pianoforte at full strength and then,

Speech Amplifier Design.—
by cutting down the magnification, let the air pressure be, say, one-fiftieth to one-hundredth the value of the original. Since the ear is relatively insensitive to low tones, these will appear to be reduced, and therefore we have apparently introduced a form of distortion. Strictly speaking, there is no distortion at all, but merely the same effect as that of music at a distance, *plus* the influence of the reflections from the boundaries of the room, and these are quite important. In general, I think it will be agreed that it is definitely desirable to hear a fair proportion of the fundamental of a violincello in a string quartet, although the output from the reproducer may be only one-hundredth that of the original. Hence we must introduce distortion to satisfy this aural propensity for low tones. Some idea of the insensitivity of the human ear will be gained from the fact that when a note two octaves *above* middle C on the piano is just audible when struck, the air pressure is one-fiftieth that when the octave below middle C is just audible, *i.e.*, for equal threshold audibilities C_1 must be fifty times the intensity of C^2. This provides food for thought.

Magnification Obtainable from Amplifier.

It may be of interest to show that the magnification obtainable with the variable characteristic amplifier can hold its own with any double note magnifier whilst yielding as good or better quality. For the best quality, the magnification is usually reduced, but, even when the amplifier is going "all-out," the quality is still good. The data in Table 4 show the various degrees of amplification possible—on the horizontal part of the characteristic—and the valves used to obtain it. The amplification is reckoned from the grid of the detector to the anode of the power valve. Allowance must be made for the frequency change at the detector from supersonic to sonic by way of a modulation coefficient. This is less than unity, since the modulation of the carrier wave is only about 25 per cent. on the average. In this case the value of the coefficient is clearly 0.25.

A comparison between the present amplifier and a good double note magnifier is given in Table 5, and the superiority of the former is evident—on paper at least. In practice there would be a lack of low tones with the double note magnifier unless the grid leak and some reaction on the R valve detector gave its assiduous assistance. The overall amplification of the variable amplifier can be still further increased by transformer-coupling the valves V_1 and V_2, but the quality is then evanescent, and this arrangement is chiefly useful for spotting very weak distant stations. In using a D.E.5B, the intensity from the loud-speaker should not be overdone, because the

TABLE 4.—DATA FOR VARIABLE CHARACTERISTIC AMPLIFIER.

No.	V_1.	V_2.	V_3.	Coupling V_1 to V_2.	Coupling V_2 to V_3.	Gross Magnification from Grid of V_1 to Anode of V_3.	Net Mag.[2]	Remarks.
1	D.E.3B.	D.E.5	D.E.5A.	Pure res.[1]	2 : 1 trans. with 0.003 mfd. cond.	450	112	Uniform mag. from 30 to 4,000 cycles.
2	D.E.3B.	D.E.5	D.E.5	Ditto.	Ditto.	900	225	Ditto.
3	D.E.3B.	D.E.5	D.E.5A.	900 hy. choke	2 : 1 trans.	730	182	Uniform mag. 40 to 4,000 cycles.
4	D.E.3B.	D.E.5	D.E.5	Ditto.	2 : 1 trans.	1,460	365	Ditto.
5	D.E.3B.	D.E.5	D.E.5	Ditto.	3 : 1 trans.	2,190	547	Increasing mag. above 3,000 cycles.
6	D.E.3B.	D.E.5B.	D.E.5A.	Pure res.	2 : 1 trans. with 0.001 to 0.002 cond.	1,300	325	Uniform mag. 50 to 4,000 cycles.
7	D.E.3B.	D.E.5B.	D.E.5	900 hy. choke	Ditto.	4,000	1,000	Uniform mag. 90 to 4,000 cycles.
8	D.E.3B.	D.E.5B.	D.E.5	900 hy. choke-res.	3 : 1 trans. with 0.003 cond.	6,000	1,500	High magnification.
9	D.E.Q.	D.E.5B.	D.E.5	Ditto.	Ditto.	8,000	2,000	Ditto.
10	D.E.3B.	D.E.3B.	D.E.3	900 hy. choke-res.	2 : 1 trans.	3,000	750	Low fil. current. Uniform 140 cycles to 4,000 cycles.

[1] 0.1 to 0.2 megohm.
[2] The energy magnification is proportional to the squares of these numbers.

TABLE 5.

V_1.	V_2.	V_3.	V_1 to V_2.	V_2 to V_3.	Gross Magnification.	Net Mag.	Remarks.
R.	D.E.5	D.E.5	3 : 1 trans.	4 : 1 trans.	5,800	1,450	Double note mag.
D.E.Q.	D.E.5B.	D.E.5	900 hy. choke-res.	3 : 1 trans. with 0.003 cond.	8,000	2,000	Variable amplifier.
D.E.3B.	D.E.5B.	D.E.5	Ditto.	Ditto.	6,000	1,500	Ditto.

Speech Amplifier Design.—
characteristic of this valve is not particularly straight, and alien tones are apt to be introduced, due to working over too large a part of the curve. The reader may ask, Why not use a D.E.5B on the double note magnifier? There is no reason why this should not be done, except that the quality will suffer considerably, due to lack of high and low tones, and it is more than probable that the set would howl. The above comparison is quite fair, because there is not a great deal of difference between the two overall characteristics, excepting that the variable amplifier has a better low tone scale, provided reaction is absent from the H.F.

To avoid reaction, the variable characteristic amplifier can be preceded by several stages of H.F. amplification. With four H.F. valves (D.E.3) giving about 5 per stage, the amplification is $5^4=625$. Thus the total magnification due to the seven valves is $625 \times 8{,}000 = 5{,}000{,}000$. Allowing for the modulation coefficient, this reduces to 1.25×10^6 with a D.E.Q as detector, and to just under a million with a D.E.3B as detector. This is about the right order of magnification for getting the evening programmes of distant British and Continental stations at loud-speaker strength on a good open aerial. The filament current consumption is only about 0.7 ampere, whilst with a D.E.3B in place of a D.E.5B for the transformer coupling, *i.e.*, for V_2, and a 120 mA power valve (D.E.8 L.F.), the current becomes 0.48 amps.—an extremely reasonable value; but we hope for its reduction.

Additional Artifices for Varying the Amplifier Characteristics.

The above by no means exhausts the devices for obtaining a variable characteristic. There are devices for neutralising resonant notes in loud-speakers and for causing a dip in the characteristic, such as that shown in Fig. 15. The LC circuit is a pure resistance equal to the effective value of choke *plus* condenser (chiefly choke) at the resonant note of the loud-speaker. If r were 100,000 ohms and at resonance the LC resistance were 20,000, the amplification would be reduced to about one-fifth its normal value (neglecting the influence of the leak, which can be assumed as 0.3 megohm).

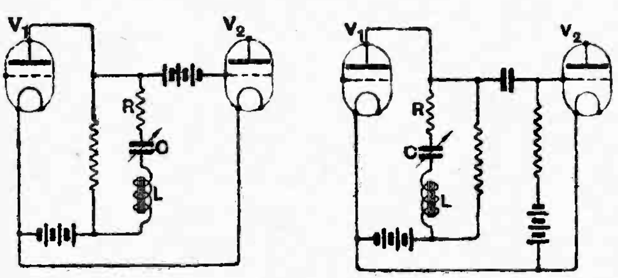


Fig. 15.—Method of producing a dip in the amplification characteristic by means of a series combination of condenser and inductance.

Then there is the combination of a low-resistance choke and relatively high-impedance valve for boosting the high tones proportionately to the frequency. (This does not neutralise the muffling due to the low damping caused by reaction in a H.F. circuit, although it brings up the high tones.) This is sometimes termed electrical differentiation. If the impedance of the choke is small compared with that of the valve, and if its self-capacity is low, the A.C. anode current for equal voltages on the grid of the valve will be nearly equal at all frequencies. Now the voltage on the choke is ωLi, where L is assumed constant. But $\omega Li = 2\pi f Li = f \times$ a constant. Hence the voltage is proportional to and increases with the frequency. If properly designed, the choke can be replaced by a transformer, but the primary inductance and self-capacity must be kept small.

A discussion of these and other artifices is beyond the scope of this article, which is primarily to show what can be done in regard to variable characteristics with relatively simple apparatus. In testing and in operating loud-speakers such an amplifier has proved of great value and can be recommended. In another form of the apparatus the coupling between V_1 and V_2 (Fig. 1, page 44 of January 13th issue) has been effected in the usual way by a *mica* condenser of 0.2 mfd. and a leak of 2 megohms. Although the resulting curves are modified the acoustic result is much the same. Admittedly, this is the easier course, because there is no computation necessary to arrive at the correct grid bias on V_2, which is rather a knotty point with valves of high "*m*" value (D.E.5B, D.E.3B), and no alteration to the bias is required if the coupling is altered from resistance to choke, or if the set is detuned. This amplifier, with an "Ideal" 2.7 : 1 transformer between V_2 and V_3 can be recommended to give good quality. Greater magnification can be secured by using a D.E.5B in place of a D.E.5 for V_2. The quality is still good.

Summary.

(1) The ultimate quality from a loud-speaker depends upon (*a*) the input to the H.F. circuit, *i.e.*, the curve from the microphone and its associated circuits at the transmitter; (*b*) the overall frequency-amplitude characteristic of the receiver; (*c*) the pressure or energy-frequency characteristic of the loud-speaker in free space; (*d*) the loudness level, this includes the physiological aspect of the matter; (*e*) the influence of the room in which the loud-speaker is situated. The better the loud-speaker the easier it is to verify these statements.

(2) From (1) it does not immediately follow that the overall characteristic of the complete receiver should show equal amplification at all frequencies. With certain types of loud-speaker used at moderate loudness level, the characteristic should dip in the middle register to give due proportion to the low and the *upper* high tones. The amount of dip varies with the degree of loudness. With other types of speaker it is sufficient to give the amplifier characteristic a prominent bass, the remainder of the characteristic being horizontal. If a speaker is very weak on lower tones, it may not be practicable to adjust the amplifier accordingly to get a good bass.

(3) Having attained the correct, or rather the most pleasing characteristic[5] for a certain loudness level there are still two salient defects: (*a*) absence of stereophonic effect, or the sense of directivity and location, (*b*)

[5] The correct characteristic for natural loudness would of course give a thin bass when cut down to, say, 1/100th normal intensity.

Speech Amplifier Design.—

resonances in the reproduction, these being introduced at various parts of the system.

(4) A variable characteristic can be secured by adopting artifices such as those described herein. When boosting low tones it must be realised that the human ear is relatively insensitive at frequencies of the order 20 to 400 cycles. Thus an inaudible tone may have to be magnified *many* times to become comfortably audible. So far as low-toned instruments are concerned, *e.g.*, double bass, these require a good *fundamental*, and ought not to be "sensed" by their overtones.

(5) Comparatively inconspicuous resonances often become prominent with increase in intensity. The time required for the resonating component to decay to inaudibility increases with the intensity. With a diaphragm type of loud-speaker, the lower the frequency of a resonance note the more sustained is its effect, because the damping is usually less for the low than for the high tones. Hence at large intensities the time for the natural vibration to die away to inaudibility is usually appreciable and causes a nasty coloration and blurring of the output. (Try the bass notes on a piano, playing chords, and compare with the treble. The latter are much clearer cut.) There is also horn resonance, which is not particularly objectionable for weak sounds but with loud sounds causes the low tones to be badly defined. Instruments like the double bass, drums, etc., are acoustically amalgamated instead of standing out separately, as in sculptural relief. Appreciable resonance causes blurring of a band of frequencies on each side of the central. The influence of heavy reaction also causes blurring. Thus the average speaker sounds best when the intensity is moderate.

Finally, I am much obliged to Mr. E. C. Cork, M.Sc., for obtaining the various curves associated with the different transformers. Without quantitative data, it would have been impossible to write with certainty on the performance of the variable characteristic amplifier.

