THE

B. B. C.

YEAR-BOOK

1930

ISSUED IN 1928 AND 1929
UNDER THE TITLE OF THE
B.B.C. HANDBOOK

THE BRITISH BROADCASTING CORPORATION
SAVOY HILL, LONDON, W.C.2

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SPECIAL ARTICLES

THE YEAR

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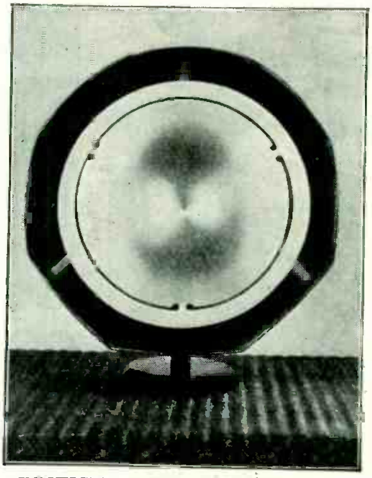

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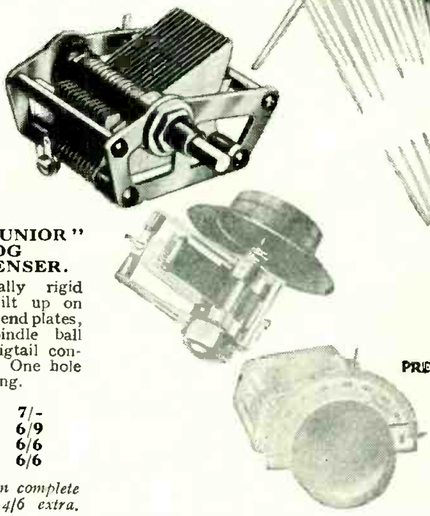

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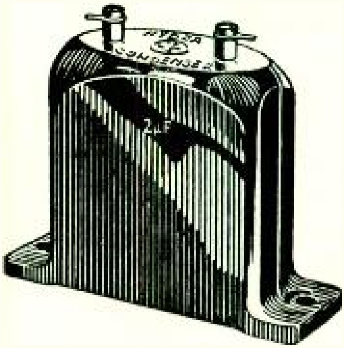

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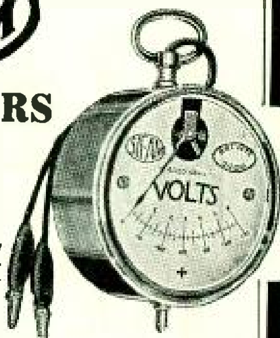
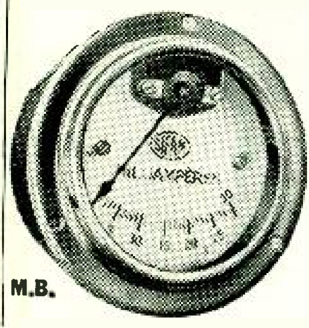


We shall be glad to send you our free leaflet "What simple meters can tell you," on receipt of a p.c.



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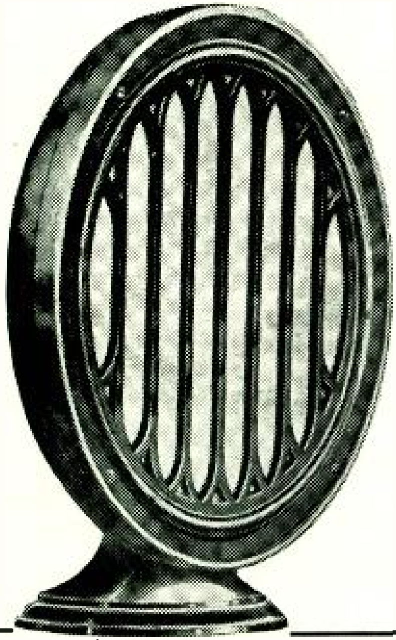