[NOTE.—The author has asked us to draw attention to the following points: (1) In Fig. 1 (page 44, Jan. 13th issue) condenser C_2 should be connected across all the *active* primary sections; (2) the D.C. feed through the primary of the high-inductance transformer should be limited to avoid saturation of the iron; (3) in Fig. 10 (page 95, Jan. 20th issue) the internal resistance of the D.E.Q. valve operating as anode rectifier was 370,000 ohms, not 37,000; hence the lack of magnification of the lower tones.]

TRANSMITTING NOTES AND QUERIES.

General Notes.

Mr. E. J. Simmonds (G 2OD) informs us that he was in communication with FI 8QQ (Saigon) on December 6th, 1925, at 1940 G.M.T., and that FI 8QQ stated that he had previously worked with G 2CC, H. S. Nicholls, Stockfield-on-Tyne. We shall be pleased to hear from any British amateur who can establish a prior claim to two-way working with FI 8QQ.

oooo

Mr. A. E. Livesey, Stourton Hall, Horncastle, states that during October he received BZ 1BD, Alberto Villela, Rio de Janeiro, on a wavelength of about 40 metres, when the Brazilian amateur was working with an input of only 5 watts, using a UV 202 with 400 volts D.C. on anode in a Hartley circuit with a Hertz aerial. Signal strength was about R.5. Mr. Livesey thinks this must be a DX record.

oooo

If the late owner of the call-sign G 6NK, who was working on November 23rd, 1925, will communicate with the present owner, R. J. Denny, 1, Hillside, Waverley Road, Weybridge, Surrey, he can have a card reporting his signals in Western Australia.

oooo

Call-signs Allotted and Stations Identified.

2AMB.—J. L. Thompson, 58, Highlever Road, North Kensington, W.10.

2BAO.—H. and L. Wilkins, Hills View, Studland Road, Elthorne, W.7. (Art. A.) (Change of address.)

2BBR.—S. C. Keville, 70, Isledon Road, N.7.

2BMM.—K. E. B. Jay, "The Quinta," Elm Grove, Amersham, Bucks. (Art. A.)

5WC.—W. Clough, 36, Victoria Street, Lower Broughton, Manchester (corrected address).

5YJ.—Major W. H. Oates, 21, Wolverton Gardens, Hammersmith, W.6.

6NO.—H. E. Norris, 48, Cold Overton Road, Oakham, transmits on 23 and 45 metres.

6RP.—C. A. Potter, Newfield Hall, Sheffield.

6TG.—R. Harris, The Rectory, Long Crichel, Wimborne, Dorset, transmits on 23, 45, 150, 200, and 440 metres.

6UZ.—W. M. Bakewell, Yeovil House, Regent Street, Stoke-on-Trent (corrected address).

I 1AM.—A. Marzoli, Via Bramanti, 3, Rome.

B J2 and B W2.—Rudolf Couppez, 3, Rue Elise, Ixelles, Brussels.

EAR24.—L. Garay, Oñate, Guipuzcoa, Spain.

O A6N (in place of O F1C).—Major J. G. Swart, Cambridge House, Milnerton, Cape Town, South Africa.

oooo

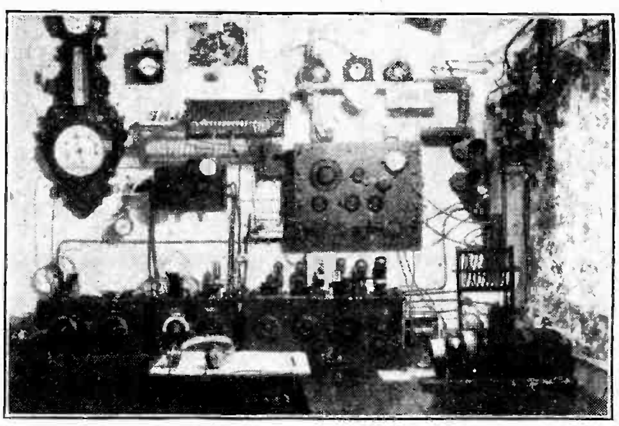
QRA's Wanted.

We have received communications for forwarding to the following transmitters and shall be glad if they, or any of our readers, will send us the required names and addresses:—

G 2APD, G 2BN, J 2BMA, G 2CL, G 2ER (?), G 2FO, G 2ZD, G 5CO, G 5PM, G 6DT, G 6ER, G 6JH, G 6KY, G 6LH, G 6ND, G 6RR, G 6YX, A 3EF, A 4RT, GC 2BE, F 8FIR, F 8PRI, F 8LZ, F 8TZ, M 4HS, Z 2AX, Z 3AO, Z 4AV. Also for G 5XO, E GEH (? Egypt). BZ PT1, P 1AE, Y HBK, LAR BU3. India: CRP, PI 1FN, AN 3FZ, F 8NN, F 8HFD, F 8RF, G 6LL.

AN IRISH TRANSMITTING STATION.

5NJ, the well-known station owned by Mr. F. R. Neill, at Chesterfield, Whitehead, Co. Antrim, was the first licensed in Northern Ireland, and has been working since June, 1925. Tests have been carried out with many British stations and two-way communication with Australia, New Zealand, North and South America, South Africa, and French Indo China.



EXPERIMENTAL TRANSMITTING STATIONS.

Supplement to the lists published in the "Wireless Annual for Amateurs and Experimenters," 1926.

At the request of many of our readers we publish below the call-signs, names and addresses of Amateur Transmitters in all parts of the world which we have received since the "Wireless Annual" went to press, and any corrections to these lists of which we have been notified since their publication. We are indebted to the Editor of *T.S.F. Moderne* for most of the French stations. It is intended to issue these supplementary lists from time to time in order that those of our readers who have copies of the "Wireless Annual" may keep their lists of Amateur Transmitters up to date. Call signs and addresses marked with an asterisk (*) supersede those in the original list.

GREAT BRITAIN (G.).

Additional Stations.

2 ACI S. Williamson, 22, Hurst Grove, Bedford.
2 AHZ L. C. Patterson, 18, Lancaster Court, Newman St., W.1.
2 AMB J. L. Thompson, 58, Highlever Rd., North Kensington, W.10.
2 AUQ S. T. Nottley, 3, Fleetwood Rd., Slough.
2 BBR S. C. Keville, 70, Isledon Rd., N.7.
2 BIK C. L. Champion, BarryFarm, Rickmansworth, Herts.
2 BJK C. Brookes, 7, Merivale Rd., Putney, S.W.15. (Artificial aerial.)
2 BLM J. C. Martin, 50, Holyhead Rd., Coventry. (Artificial aerial.)
2 BMM K. E. B. Jay, The Quinta, Elm Close, Amersham. Bucks. (Artificial aerial.)
2 BNN T. H. F. Wagstaff, 24, Earl Howe St., Leicester.
2 CO G. E. Pohu, 10, Colville Rd., Bayswater, W.11.
2 FV W. Scott Hay, "Ivycraig," Newton Mearns, Renfrewshire.
2 GW* G. S. White, Fiveways, Chippenham, Wilts.
2 IT* B. Walsh, "Clovelly," Victoria St., Armagh, N. Ireland.
2 JC* G. Sykes, 13, Lingford St., Gorton, Manchester.
2 KV W. J. Crampton, Huntington House, South Cliff, Bexhill.
2 NH* E. A. Dedman, 65, Kingston Rd., New Malden, Surrey (late 2 BGM).
2 NT A. C. C. Willway, Knole Hill, Mayfield, Sussex.
2 OZ* J. W. Norton, 20, Perryn Rd., Acton, W.3.
2 RK* C. St. V. Roper, 7, Yale Court, Honeybourne Rd., N.W.6.
2 YG* W. H. Andrews, "Tramore," Totnes Rd., Paignton.
5 BY H. L. O'Heffernan, 69, Lower Addiscombe Rd., Croydon.
5 CJ* O. Carpenter, 35, Sunnyside Rd., Weston-Super-Mare.
5 FF R. Ferguson, 23, Cavendish Ave., Church End, Finchley, N.3.
5 FQ E. H. Capel, "Sunnyside," 32, College Rd., Harrow (late 2 BBQ).
5 IR H. Field, 62, Chertsey Rd., Woking.
5 JD* J. L. Wood, Stanhurst, Burntisland, Fife.
5 JW* P. Cox, 101, Birchfield Rd., Longsight, Manchester.
5 KR C. M. Thorpe, The Crossways, Rhuddlan, N. Wales.
5 KU R. Pollock, 4, Glenhurst Ave., N.W.5.
5 WP* W. E. Russell, 5, Walton Rd., Woking.
5 WV D. Woods, Station House, Braintree, Essex (late 2 AXZ).
5 YJ Major W. H. Oates, 21, Wolverton Gdns., Hammersmith, W.6.
5 ZG* R. P. Hawkey, "Tregenna," Grange Ave., Woodford Green, Essex.
6 AT F. Aughtie, 28, Terry St., Dudley, Worcs.
6 CJ F. J. H. Charman, 76, Salisbury Rd., Bedford.
6 DA S. D. Davy, 80, Essendine Mansions, Maida Vale, W.9.
6 FT R. T. Frost, 19, Highfield Rd., Felixstowe (late 2 BIU).
6 HF M. H. Wynter-Blyth, Tankersley, nr. Barnsley Yorks.
6 MW Lt.-Col. C. W. Thomas, Clifton House, Old Swinford, Stourbridge.
6 NK R. J. Denny, 1, Hillside, Waverley Rd., Weybridge.
6 NO* H. E. Norris, 48, Cold Overton Rd., Oakham.
6 OG R. A. Webber, 8, Theresa Ave., Bishopston, Bristol (late 2 BDQ).
6 RP C. A. Potter, Newfield Hall, Sheffield.
6 SQ G. A. Heaney, 5, Dunedin, Antrim Rd., Belfast.
6 TG R. Harris, The Rectory, Long Crichel, Wimborne, Dorset.
6 VO* D. Simpson, 18, Bank St., Lerryhill, Aberdeen.
6 VZ A. E. Stephens, West View, Chewton Rd., Keynsham, Bristol.
6 XR T. Mitchell, Bentfield, Newhey, nr. Rochdale.
6 YV S. F. Evans, 3, Clarence Cres., Whitley Bay, Northumberland.
6 YW T. P. Allen, 19, Ardgreenan Drive, Strandtown, Belfast.

Corrections or Changes of Address.

2 ARG W. E. Rhodes, Wayside, Luard Rd., Cambridge (change of address).
2 BM H. L. Garfath, 166, Birchanger Rd., South Norwood, S.E.25 (change of address).
2 BAO H. O. L. Wilkins, Hills View, Studland Rd., Elthorne, W.7 (change of address).
2 DY } **2 DZ** } F. H. Haynes, 38, Sittingbourne Ave., Enfield, Middlesex (corrected address).
2 MD C. Chipperfield, 5, Nacton Rd., Ipswich (change of address).
2 TK K. H. Thow, 2, Victoria Rd., Eltham, S.E.9 (change of address).
2 UN W. Bensley, 13, Kelfield Gardens, W.10 (corrected address).
2 ZO } **5 LA** } L. H. Soundy, 8, Chester Gardens, Argyle Rd., Ealing (change of address).
5 WC W. Clough, 36, Victoria St., Lower Broughton, Manchester (corrected address).
6 LJ S. K. Lewer, 32, Gascony Rd., West Hampstead, London, N.W.6 (corrected address).
6 MP O. W. Nicholson, Basing Park, Alton, Hants. (corrected address).
6 TH C. W. Liles, "Morningside," Fields Rd., Newport, Mon. (change of address).
6 UZ W. M. Bakewell, Yeovil House, Regent St., Stoke-on-Trent (change of address).

FRANCE (F.).

Additional Stations.

8 ALG P. Longayron, 10 Rue Nelson, Chierico, Algiers.
8 AH — Bourgognat, 10 Impasse de Fort Malakoff, Paris.
8 FD* Prof. M. Reyt, Lycée d'Orléans.
8 FO Syndicat Forestier de Provence, 34 Rue de l'Arsenal, Marseilles.
8 GF C. Perrot, Radio Club du Bas Rhin, Strasbourg.
8 GG — Hennequin, 6 Rue St. Eucaire, Metz (Moselle).
8 GR Soc. Hydroélectrique de Lyon, 5 Place Sathonay, Lyons.
8 GU } **8 GV** } Observatoire du Pic du Midi.
8 GY Sim Radioline, 32 Rue Neuve, Marseilles.
8 HA — Gastine, Rue de la Gare, Ste. Anne d'Auray (Morbilian).
8 HC — Sarraillior, 63 Rue St. Ferréol, Marseilles.
8 HP Dr. Dupont, Bould de Laré, Marmande (Lot & Garonne).
8 HQ } **8 HR** } **8 HS** } **8 HT** } Soc. d'Encouragement pour l'Amélioration es races de Checaux en France, 3 Rue Scribe, Paris.
8 IE — Beaugez, Etabs. Bardon, 61 Bould. National, Clichy (Seine).
8 II — Trouvais, La Ferté St. Cyr (Loir & Cher).
8 IL A. Lamy, 2 Rue de Provence, Paris.
8 IM — Vandeville, 42 Rue Thiers, Denain (Nord).
8 IO L. Roussel, 40 Quai Fulchiron, Lyons.
8 IR — Chechan, 31 Rue Danfert, Rochereau, Algiers.
8 IS — Courtière, 19 Rue St. Lambert, Paris.
8 IT Y. Savous, 9 Rue Citoyen Bézy Oran.
8 IU — Combe, Av. Béranger, Ecully (Rhone).
8 IV — Perrin, 10 Rue de Jeu de Paume, Dunkerque (Nord).
8 IX R. Simon, 44 Rue Pelletat, Choisy-le-Roi (Seine).
8 JA H. Gauny, 1 Promenade de la Digue, Verdun-sur-Meuse.
8 JB MM. Dardonville and Viard, 35 Rue Besançon, and 10 Rue Gambetta, Langres (Haute Marne).
8 JD J. F. Bastide, 14, Place St. Servin, Toulouse.
8 JG — Debacq, 4 Rue de Constantine, Algiers.
8 JH Hemet Frères, 13 Rue de Besuvallet, Havre.
8 JI — Coutrille, 34 Impasse Visitadine, Toulouse (Gironde).
8 JJ Etabl. Belin, 272 Av. de Paris, Rueil (S. & O.)
8 JK Lt. Robert, 51 Rue Pierre Duhem, Bordeaux.
8 JM A. H. Thiehlment, Fair View, Ile de Puteaux (Seine).
8 JN L. Carrot & Levassor, 5 Rue du President Despatys, Melun (Seine & Marne).
8 JR Radio Club de Lille.
8 JU M. Vidrequin, Villa Faldony, Av. du Clos Toutain, Vaucresson (S. & O.).
8 JVX J. Vial, 6 Rue de la Calle, Le Chesnay (S. & O.).
8 MB L. Bensimohn, P.O. Box 19, Casablanca.
8 NA — Viville, 77 Rue de la Raffinerie, St. Quintin (Aisne).
8 WK (Provisional). Radio Club de Lille (see 8 JR).

Corrections and Changes of Address.

8 AL A. Gody, Quai des Marais, Amboise (Indre & Loire) (change of address).
8 CC H. Suquet, Usine de Fourneau, Chatillon-sur-Seine (Côte d'Or).
8 AE Dr. P. Corret, 97 Av. de la Republique, Versailles (change of address).
8 BX — Vatinet, Villa Geneviève, Allée des Roses, Orly (Seine) (change of address).
8 CL Mme. Lebaudy (vve. Martin-le-Roy), Moisson, La Roche-Guyon (S. & O.) (corrected address).
8 CN P. Lafond, 70 Rue des Carmes, Rouen (change of address).
8 DC A. Gaby, 143, Av de Saxe, Paris (change of address).
8 GQ R. Gizeau, 30 bis Bould. National, La Garenne-Columbes (Seine) (change of address).
8 HV J. Rougeron, 10 Route Nationale, Annapes (Nord) (change of address).

GERMANY (K.)

Additional Stations.

Y 8 Rolf Horkheimer, Rottenburg-a-Neckar.
V 2 } **V 3** } C. Lorenz, A/G (short-wave testing stations).

SWEDEN (S.).

Additional Stations.

SMRG Gösta Siljeholm, Kristianstad.
SMUI E. Aulin, Humlegatan 19, Malmö.

FINLAND (S.).

Additional Stations.

2 CO Radiokoulu Santakamina, Helsingfors.
2 NCB A. Wahlstedt, Santakamina, Helsingfors.

ICELAND (I.C.).

BG 1 B. Gardarsson, Laufasveg 53, Reykjavik.

NORWAY (LA).

1 A J. Diesen, Moen i Maalselv, Tromsö.

ITALY (I.).

Additional Stations.

1 BB F. & G. Lescovic, Via Caterina Percoto 2–6, Udine (late 1 WA).
1 BD E. Pirovaso, Viale Varese 11, Como.
1 BE G. Luciolli, Via Bezzecca 3, Borgo Trento, Verona.
1 BF O. Santini, Viale Cavour 48, Ferrara.
1 BS F. Luise, Piazza Manzi 10, Piacenza.
1 CA Righetti.
1 GB F. L. Fracarro, Castelfranco, Veneto.
1 GW B. Brunacci, Via Evangelista Torricelli 1, Rome.
1 MA A. Marzoli, Via Bramante 3, Rome.
1 RM Associazione Radio Montatori, Viale Angelico 19, Rome.
1 RR G. Bargilli, Via Nino Capponi 6, Florence.
3 TR L. M. di Villahermosa, Laconi, Sardinia.

Corrections (in the original list the christian and surnames were, in some instances, confused).

1 AM A. Melzi, Via Durini 24, Milan.
1 AS Dr. S. Pozzi, Corso Torino 1, Novara.
1 AU F. Strada, Via Ospedale 14, Turin.
1 AZ E. Pesenti, Alzano Maggiore, Bergamo.
1 AY G. Fontana, Via Campagna 43, Piacenza.
1 AX Ing. U. E. Martini, Via Savoia 80, Rome.
1 EP F. Pugliese, Via Borgonuovo 21, Milan.
1 FL E. Flori, Viale Magenta 24, Milan.
1 GN Ing. E. Gnesutta, Via Filodrammatici 4, Milan.
1 GV G. Gardoncini, Via Larga 6, Milan.
1 KX A. Niutta, Via Muzio Clementi 48, Rome.
1 NO F. Marietti, Corso Dante 8, Turin.
3 AM A. Muzio, Milan.
1 WA Delete (see 1 BB).

SPAIN (E.).

EAR 24 L. Garay, Oñate, Guipuzcoa.

YUGO-SLAVIA (Y.).

7 XX M. Torbarina, Gruz.

KENYA COLONY (KY).

1 VP L. J. Hughes, c/o Mombasa Radio (VPQ), Mombasa.

MADEIRA.

P3CO A. C. de Oliveira, c/o Western Telegr. Co., Box 56, Funchal.
R 31 H. T. Gomes de Freitas, Janeiro 141, Funchal.

MOROCCO.

1 TZ M. Truxler, Detachement Radio, Secteur Postal 402, Taza.

PALESTINE.

G6ZK J. E. Spillard, Signal Dept., Ramleh.

SOUTH AFRICA (O.).

A 6B R. G. Baird, Box 1828, Durban.
A 6C W. G. Yapp, Box 27, Vereeniging.
A 6D Rev. N. Roberts, Potchefstroom.
A 6E B. A. O'Brien, Queen St., Adelaide.
A 6F F. W. S. Ochley, Warner Beach.
A 6G J. B. Turner, 158, Berg St., Pietermaritzburg.
A 6H D. M. Jamieson, 84, Currie St., Quigney, East London.
A 6J D. L. Rous, 138, Muller St., Bellevue East, Johannesburg.
A 6N (in place of F 1C). J. G. Swart, Cambridge House, Milnerton, Capetown.
B 1D B. Hill, 71, Cape Rd., Port Elizabeth.
JAI / **JSP** A. S. Innes, 47, Rockey St., Bellevue East, Johannesburg.

Change of Address.

A 4V L. E. Green, Box 7007, Johannesburg.

INDIA (Y.).

2 HX — Bremner, Radio Club of Bengal, 19B, Chowsinghee, Calcutta.
G 20 Chota Nagpur Regiment, Adjutant's Residence, Ranchi.
G 21 Chota Nagpur Regiment, Lt. H. Bates, Signal Officer, Sobaya.
G 22 Chota Nagpur Regiment, "C" Coy., Dhanbad.
G 23 Chota Nagpur Regiment, F. Boga, Kusunda Colliery, Jherria.
G 24 Chota Nagpur Regiment, "B" Squadron, Asansol.
G 26 Chota Nagpur Regiment, "A" Squadron, Jamshedpur.
G30 Chota Nagpur Regiment, Headquarters, Ranchi.
FGG Sergt. M. H. Figg, Royal Signals, Sialkot, Punjab.

CEYLON.

4 VX R. C. Scott, Ottery Estate, Dickoya.

AUSTRALIA (A.).

Additional Stations.

New South Wales.

2 FS A. C. Smith, 38, Cheltenham Rd., Croydon.
2 LR Lismore & District Radio Club (R. H. Atkinson), Keen St., Lismore.
2 OI A. T. Whitaker, 31, Railway Cres., Banksia.
2 QY E. A. Williams, Crown St., Wollongong.
2 RA K. J. Vickery, Kolbridge St., Hurlstone Park.
2 TS A. W. Gill, "Illaroo," Greengate Rd., Killara.
2 UW O. Sandel, Mooramie Ave., Kensington.
2 VX D. G. McIntyre, Livingstone Ave., Pymble.

Victoria.

3 CG R. C. Gurner, 55, Spencer St., St. Kilda.
3 CZ H. B. Mitchell, 22, Normanby Rd., Elwood.
3 DF F. D. Short, 2, Mozart St., St. Kilda.
3 DL L. C. Falls, North Rd., Caulfield.
3 EF H. W. Maddick, Spray St., Elwood.
3 FH R. F. Hall, Glindabourn Ave., Toorak.
3 HB Sunshine Radio Club (H. S. Bird), Hampshire Rd., Sunshine.
3 JU R. A. Hull, 38, Charnwood Rd., St. Kilda.
3 KB A. Kissick, McFarland St., Brunswick.
3 LQ W. E. Downing, Henna St., Warrnambool.
3 LS R. T. Bushch, 20, Woodsworth St., Moonee Ponds.
3 PS V. L. Smyth, McIvor St., Bendigo.
3 QF J. A. Muir, 10, Young St., Brighton.
3 RF C. H. Cordingly, 77, Bank St., East Ascot Vale.
3 TM A. H. Buck, 759, Glenhuntly Rd., Glenhuntly.
3 VS O. J. Philpot, 26, Lumeah Rd., Caulfield.
3 XW C. A. Cullinan, "Bayview," Digger's Rest.

Queensland.

4 AP T. W. Bridger, c/o P. A. W. Anthony, Circle St., Hamilton.
4 CH A. E. Dillon, "Electra," Brown St., New Farm.
4 CM V. McDowell, Preston House, Queen St., Brisbane.
4 CP C. R. Pinney, Konedobu, Port Moresby, Papua.
4 CV N. E. Husband, Alan St., Charter's Tower.
4 GO Radio Soc. of Queensland (G. Creed-Jacobs), Nightingale St., Maryborough.
4 LG W. L. Gibson, Kirkland Av., Greenslopes, Brisbane.

Western Australia.

6 KX H. Simmonds, Nicholson Rd., Subiaco.
6 SR Subiaco Radio Soc., 63, Gloster St., Subiaco.

Tasmania.

7 AK S. E. Deegan, St. Virgil's College, Hobart.

Corrections.