B T-H

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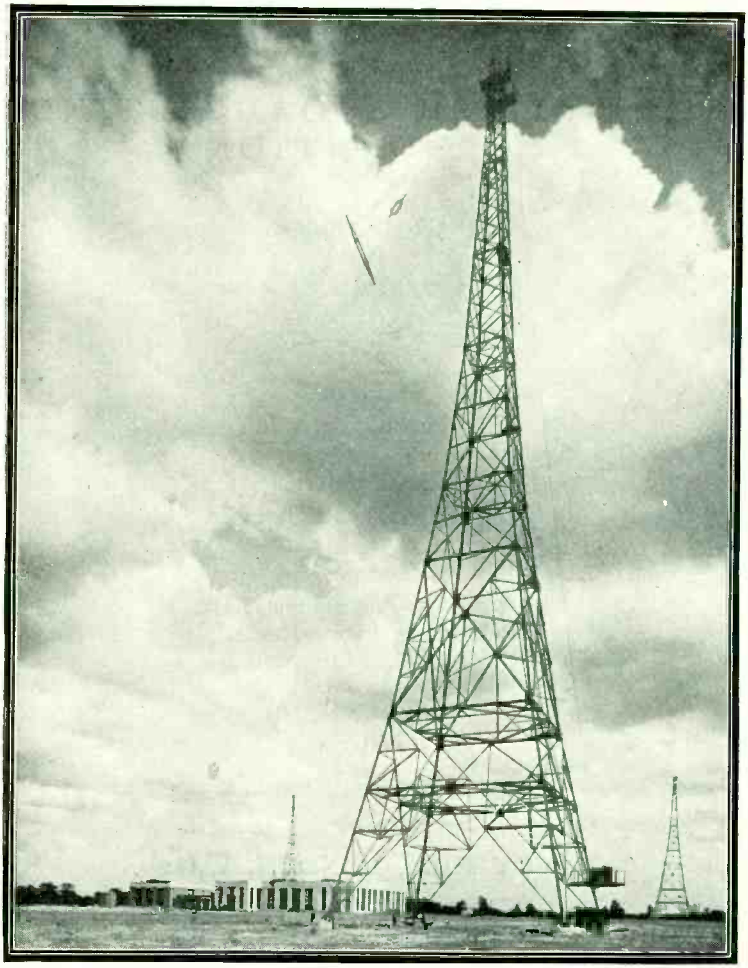
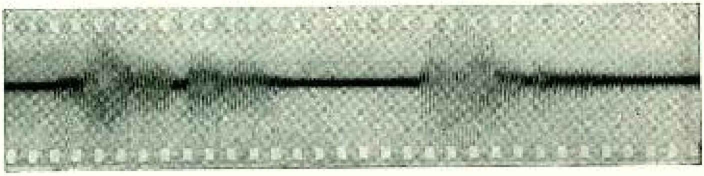


THE FIRST TWIN-WAVE TRANSMITTER IN THE WORLD

The new London Station at Brookman's Park



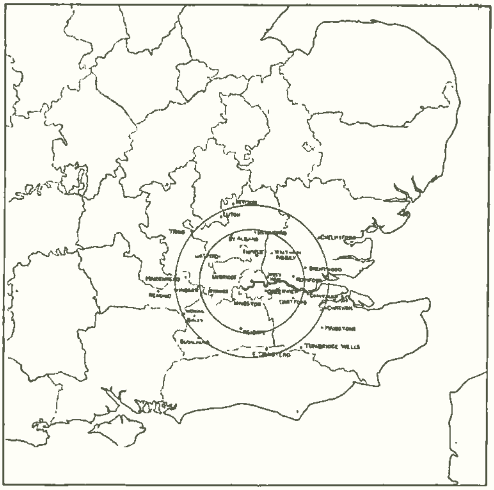
LO - N DO - N CA - LLING

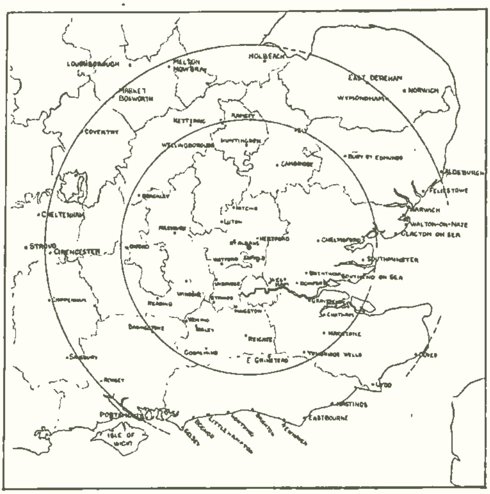
A sound film of the familiar words

INTRODUCTION

THE Handbooks of 1928 and 1929 are now followed by the first issue of the Year-Book, which, it is believed, takes its place as an important auxiliary to the broadcasting service. The task of consolidation and preparation for the Regional Scheme has been carried forward another important stage. The new high-power twin-wave transmitter for London and the South-East is now an accomplished fact. Work has begun on the new transmitter for the North of England, and preliminary measures are being taken for the corresponding transmitters in Scotland and in the West Country. Plans have been approved for the new headquarters of broadcasting in London, and the building is now being erected. There is development to record in all departments of the work. A notable programme event of the year was the inauguration of the National Lectures. Broadcasting was turned to good account in the General Election, proving to be not only a most effective disseminator of views, but also a powerful agency for encouraging study of political issues.

EFFECT OF THE NEW LONDON STATION





The first map shows approximately the area to which a single programme was supplied by the old Oxford Street transmitter. The larger circle represents the average maximum distance at which really satisfactory and reliable reception has been possible on valve receivers, while the smaller circle represents the average maximum range at which reception on a crystal set has been feasible.

The second shows the service area of the London Regional Station at Brookman's Park. The larger circle, some 80 miles in radius, shows the maximum area to which the new London Station will provide a service. The smaller circle represents the distance for consistent reception on a crystal set with a good outside aerial.