2 UU R. G. Roberts, 9, Church St., Ashfield, N.S.W. (change of address).
3 AU S. H. Milligan, 117, Autumn St., Geelong, Victoria (change of address).
3 BS H. B. Sunter, Lambert Rd., Toorak, Victoria (change of address).
3 CP C. H. Philpot, 36, Melbourne Rd., North Geelong, Victoria (change of address).
3 DP N. Culliver, 57, Simpson St., East Melbourne, Victoria (change of address).
3 KJ W. E. C. Sawyer, 127, Mitchell St., Northcote, Victoria (change of address).

NEW ZEALAND (Z.).

1 AX R. J. Orbell, Box 69, Te Aroha (in place of 3 AA, Christchurch).
2 BX R. G. Black, 22, Stafford St., Wellington.
2 XA E. A. Shrimpton, 38, Rongotai Terrace, Wellington.
4 AS — Mason, Box 605, Dunedin.

ARGENTINE REPUBLIC (R.).

Federal Capital.

BG 9 D. E. Conway, Venezuela 2166.
BH 1 M. D. Bourgeon, Lavalle 3233.
BH 2 B. Vignolo, Pinzón 311.
BH 3 V. Tonda, Olavarria 94.
BH 4 P. R. Casellini, Santa Fé 422.
BH 5 R. Espina, Garay 3808.
BH 6 A. D. Huicque, Sadi Carnot 3841.
BH 7 A. Colombo, Pasaje Ferrari 692.

Province of Buenos Aires.

DU 4 D. Genneri, Ing. Luiggi 35, P. Alta.
DU 5 P. Casademut, Güemes 2595, Mar del Plata.
DU 6 L. Larralde, Dolores.
DU 7 N. M. Júarez García, Dolores.
EJ 9 J. (hijo) Augiorama, Vedia.
EK 1 C. A. Monti, Puán.
EK 2 M. Monti, Maipú.
EK 3 M. Fernández, Lincoln.

Province of Santa Fe.

FH 6 A. Hosch, Candiotti 286, Santa Fé.
GF 3 M. Viña, Firmat.
GF 4 E. M. Vimo, San Genaro.

Province of Cordoba.

HD 2 J. C. Cangiano, Córdoba.
HD 3 R. Moller, Leones.
HD 4 R. Martinez, Córdoba.
HD 5 E. Favier, Córdoba.
HD 6 M. Pedra, Cañada Verde.
HD 7 R. Granillo Barros, Córdoba.
HD 8 L. Sanz, Córdoba.
HD 9 J. Rodriguez Leguizamon, Córdoba (Broadcasting "A").
H 5 Rodriquez Arturo, Rio Cuarto.
H 6 "Los Principios," Córdoba.

Province of Tucuman.

KC 2 J. Frias Silva, Tafi del Valle.

Province of San Luis.

QA 5 G. Santolalla, San Luis.

Territory of La Pampa.

UA 7 C. F. Chauvin, Sarah.

BRAZIL (BZ).

(Through the courtesy of Señr. P. S. Chermont, BZ 1AD.)

Additional Stations.

1 AH* H. May, Caixa Postal 176, Rio de Janeiro.
1 AW* V. Alven, Rua Riachuelo 89 CIV., Rio de Janeiro.
1 BB R. K. de Lemos, Caixa Postal 1587, Rio de Janeiro.
1 BC R. Berrogain, Rua Gomes Carnerio 144, Rio de Janeiro.
1 BD A. L. Villela, Rua Cosme Velho 76, Rio de Janeiro.
1 BF G. Mesquita, Rua do Cattete 319, Rio de Janeiro.
1 BG G. P. Machado, Avenida Rio Branco 46–1°, Rio de Janeiro.
1 IB A. S. Freire, Rua Oswaldo Cruz 46, Nictheroy, Estado do Rio.
2 AA L. Y. Jones, Jr., Rio Frei Caneca 22, São Paulo
2 AB S. Justi, Rua Visconde Rio Branco 19A, São Paulo.
2 AC L. do A. Cesar, Rua Frei Caneca 20A, São Paulo.
2 AD G. Borbisier, Caixa Postal 150, São Paulo.
2 AE J. Boccolini, Av. Angelica 51, São Paulo.
2 AF J. S. Goés, Rua Cardoso de Almeida 96, São Paulo.
2 AG C. Yazebek, Rua Ipiranga 12, São Paulo.
2 AH J. Tonglet, Rua Barão de Itapitininga 37A, São Paulo.
2 AI L. F. de Mesquita, Av. Paulista 73, São Paulo.
2 AJ J. R. Baccarat, Rua Conselheiro Nebias 504, Santos, Estado de São Paulo.
2 AK C. Baccarat, Caixa Postal 57, Santos, Estado de São Paulo.
3 QA T. R. Vianna, S. Francisco de Assis, Estado do Rio Grande do Sul.
5 AA T. de A. F. Xavier, Rua Padre Lemos 110, Recife, Estado de Pernambuco.
5 AB J. C. Ayres, Caixa Postal 257, Recife, Estado de Pernambuco.
6 QA (ex 7 AA). A. Alves dos Santos, S. Luiz do Maranhão, Estado do Maranhão.

CHILE (CH).

1 ER E. Guevara, Cosilla 69, Vilcun; and (during the Summer) 646 Av. Libertad, Viña del Mar.

CUBA (Q.).

2 BY F. W. Borton, Galiano 29, Havana.
2 MK R. V. Waters, Galiano 29, Havana.

FRENCH INDO-CHINA.

HVA M. Mirville, Hanoi.
8 QQ R. Jamas, 21 Rue Richard, Saigon.

HONG KONG.

XA 1 Tang Fong Laum, Man Chu Tai, 35, Connaught Rd. West.

JAPAN (J.).

1 AA Dept. of Communication, Short-wave Station, Tokio.

PHILIPPINE ISLANDS (PI).

3 AA F. Johnson, Elser, Baquio.
1 DL A. de Lange, Box 669, Manila.

SALVADOR (SR).

FMH J. F. Mejia, 14 Avenida Norte No. 21, San Salvador.

DICTIONARY OF TECHNICAL TERMS

Definitions of Terms and Expressions commonly used in Wireless Telegraphy and Telephony.

This section is being continued week by week and will form an authoritative work of reference.

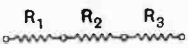
Self-Inductance or **Self-Induction**. A circuit is said to possess self-inductance if a magnetic flux linked with the circuit is set up when a current flows through it; so that if the current varies an *electromotive force* is induced in the circuit by the changing of the magnetic flux (see ELECTROMAGNETIC INDUCTION). In a circuit possessing self-inductance the electromotive force induced when the current is changing is proportional to the rate of change of current and acts in such a direction as to oppose the changing of the current (Lenz's Law), and therefore the current in an inductive circuit cannot be changed instantaneously, but takes time to change from one value to another, even though the applied voltage is changed suddenly. For this reason self-inductance is sometimes referred to as "electrical inertia." (See TIME CONSTANT.) The unit of self-inductance is the *henry* (for definition see COEFFICIENT OF SELF INDUCTION).

When an alternating potential difference is applied to a circuit possessing self-inductance the varying of the magnetic flux sets up an alternating E.M.F. which tends to choke back the current and also causes the current to *lag* in *phase* behind the applied potential difference. See ALTERNATING CURRENT CIRCUITS.

Self-Oscillation. The name applied to the occurrence of continuous oscillations in a valve receiving circuit. Such oscillations may be produced intentionally by means of *reaction* for the purpose of *beat reception* (see SELF-HETERODYNE), or it may occur spontaneously through the presence of stray couplings between various parts of the circuit, *e.g.*, through the coupling provided by the *inter-electrode* capacity of the valve or valves. Spontaneous self-oscillation is very difficult to prevent in multi-stage tuned high-frequency amplifiers unless special precautions are taken in the design of the amplifier.

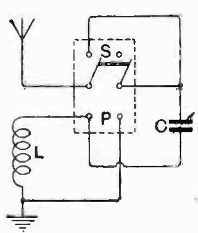
Separate Heterodyne. In one method of *beat reception* of continuous wave signals the local oscillations of slightly different frequency from that of the received signal are produced by a valve oscillator which is entirely independent and apart from the receiving apparatus itself. Such an oscillator is referred to as a "separate heterodyne." Cf. ENDODYNE.

Series Connection. The arrangement of a number of pieces of apparatus in a circuit in such a manner that the same current passes through all of them in succession without dividing. Cf. PARALLEL CONNECTION.



Resistances in series, giving resultant resistance $R_1 + R_2 + R_3$.

Series-Parallel Switch. A double-pole double-throw switch for connecting a piece of apparatus either in *series* or in *parallel* with another piece of apparatus or part of a circuit, for example a switch for connecting the *tuning condenser* either in series or in parallel with the *aerial tuning inductance* of a wireless receiving set.



Switch for connecting C either in series or in parallel with L.

Sharp Tuning. See SELECTIVITY.

Sheath. A name sometimes given to the *anode* or *plate* of a *thermionic valve*.

Shock Excitation. The production of electrical oscillations in an *oscillatory circuit* by a sudden discharge such as that of a spark or by any other cause where the influence starting the oscillations is only a momentary one.

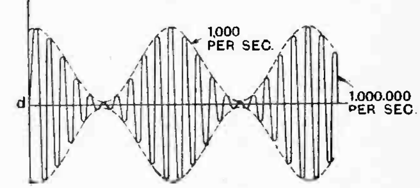
Short Circuit. A low resistance connection between two points in a circuit. Such a connection may be accidental or otherwise. In the former case the resulting current may be so much greater than the normal value as to cause damage. In the latter case the current may not be much changed by introducing the short circuit, *e.g.*, when short circuiting an ammeter in order to remove it from the circuit without interrupting the current.

Shortening Condenser. A condenser connected in series with an aerial circuit in order to shorten the wavelength to which the aerial will respond. Compare LOADING COIL.

Shunt. A resistance connected in *parallel* with a given piece of apparatus or instrument in order that part only of the current will pass through the instrument. For instance, shunts are used in conjunction with a *moving coil instrument* to give various current ranges.

S.I.C. Abbreviation for *specific inductive capacity*.

Side Bands. The modified *carrier wave* employed in wireless telephony (see MODULATION) is really the resultant of three or more high-frequency waves, all of constant amplitude but of slightly different frequencies. Suppose, for instance, that a high-frequency oscillation whose frequency is 1,000,000 cycles per second (corresponding to a wavelength of 300 metres) has a *sine wave* of low frequency at, say, 1,000 cycles per second superimposed upon it; then the H.F. oscillation will be varying in amplitude at 1,000 cycles per second. This unsteady oscillation is really the resultant of three H.F. oscillations, the low-frequency variation being the *beat frequency* or *beat note* which is produced by the interaction



Modulated H.F. oscillations analysed into carrier wave and side bands.

Dictionary of Technical Terms.—

of the three H.F. oscillations, just as in the case of *beat reception* of C.W. signals the beat note is the difference between the frequency of the incoming signal and the frequency of the local oscillations. Thus, in the case considered here, the three constituent waves will have frequencies of 999,000, 1,000,000 and 1,001,000 cycles per second respectively, the middle frequency representing the true carrier wave. The lowest frequency is called the "lower side frequency," and the highest is called the "upper side frequency." The interaction of either of the side frequencies with the carrier frequency produces a beat note of 1,000 cycles per second.

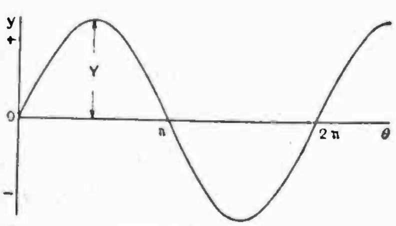
In the transmission of speech several *audio-frequencies* are superposed on the carrier wave simultaneously, and therefore there will be a number of side frequencies both above and below the carrier frequency and these bands of frequencies represent the *upper side band* and *lower side band* respectively. The interaction of all the frequencies in the "side bands" with the true carrier wave go to make up the complex wave forms of speech or music.

Side Band Telephony. A system of wireless telephony transmission in which the true *carrier wave* itself is suppressed, only the *side band* frequencies being radiated, usually the frequencies of one side band only being transmitted. The sounds heard in an ordinary receiver are quite unintelligible unless the equivalent of the missing carrier wave is provided by a local oscillator at the receiving station. See SIDE BANDS.

Side Tone. The signals of a transmitting station heard in a telephone at the station itself, so that the operator can judge the nature or quality of the signals being sent out.

Simple Rectification. A name applied to *anode rectification* by means of a *three-electrode valve* for detecting high-frequency oscillations.

Sine Curve. A curve or graph in which the sine of an angle is plotted vertically against the angle itself horizontally.



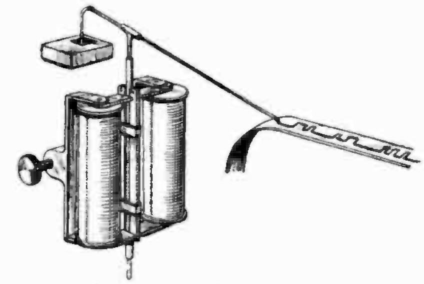
Sine curve plotted from the expression $y = \gamma \sin \theta$.

Sine Wave (of current, voltage, etc.). An alternating current, voltage, etc., which varies according to a sine law, *i.e.*, one whose wave form is the same shape as a sine curve.

Single Phase. Refers to an ordinary alternating current system where there is a single current only supplied by the generator through the equivalent of one pair of wires. Cf. POLYPHASE and THREE PHASE.

Sinusoidal. A term meaning "obeying the *sine law*" or having a wave form the same shape as a *sine curve*.

Siphon Recorder. A special form of *Morse inker* in which the moving part consists of a coil similar to that of a moving coil galvanometer. The pen itself is in the form of a fine glass or silver siphon, and is deflected by the moving coil or magnet system, making a wavy line on the tape.



Syphon recorder movement.

Skinderviken Button. The chief component part of a certain type of carbon granule microphone, the "button" itself being a small compact container which holds the carbon granules. The "button" can be purchased separately, and is useful for the construction of *microphone amplifiers*, etc.

Skin Effect. When an alternating current flows through a solid conductor alternating magnetic fluxes are set up inside the conductor and induce *eddy currents* which are in such a direction as to weaken the current at the centre of the conductor and strengthen it at the outer surface. Thus the *current density* is greater near the surface of the conductor than in the centre. This phenomenon is known as "skin effect." The higher the frequency of the current the more marked is the skin effect and the greater the effective resistance of the conductor. At radio-frequencies the skin effect plays a very important part, increasing the resistance of the conductor many times. See HIGH-FREQUENCY RESISTANCE.

Slab Coil. An inductance coil wound on a former of such a shape that the radial depth of the coil is much greater than its axial length. The coil is usually impregnated with wax and removed from the former, being then self-supporting. Not very suitable for short wavelengths on account of the high *self-capacity* and *dielectric losses*.

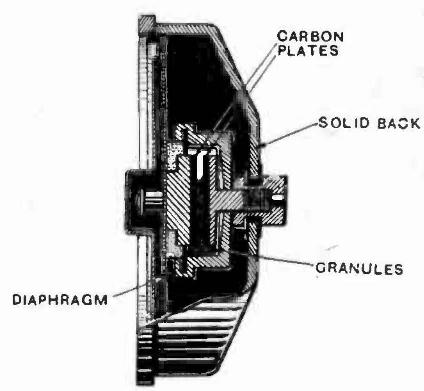
Slide Wire. A piece of resistance wire, bare, and of uniform resistance per unit of length stretched between two points. When a steady current is passed through the wire the *potential drop* along its length is proportional to the distance from one end. A great many electrical measurements can be made by the aid of such a slide wire, *e.g.*, measurement of resistance by means of the *metre bridge*.

Smoothing Circuit or Smoother. A combination of inductances (choke coils) and condensers arranged so as to "smooth out" the ripples of a pulsating current such as that obtained from a *rectifier*, in order that the current shall approach as nearly as possible a steady direct current.

Soft Valve. A *thermionic valve* in which the vacuum is not of a very high degree, traces of gas being left in the bulb, so that the current passing between the filament and the plate is composed partly of true electronic emission and partly of conduction current carried by the *ionised* gas. Such valves are particularly sensitive as detectors, but the length of life does not compare favourably with that of a *hard valve*.

Solenoid. A coil of wire wound on a bobbin with hollow centre and having no fixed iron core. Such an arrangement acts as an ordinary electromagnet, and is usually employed in conjunction with a movable iron plunger which is drawn into the centre of the coil when the current is switched on, giving a large attractive force over a considerable range of movement.

Solid Back Microphone. A *microphone* with two carbon discs mounted one on the diaphragm and one on the solid back of the casing with carbon granules between them.

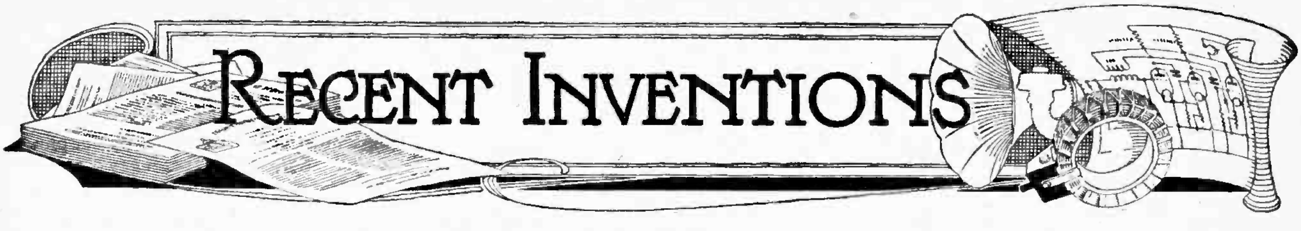


Solid back microphone.

Space Charge. The stream of electrons flowing from the hot filament to the *plate* of a *thermionic valve* give rise to an electric field between the filament and the plate because the electrons themselves are really negative charges. This electric field tends to drive back those electrons which are just leaving the filament and is known as the "space charge."

Spacing Wave. See MARKING AND SPACING WAVES.

Spade Tuning. The tuning of a circuit by the moving of a flat metallic disc or "spade" across the face of a flat coil. The *eddy currents* induced in the metal set up magnetic fields of their own, which react on the coil and reduce the effective inductance, so reducing the wavelength. Such an arrangement is simple and cheap, but there is a slight loss of energy due to eddy currents.



Brain Waves of the Wireless Engineer.

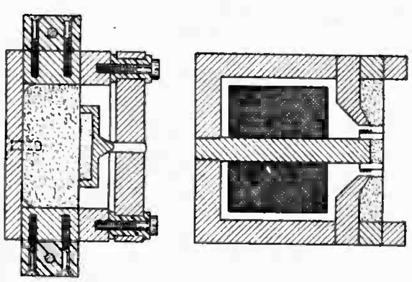
Diaphragms for Acoustic Instruments. (No. 241,277.)

Application date July 16th, 1924.

Mr. H. J. Round describes in the above patent specification a diaphragm consisting of very thin light material rigidly clamped in a case made very heavy in comparison with the weight of the diaphragm, and damped over the whole or substantially the whole of its surface on one side by sponge rubber preferably smeared with thick oil on the surface in contact with the diaphragm.

The material of which the diaphragm is formed may be metallic or non-metallic, according to the use to which it is to be put.

The invention, applied to a microphone of the varying resistance type, is shown at (*a*), and (*b*) shows the invention applied to a telephone of the moving coil type.



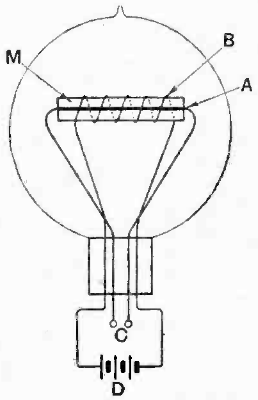
Improvements in microphone and telephone diaphragms. (No. 241,277.)

o o o o

Thermionic Valves. (No. 234,480.)

Application date (France) May 26th, 1924.

Mr. J. Hawardier describes in the above patent specification a thermionic valve having a secondary filament A, heated to incandescence by an alternating current C, and surrounded by a small mass of quartz M, which forms a support for the usual filament B, which is heated by a source of direct current D. The secondary filament A, heated by the alternating current C, communicates a substantially constant amount of heat to the quartz M, which in turn transmits heat by thermal conduction to the working filament B, the object being to economise the continuous current, which is now only required to raise the filament to the necessary temperature above that imparted to it by the auxiliary source of heat supplied by the filament A.



Valve filament with auxiliary A.C. heater. (No. 234,480.)

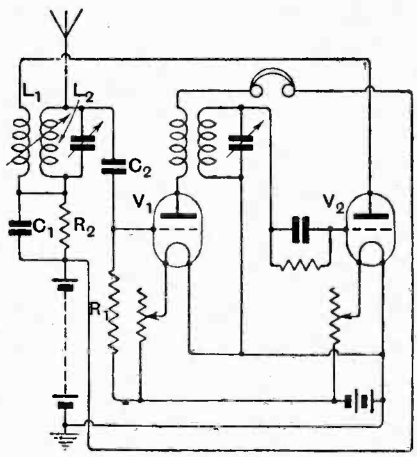
o o o o

Reflex Receiving Circuit. (No. 243,039.)

Application date June 18th, 1924.

Mr. John Scott-Taggart describes in the above patent specification a reflex or dual circuit, in which the low-frequency currents are fed back by means of a resistance.

As shown, the valve V_1 acts as a high-frequency amplifier, and the valve V_2 as a detector.



Reflex receiver circuit. (No. 243,039.)

The rectified low-frequency currents are fed into the grid circuit of the valve V_1 through a resistance R_2 of the order of 70,000 ohms. A by-pass condenser C_1 of 0.0001 mfd. capacity, is connected across the 70,000 resistance R_2, and the aerial is connected through a fixed condenser C_2 of 0.25 mfd. to the grid of the valve V_1.

A leak R_1 of 1 megohm is connected across the grid and negative terminal of the filament accumulator.

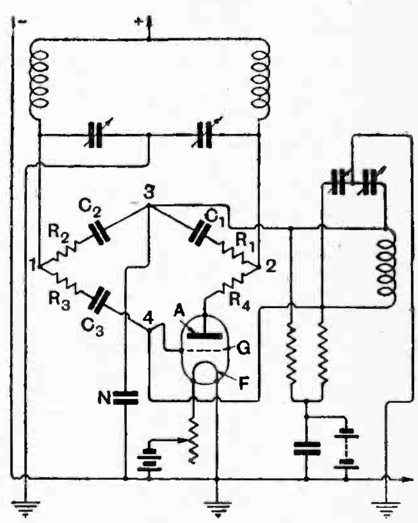
A reaction effect is obtained by coupling the inductance L_1 in the plate circuit of the detector valve V_2 to the aerial inductance L_2.

o o o o

Preventing Reaction between Anode and Grid Circuits. (No. 241,289.)

Application date July 17th, 1924.

Messrs. C. S. Franklin and E. Green describe in the above patent specification a transmitting or receiving amplifier especially applicable to amplifying systems dealing with frequencies of the order of 3,000 kilocycles per second or more. The reaction effect between the anode and grid circuits is balanced out by a Wheatstone bridge, of which one arm includes the grid-anode capacity.



Valve oscillator or amplifier for short wavelengths. (No. 241,289.)

The anode and grid circuits are connected as the respective diagonals of the bridge, and each is arranged symmetrically with respect to earth, so that oscillations in either circuit produce no potential in the other circuit either in or between any parts thereof or to earth.

A preferred form of the invention is shown in the accompanying illustration, in which the grid G and plate A are connected as one arm of a Wheatstone bridge, the other three arms being formed by preferably equal capacities, C_1, C_2, C_3. Small adjustable resistances, R_1, R_2, R_3, and R_4, are placed in the arms to ensure that the resistances of the arms are equal. A small condenser N is connected from the common point 3 of C_1 and C_3 to earth. The capacity N should be equal to the capacity between the grid G and filament F.

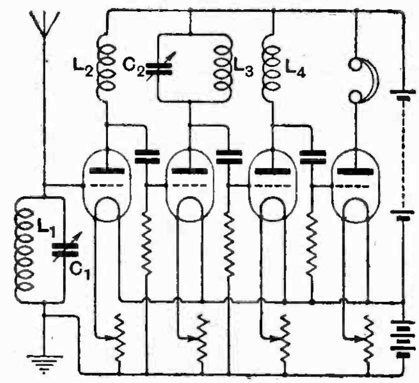
The primary circuit is connected across points 1 and 2, and the grid circuit across 3 and 4.

○○○○

High Frequency Amplification.
(No. 243,038.)

Application date May 24th, 1924.

Mr. John Scott-Taggart describes in the above patent specification an amplifying system in which the tendency to self-oscillation is reduced by avoiding the effects of a plurality of tuned circuits intended to be associated with the anode circuits of successive valves by arranging the anode circuits so that the tuned circuits have interposed electrically between them an untuned circuit or circuits. One example of the invention is illustrated as applied to a four-valve receiver employing a so-called tuned-aperiodic-tuned system. In this circuit two choke couplings are separated by a tuned anode coupling.



Improvements in tuned anode coupling.
(No. 243,038.)

The first high-frequency amplifying valve does not oscillate, because, though the grid circuit is tuned, the anode circuit is not. The second valve will not oscillate because the grid circuit L_2 is untuned, and the anode circuit L_3 C_2 is tuned. The third valve will not oscillate because, although the grid circuit L_3 C_2 is tuned, the anode circuit L_4 is not tuned. The last valve will not oscillate because neither the grid nor the anode circuits are tuned.

The choke coils are preferably wound with high-resistance wire to improve their aperiodicity; the wire may be No. 44 gauge platinoid wire, suitably insulated, and preferably so wound as to avoid self-capacity effects.

Calls Heard.

Extracts from Readers' Logs.

Horncastle, Lincs.

(January 7th, 10th, and 11th.)

U.S.A.: 1AMH, 1UE, 1SI, 1AMD, 1AFM, 1CMX, 1CKP, 1BGO, 1GA, 1CAW, 1SK, 1AP, 1MD, 1NT, 1YD, 1II, 1ZS, 1BM, 1AOF, 1YB, 1CMP, 1CK, 1SW, 1BPX, 1BPB, 1AEP, 1BG, 2CYX, 2APV, 2NZ, 2PP, 2KG, 2CT, 2CCK, 2EV, 2WS, 2FC, 2BN, 2CV, 2BL, 2ARM, 2IHM, 2CTH, 2MU, 2MP, 2OP, 2GK, 2BL, 2AVS, 2XBQ, 2CRP, 2CJE, 2BWA, 2AES, 3QT, 3UFW, 3CDN, 3CEL, 3HG, 3LW, 3AVS, 4BX, 5ATX, 5YD, 6ZR, 7QR, 7DF, 8CCR, 8ALY, 8ES, 8BYN, 8BAU, 8AIG, 8XAL, 8AMD, 8BTH, 8ALF, 8QB, 8PL, 8BW, 8BDS, 8BPL, 8BAF, 8CYI, 9BJK, 9VO, 9MBD, 9EJI, 9DOL, 9ADK, 9AD, 9AIO, 9EGH, 9BVH, 9XE, 9BMJ, 9EGU, 9GK, 9DTE, NAL. Brazil: 1AA, 1AB, 1AC, 1AD, 1AF, 1AH, 1AN, 1AO, 1AP, 1AW, 1BF, 5AA, 5AB, 1IN, 1IA, 2AB, 2AF, 2AL. Argentina: FA1, FA3, DB2. New Zealand: 4AC, 2AC, 3AF. Australia: 3XO (WKG, G.6NF). India: CRP. Palestine: 6ZK. South Africa: OA6N. Indo-China: FI 8QQ. Scandinavia: SMWF, SMZS, SMXR, SMUA, SGC, SDK, S2NB, D7ZM. Various: GHA, GFP, BYZ, BYV, BYC, EGEH.

(0-v-1 Reinartz.) On 30-45 metres.

A. E. and G. G. Livesey.

Thornton Heath.

(December 18th to 30th.)

Australia: 3BD, 3XO, 5BG. Philippines: 1FN, NEQQ. French Indo-China: FI8QQ. South Africa: A3B, A3E, A4Z, A6N. Egypt: EGEH. Palestine: 6ZK, 6YX. Brazil: AABZ (?), SQ1. India (?): X 2BG. U.S.A.: 5MI, 5ZAI, 9AIO, 9BMD, 9ZA. Luxembourg: L 1JW. Sweden: SMSS, SMXT, SMXU, SMZV. Telephony: G5GQ, G5XO, G6MP, G6OX, G6YU. Miscellaneous: 11B, FTJ, 1DH, L 6C, SGT, NSZ3, F10-KZ, EAR1, EAR21, OCMV.

(0-v-0.) On 30 to 50 metres.

W. A. J. Warren.

Amersham, Bucks.

Great Britain: ('Phone) 2KF, 2LZ, 2NM, 2SZ, 5XO, 6OX, 6YU; (Morse) 2AO, 2BZ, 2CC, 2DX, 2FK, 2FM, 2GO, 2KW, 2MA, 2NJ, 2OF, 2QB, 2QM, 2QV, 2SH, 2WJ, 2XV, 2XY, 5JW, 5KZ, 5LS, 5MA, 5OC, 5QM, 5ST, 5TZ, 5WV, 5YM, 6BD, 6BS, 6DO, 6GH, 6KK, 6LJ, 6ME, 6MP, 6OP, 6RY, 6TB, 6TD, 6TM, 6UT, 6UZ, 6VP, 6YC, 6YU, 6YV, 6ZM. France: 8AWI, 8DP, 8HSF, 8HLL, 8HU, 8IP, 8JYZ, 8LDR, 8MAR, 8MR, 8NN, 8PEP, 8SSS, 8TIS, 8WR, 8XH, FL, MAROC. Holland: OAW, OBL, OCZ, OEA, OGG, OII, OKV, OPX, OWC, 2PZ, 12BB, 8RN, PB7, PB10. Belgium: G6, J9, K5, K8, R2, S2, S4, S5, S6. Germany: K7, PL, W3, Y6, Y8, 4LV, POW. Italy: 1BW, 1GW, 1RM. Finland: 2BS, 2CO, 2ND. Sweden: SMZS. Norway: LA4X, LA1A. Denmark: 7BX. Various: SAJ, MUU, GHA, OCDJ.

All on 35 to 45 metres.

K. E. B. Jay (G-2BMM).

Thornton Heath.

(December.)

New Zealand: 2AC, 2XA, 4AC, 4AS. Australia: 2CM, 2YI, 3BD, 3BM, 3XO, 3YX. China: GFUP. Philippines: 1HR, NEQQ. French Indo-China: FI8QQ. South Africa: A4Z, A6N. Brazil: 1AB, 1AF, SQ1. U.S.A.: 5ATT, 5YD, 6SST, NPG, 9BHT, 9XAX. Bermudas: BER. Miscellaneous: NISM, RRP, 6LF, GHA, IDO, CHP, SKA, F T3, 6YX, PE 6ZK.

(0-v-0.)

M. E. Coaffee.

South Normanton, Derbyshire.

(January 7, 8 and 10.)

Great Britain: 6MJ, 2PZ, 5ZA, 6IZ, 2UB, 2PX, 6LA, 2XY, 5TZ, 2RW, 2NM. (Phone) 5KA, 2WJ, 5XO, 2KL, 5DS, 6NF. Italy: 1GB, 1BE. Belgium: C22, 3R, V2, Bi3, U5. France: 8JN, 8MS, 8RRR, 8FI, 8UT, 8KK, 8VE, 8IL, 8ZE, 8NA, 8KX, 8UF, FL. Holland: OPN, OME, P9EF, PCUU, OPM, PCLL, OBX, PKB, OMS, OMK, OF3, PKX. Germany: C5, POX, 2HR. Spain: EAR20, EAR2, EAR1, EAR9, EAR3. Finland: 1NC. Sweden: SMXT, SMUK. Portugal: P 1AE. Morocco: AIN. U.S.A.: KDKA, WIR, WIZ, ABC, 1RM, 1CH, FW. Unknown: 4VEU, 9MS, 9AR, SASA, 6CTN, NR3A, CY2, 2IP, 1AF, OCDB, OCDV, 4EU, 1SM, 9ASC, S2CO, NIPZ.

(0-v-1.) 38 to 90 metres.

H. Bishop.

Haslemere.

Great Britain: 2ZF, 2QB, 2XY, 2KW, 5HA, 5HX, 5LS, 5LF, 5AX, 5GS, 5SI, 5YK, 5QT, 6TW, 6VP, 6LB, 6GF, 6LJ, 6YN, 6TM. Australia: 3XO. France: 8GI, 8JN, 8VO, 8VX, 8RBP, 8JMS, 8YP, 8HU, 8CAD, 8RIC, 8AOX, 8JN, 8IP, 8IN, 8RZ, 8EU, 8SD, 8PRD, 7VX. Germany: KY8, W5. Holland: 0HB, 0WB, 0WK, 0BX, 0NAA, PB7. Spain: EAR8, EAR2. Italy: 1GB, 1AU, 1MD, 1DR, 1CO. Sweden: SMZS.

(0-v-1, Reinartz.) On 35 to 45 metres.

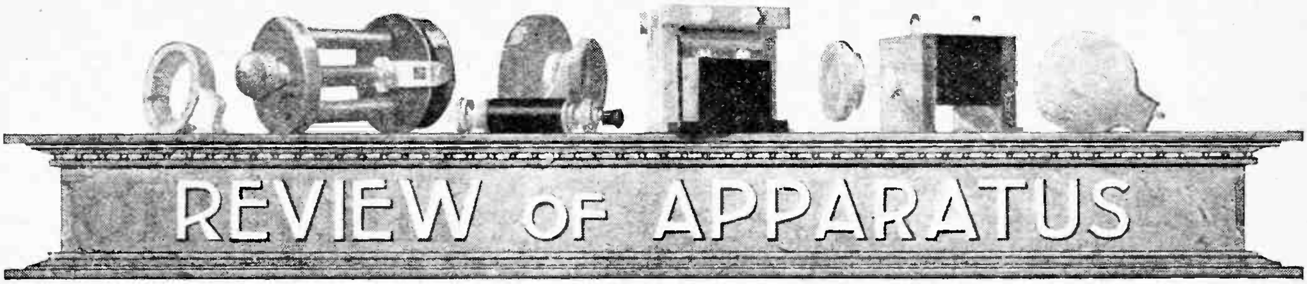
"Listener."

Jersey.

(January 2nd to 8th.)

Great Britain: 2DO, 2GY, 2SZ (telephony) 5GW, 5UA, 6GG, 6TD, 6YB, 6YS. France: 8CS, 8CAB, 8DY, 8JN, 8JZ, 8KS, 8NA, 8RR, 8ST. Italy: 1AS, 1BD, 1MT, 1RM. Peru: 6ZK. Australia: A6NO. Denmark: 6YU. Spain: EAR24, EAR28. Argentina: AA8. Various: FSRX, GHA (Malta).

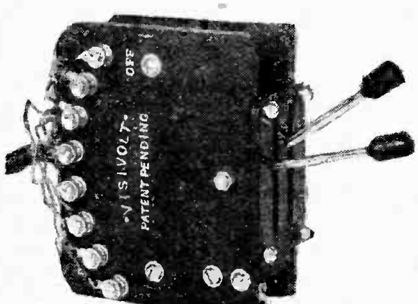
A. M. Houston Fergus
(G2ZC and MAG).



Latest Products of the Manufacturers.

VISIVOLT BATTERY SWITCH.

It is probably because high tension batteries are not always easily accessible that valves are so often operated with an incorrect H.T. potential. For instance, it is not unusual for valves to be changed without paying attention to the readjustment of the high tension battery plugs.



A new switch designed for panel mounting, for regulating H.T. battery potential.

In order to bring the control of the H.T. battery on to the front of the instrument panel so that the potential can be carefully regulated in conjunction with other adjustments, the "Visivolt" multi-contact switch has recently been introduced.

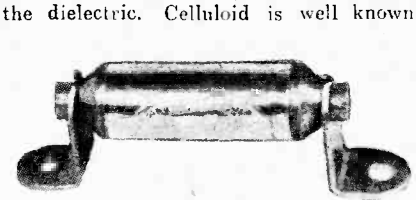
Designed for panel mounting, the operating levers occupy very little space on the front of the instrument. Fifteen contacts are provided, as well as an "off" position, the terminals being arranged alternately on each side of the frame, so as to permit of liberal spacing. A pair of levers move over the contacts to tap off two potentials, so that a switch of the type shown in the illustration might be used with a two-valve receiver consisting of a detector and note magnifier. The levers are fitted with ball contacts, which not only produce a particularly smooth movement, but provide a snap action so that the switch, when at rest, is always making contact and is retained in position. The contacts are small brass bars of 14 gauge wire spaced between short pieces of ⅛in. ebonite rod, so that in no position are two contacts bridged across, which is an essential feature of a switch used for battery control. Hard spring brush contacts make reliable connection with the levers.

This switch has many applications, such as grid bias control in a power amplifier, as well as serving all the purposes of a multi-contact switch having the advantage that all its contacts are totally enclosed. A length of braided cable with 15 flexible conductors is supplied for connecting up with the battery. This switch, although of simple construction, is robustly built and possesses a finish of a higher grade than many other wireless components of moderate price.

oooo

"K" TUBULAR CONDENSER.

Wates Bros., Ltd., 12-14, Great Queen Street, Kingsway, London, W.C.2, are manufacturing a small tubular type fixed capacity condenser which, in general outline, presents an attractive appearance and possesses the merit that by means of clip mounting it can be easily interchanged so that various capacity values can be tested. The form of mounting is an improvement on the arrangement usually adopted in the case of interchangeable high resistances, cheese-headed screws being inserted in the ends so that reliable contact is made with the clips, or, alternatively, the condenser may be attached to the instrument wiring by means of tags. The condenser consists of a pair of copper plates rolled together between two strips of insulating material. Celluloid is used as a protective covering, but it is somewhat surprising to observe that the celluloid continues as a roll and forms the dielectric. Celluloid is well known



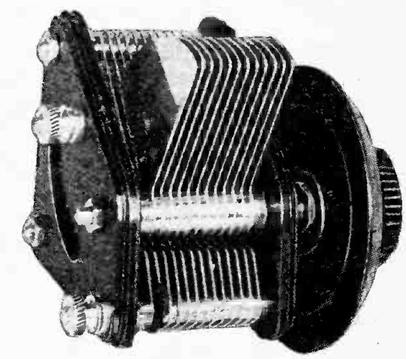
The "K" fixed capacity condenser.

to be a poor dielectric material, and the substitution of a mica insulated condenser wound on a centre core with, perhaps, a protecting wrapper of celluloid, would be an improvement on the present form of construction.

oooo

ASHDOWN VARIABLE CONDENSER.

In commenting on any component, particularly a variable condenser, the price for which it is sold must be borne in mind. The variable condenser market is a particularly competitive one, and there is a tendency, therefore, to offer an inferior article. H. E. Ashdown (Birmingham), Ltd., Perry Barr, Birmingham, are producing a popular priced condenser which can be relied upon to be a thoroughly sound job. Aluminium plates with brass spacing washers are employed, and it is to be noticed that the fixed plates are rigidly set up with the moving plates accurately centred between them. A



Ashdown square law variable condenser, fitted with Bakelite end plates.

threaded spindle is employed, yet not the slightest play can be detected in the top bearing. One-hole fixing is provided, and reliable contact is made with the moving plates by means of a coiled pigtail connector. The knob and dial are separated, the former having a brass bush, and thus the dial can be rigidly locked at its correct setting on the spindle.

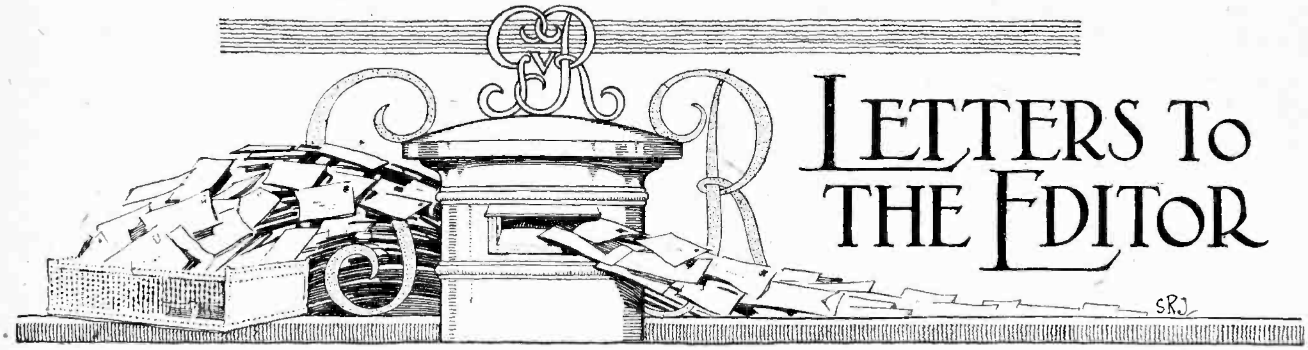
A good clean finish is obtained by the adoption of Bakelite end plates, this being an improvement on the use of ebonite, as it will not bend under the strain exerted by the centre spindle. The moving plates are held accurately in position without the employment of the customary spring washer.

Catalogues Received.

"Hobbies, Limited." (Dereham, Norfolk.) Pamphlet describing wood polishing outfits, which include Hobbies' Lightning Polish.

oooo

"Herbert Terry and Sons, Ltd." (Redditch.) Illustrated pamphlet dealing with the "Terry" 4-valve receiver and power amplifier.



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.

"A PROPRIETARY NAME."

Sir,—With reference to the word "Leclanche," we have read with interest your correspondents' letters, and we beg to state that the name "Leclanche," although it has been used in many parts of the world in conjunction with wet batteries or cells, is nevertheless the property of the Leclanche firm, the inventors and actual makers of this type of cell, whom we represent in the British Empire.

We might further add that this matter has been brought into the Courts, and it was decided that manufacturers, other than Leclanche, could only call their articles "Leclanche type" in the case of wet cells, and we therefore mean to stop the use of the name "Leclanche" for cells which are not manufactured by our principals, and thereby *not genuine* Leclanche.

ALBERT GREGG (General Manager),
RIPAULTS, LTD.

RADIO TOULOUSE ON A CRYSTAL.

Sir,—An interesting matter that I have to report is that, between the hours of twelve midnight and 2 a.m. just before Christmas, I received *Radio Toulouse* on an unaided crystal set (variometer tuned) sufficiently well to hear all the items and announcements. The aerial consists of a loop of 81/36 (enamelled), but it is screened from the S.E. by a tall building. Some local oscillation was going on, but apparently a good distance away. The signals were about R2, varying to a trifle less. The aerial is just under 40 feet high. H. O. CRISP.

Stratford, S.E.15.

WIRELESS IN THE TERRITORIAL ARMY.

Sir,—I am endeavouring to raise recruits to complete the establishment of a Royal Corp of Signals Unit, Territorial Army.

How many readers would like to enlist in the Territorial Army Signals for wireless duties? The obligations are few, the expense nil. The recruit combines excellent training with his hobby. There are 40 and 120 "watters" to operate, and the greater the number of recruits the larger the schemes we can arrange. A two weeks' camp with wireless is both interesting and healthy. For those who are inclined there are other duties in the unit employing all means of signal communication. Technical knowledge is not essential on enlistment.

The headquarters of the unit is at Putney Bridge, and here we have splendid socials and dances. If any readers would care to write to me I will gladly forward information.

27, Copthall Gardens, (Lieut.) W. H. LLOYD.
Twickenham, Middlesex.

CURIOUS LIGHTNING EFFECT.

Sir,—We hear at times, though at rare intervals, of an aerial being struck by lightning causing not unfrequently serious damage. The interesting article of "John Citizen" recently published in the *Wireless World and Radio Review* describes a typical case of the vagaries of the current of a lightning discharge when seeking its path. The following description of an accident to a wireless instrument due to lightning is of quite another order.

The early morning of October 13th, 1925, had been very stormy, and a storm was passing to the north of the observatory, much nearer than usual. Suddenly a flash of lightning occurred, followed almost immediately by a heavy crash of thunder. With the flash I heard a faint but distinct metallic click.

It was immediately evident that the aerial just over our heads had not been struck. Everything seemed in order; no wires fused, nor other damage visible. I had the impression, however, that there was a faint odour of burnt rubber or varnish in the air, but could not trace its source at the moment.

The receiver has separate primary and secondary circuits loosely coupled and variable. At the time of the accident this instrument was disconnected both from aerial and earth, with its leads leaning against the wall a few inches from the aerial and earth lead-in terminals. A 6-volt accumulator was attached, and consequently the negative lead-in contact with all eight filaments.

A careful inspection of the instruments showed that the filaments of all four receiving valves on this set had completely fused. Examination of the burnt-out valves revealed that the globe of each valve contained very minute particles of glass, detached more probably from the seal-in pinch than from the walls of the valve, as the vacuum was still good. The fused filaments had been projected upon the plates and grids in the form of minute spheres, and were completely welded to these parts. When detached (under a dissecting microscope) they either broke, leaving a portion still adhering, or tore away with them a part of the metal to which they were welded.

The primary winding of the telephone transformer had also been burnt out.

The aerial had not been struck by the lightning, and I think that we may conjecture that the damage done was caused by some strange effect of the return shock.

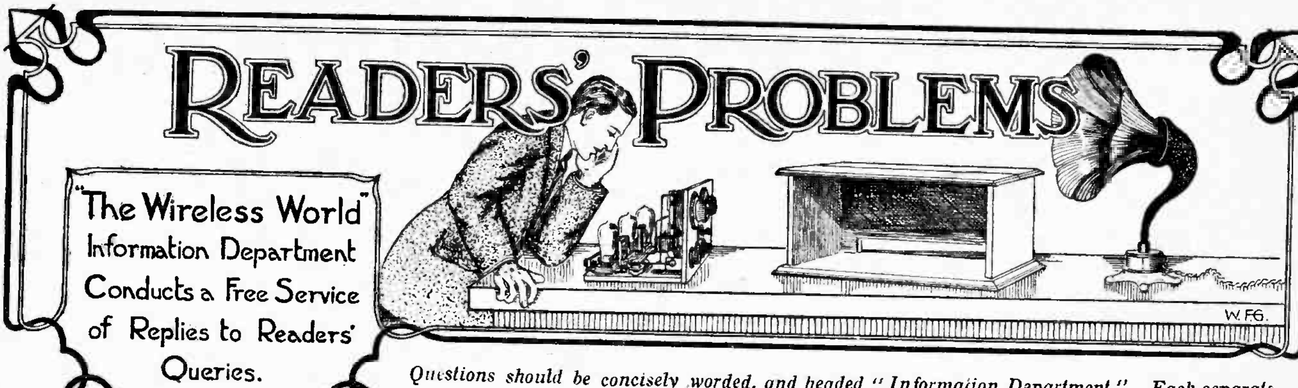
I easily discovered the spot where the lightning struck the earth, as a secretary of the observatory had had the good luck to see the discharge. The exact distance from the wireless room was 671 yards. Two small conical holes about five yards apart were found, with their surfaces calcined. The shock must have been fairly severe, as a farm labourer who was ploughing with a yoke of oxen in the same field a few dozens of yards from the spot was overthrown, together with the two beasts, but received no injury.

I have not been able to find a plausible cause to account for this peculiar accident.

I am inclined to think that the cause should be sought for in a condenser discharge of some sort, the negative lead of the motor side of the converter of the transmitter, perhaps, forming the direct link from earth to a series of condensers, which finally discharging with a spark created a strong oscillating field.

G. H. J. HORAN,

Observatoire de Ksara, Sâad-Naïl, Beyrout, Syria.



Questions should be concisely worded, and headed "Information Department." Each separate question must be accompanied by a stamped addressed envelope for postal reply.

Improving the Selectivity of a Single Valve Receiver.

I have in use a single-valve receiver of fairly conventional design, but wish to improve the selectivity of same. I have tried using loose coupling of the conventional type, and although this arrangement has given high selectivity I find that searching for distant stations is a matter of great difficulty, owing to the necessity of operating four tuning adjustments, namely, the tuning condensers of aerial and secondary coils and the adjustment of the coupling of reaction and aerial coils, and am writing to ask if you can suggest any more suitable method of obtaining selectivity other than the use of an H.F. stage. W.B.M.

As you suggest, it is by no means a simple matter to "search" for distant stations when employing a receiver of this type. There is, however, no need to use a tuned aerial circuit, and if you will adopt a so-called aperiodic aerial circuit you can dispense both with the variable condenser tuning the aerial coil and also the variable coupling between aerial and secondary coils. Our suggestion is that you adopt the circuit given in Fig. 1, where the "untuned" aerial coil is in fixed relationship with the secondary coil, selectivity being obtained by cutting

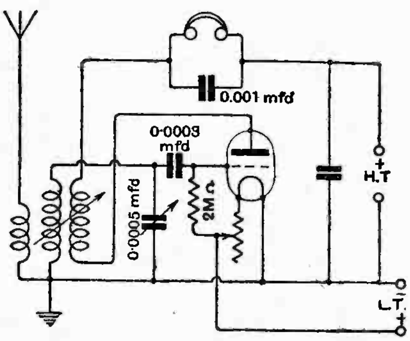


Fig. 1.—Single-valve receiver with "aperiodic" coupling to aerial circuit.

down the number of turns in the aerial coil. We suggest that you obtain a fixed coil mounting and place it in such a position that the aerial coil is in juxtaposition and parallel to the existing aerial coil, which will then become the secondary coil. We suggest that on the B.B.C. wavelengths you employ a coil having about 15 to 18 turns, such as a Gambrell "A2," whilst the secondary coil will require to be a No. 50 coil or a Gambrell "B." It will be found that the value of reaction coil required will be less than that required when a direct-coupled aerial circuit is used. On the Daventry wavelength the aerial coil may be a No. 100 coil, the secondary being No 250, whilst a No. 100 coil should suffice for reaction. It is not generally recommended that an "untuned" aerial circuit be used when operating on 1,600 metres, and many readers using a circuit of this type arrange to plug-in a No. 150 coil in the aerial socket, and connect an external tuning condenser across the aerial and earth terminals when receiving on the Daventry wavelength. This is, however, quite unnecessary, since if a tuned aerial circuit is desired the use of a No. 200 aerial coil (not No. 150) in the circuit given in Fig. 1 will effectively tune the aerial circuit to Daventry's wavelength, no tuning condenser being required. This is explainable owing to the broadness of tuning of the high-powered station's transmission, and in actual practice will be found to function very well indeed.

oooo

An Efficient Two-Valve Receiver.

I have constructed a single-valve receiver following the circuit diagram given in Fig. 1, page 759, of your November 25th issue, and have obtained most excellent results on distant stations, but now wish to experiment with a stage of H.F. in front of this detector, and should be glad of suggestions as to the most suitable form of H.F. coupling to use. H.K.S.

The single-valve circuit to which you refer will, if carefully constructed and operated, bring in a large number of distant stations owing to the delicate and smooth control which it gives over reaction. Now, if a stage of conventional H.F. coupling, such as tuned anode or tuned transformer, is added to it, there is a stray possibility that it may be found that the range of the receiver is in no way increased, and may in fact, be apparently diminished, distant stations which were tuned in faintly on the single valve being not heard when the H.F. stage is added. The reason for this is that an extra tuning control is brought into the receiver, and unless you are possessed of more than ordinary skill the operation of this receiver with this extra tuning control may prevent a very large percentage of efficiency being obtained from the

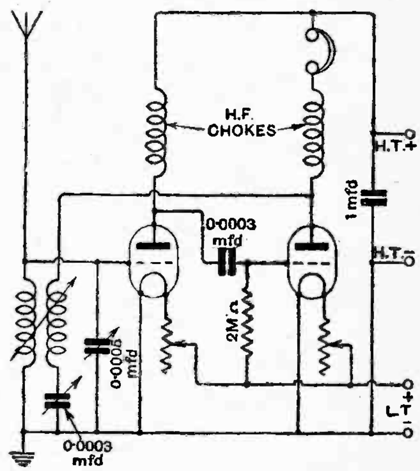


Fig. 2.—Choke-coupled H.F. amplification

arrangement. By far the most suitable form of H.F. amplification to use is that shown in Fig. 2. You will notice that you will require an additional H.F. choke. In the case of both these chokes it is imperative that an instrument of high efficiency be used which is suitable for wavelengths varying from 250 to 4,000 metres and need not be interchangeable, and you are advised to read again our remarks concerning this which were given on page 759 of the November 25th issue. The two chokes must not be mounted side by side, but should be placed at right angles to each other, and, more important still, great care should be taken in disposing the other components so that no accidental capacity whatever exists across either of these chokes, or the efficiency of the receiver will be destroyed. Such a fault could occur, for instance, in mounting the H.T. battery inside the cabinet in close proximity to the tuning coils or chokes or to the wiring associated with the valves, and care should be taken to avoid this.

Properly constructed and handled, a receiver of this type should be capable of really long-distance results even in the hands of quite unskilled people.

○○○○

Reading a Valve Curve.

It is frequently stated in various technical journals that the purchase of a grid bias battery will double the life obtainable from an H.T. battery. I shall be glad if you will explain exactly how this is brought about, and also explain the reason why distortion can be reduced by raising the value of the H.T. employed on the anode of the final valve. S. G. R.

In order to explain these points it will be necessary for you to refer to Fig. 3, which represents graphically the anode current obtainable from a D.E.5 type valve when various values of H.T. and grid bias are used. The curve shown in dotted lines represents the grid current obtainable at different grid potentials. The curve shows us that if we apply no bias to the grid and 60 volts H.T. we shall obtain a steady plate current of 6.5 milliamps. Now, assume that the receiver is tuned to a strong local signal which gives us a grid swing of, say, 8 volts, which means that the normal grid voltage varies from a 4-volt positive to 4-volt negative value. Under these circumstances the curve shows us that the plate current will undergo a sympathetic variation of from about 2.75 milliamp. minimum to a high maximum value, which is not shown in the curve, the mean value remaining at 6.5 milliamps. But the fact of the grid having a 4-volt positive potential will also have another effect, namely, that of causing a grid current of several microamps. to flow, which will cause considerable distortion. Now, if we apply a permanent steady negative voltage of 2 volts to the grid by means of a small dry cell, we shall, in the first place, reduce the steady plate current to 4.6 milliamps., which will mean that the drain on the H.T. battery is not so great. A voltage swing of eight on the grid as before will, however, still permit of grid current flowing and causing distortion at the positive swing, whilst the negative swing will carry our operating point well round the lower bend of the curve, thus causing distortion due to rectification of the low-frequency impulses. If, however, we increase our plate current to 120 volts, still keeping our grid bias at 2 volts, we shall obtain a steady plate current of 10 milliamps., and our 8-volt grid swing will still permit grid current to flow during the positive half-cycle, but we shall have eliminated the rectification at the other end of the curve. Now if, still keeping our anode voltage at 120, we increase our negative grid voltage to 4½, we shall greatly lengthen the life of our H.T. battery by reducing the steady plate current to 7.5 milliamps., and at the same time a grid swing of 8 volts will neither carry the operating point down to the bottom bend, nor will it carry it past the zero grid volts line, where grid current commences to flow, and so all distortion due to valve overloading is eliminated. Actually, our valve will handle a grid swing of 9 volts. If a grid swing of 10 to 11 volts occurs, however, owing to the proximity of a broadcasting station or to the interposition of an additional stage of L.F. before the final stage, we shall once more suffer from overload distortion, and, under these circumstances, we can raise our anode voltage to a few volts in excess of 120, the grid voltage being raised proportionally, and thus be able to accommodate this grid swing. Any further raising of the anode voltage, however, will have no effect in giving us a long straight working portion of curve, and will ruin the valve. If, therefore, we require a very great volume, we must employ a valve such as the D.E.5A., which, at an anode voltage of 120 volts, will give us a longer straight line portion of curve to work on and will thus handle a far greater grid swing, the figures actually being 20 volts grid swing at 120 volts H.T., and, of course, 10 volts negative grid bias. Many people fall into the error of using too great a value of grid bias in proportion to the H.T. voltage they are using. This will cause distortion equally as bad as that caused by employing too little. Suppose, for instance, when handling a grid voltage swing of 8 volts with an anode voltage of 120, we biased our grid 7 volts negative? It will at once be seen that each negative half-cycle will cause the valve to rectify at the bottom bend of the curve, and produce considerable distortion. Similarly, if, when using an H.T. voltage of 60 with the correct grid bias of 2 volts, valve overloading occurs, it will be quite useless to increase the value of grid bias, and, in fact, it is better from the point of view of intelligibility of speech (although not from the point of view of the life of the H.T. battery) to reduce it, since "grid current" distortion is considerably less objectionable in practice than is "rectification" distortion. "Bottom bend" rectification in an L.F. amplifying valve can always be detected by placing a milliammeter in the plate circuit if, indeed, the ear of the listener has not already detected it. A moment's consideration will reveal that if rectification occurs at the bottom bend of the curve, the value of the mean anode current will fall, and, since the milliammeter indicates the mean anode current, the needle of the instrument will give a "kick" when the rectification commences.

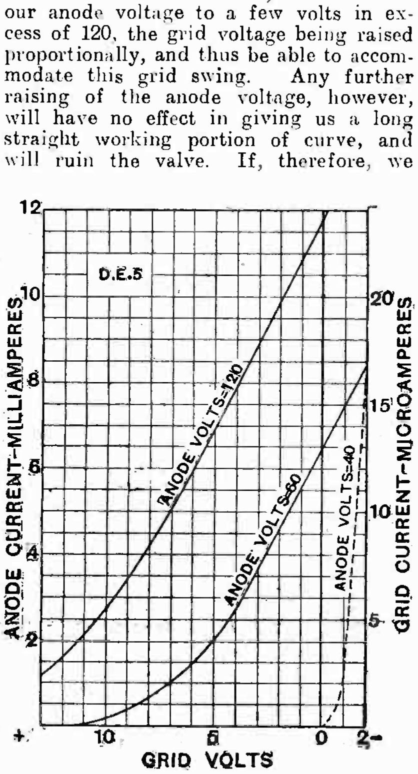


Fig. 3.—Anode and grid current curves for a D.E.5 valve.

○○○○

Charging Accumulators with Wire-wound Resistances.

When charging accumulators from D.C. mains, is it absolutely necessary to make use of lamp resistances? I wish to charge my 4-volt 30 ampere hour accumulator from my mains, which are 240 volts D.C., and desire to use resistances in place of lamps, if possible. A.T.O.

It is by no means necessary to make use of lamps, and suitable resistances may well be used. Since the charging rate of your accumulator will be about three amperes, we shall obviously need a resistance of 80 ohms in order to restrict the current to this value. Standard resistances of this value may be obtained from various manufacturers, care being taken when ordering that the resistances are suitably wound for carrying a continuous current of this value. Alternatively, resistance wire such as "Eureka" could be wound on suitable formers. The gauge and length of such wire necessary in order to produce such a resistance, and at the same time to safely carry a current of 3 amps., would be approximately 120 yards of No. 20 gauge.