The alternative programme service will in general be available to crystal set users with sufficiently selective sets within the area of the smaller circle.

N.B.—The above maps are only comparative representations of reception conditions, since the polar diagram of a wireless transmitter is never by any means circular. This is due, amongst other factors, to the variation in the attenuation in different directions, dependent upon the type of country over which the waves have to travel.

THE REGIONAL SCHEME

THE Regional Scheme consists, as it always has consisted, of a distribution of stations designed to radiate two contrasted programmes from two separate transmitters but from effectively the same geographical point. Thus Daventry 5XX and Daventry 5GB made, so far as the service aspect is concerned, the first twin-wave transmitting arrangement seen in the world, and found the first instalment of the Regional Scheme. Daventry 5XX and Daventry 5GB are really two separate stations albeit they are contained on the same forty-acre site, but the new London Regional Station is designed as a twin-wave station as such, and the requisite two transmitters are housed in the same building.

The completion of the whole scheme will take some time owing to the necessity of accumulating funds from revenue, because the supervision work in station building cannot be "farmed out," and because the choosing of sites requires a good deal of detailed study. It is possible, however, to give a general forecast of the development of the scheme as follows.

The London twin-wave transmitter will have started in service in the autumn of 1929 on a single-wave basis—that is to say, only one transmitter will be energised, making a single programme distribution over the metropolis and Home Counties. Some dislocation is bound to occur because the abandoning of the present centre of transmission will give weaker signals to those living in Central London, while the adoption of a new site on the North periphery of London will wipe out many sets in Northern districts. There will need to be a considerable readjustment of sets, and the B.B.C. staff will have hard work trying to help those who are either non-technical or who do not understand the implications of the new scheme. When a fair readjustment is brought about it will be time to introduce the second programme on the second wave of 260 metres. In order to reduce the dislocation which is bound to occur to those whose sets are very unselective, this programme will at first be of short duration and late at night. This will give plenty of time for readjustment of sets and will deny little of real programme time to those who are affected. The time of double programme giving will, however, be gradually increased until the whole area is flooded with alternative programmes, either picked up at will.

This then will complete the Regional Scheme for the Midlands, and the Metropolis and Home Counties. Already a site is chosen for the Northern Regional Transmitter. This is to be found on Moorside Edge near Pole Moor above Slaithwaite on the Pennines, dividing Yorkshire and Lancashire. (A small-scale map shows Huddersfield as the nearest big town.)

The Northern station's design will be exactly the same as that used at Brookman's Park, except that the exterior will be different, being in red brick and not in stone.

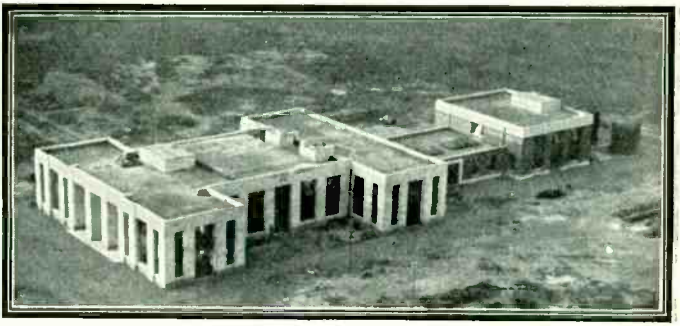
The station will use the longest medium wave and will cover an area containing several millions of persons. Its service area will be greater than London on account of the longer wave, the fact that it will use three 500-ft. masts to support the two aerials, and its available power of 30 k.w. The London station has the same available power but has four 200-ft. masts. Higher masts would have been used for London if the Air Ministry could have been persuaded to give the necessary permission, but the longer wave for Manchester is necessary adequately to cover the enormous but widely separated populations of Lancashire and Yorkshire. London has a more concentrated population.

The Regional Stations of Daventry, London, and Manchester will cover about 75 per cent. of the population of the British Isles with a service of alternative programmes. The Scottish Regional Station, based on Edinburgh and Glasgow, and the West Regional Station, based on Cardiff, Swansea and Bristol, cover the remaining 25 per cent. The Glasgow station will use a long medium wave—longer than London, that is—but it should be recognised that no existing wave unless a so-called long wave (very few of which obtain in the world) could be made to penetrate into the remote Highlands. Mountains have a severe shielding effect which cannot be overcome except by using long waves. If there are no spare long waves to use, we must face facts and realise that the Scottish high-power station can only serve the Lowlands. Less than 2 per cent. of the population of Scotland is, however, left out, although a large part of its area is unserved. Even Daventry 5XX is bound to give poor service to the

Highlands; its waves have had a rough journey up the backbone of England before they arrive.

The Welsh situation is in some ways nearly as difficult as the Scottish. The centre of Wales is very mountainous, but fortunately Daventry 5XX is much closer and so gives a better service than to the Highlands of Scotland. It is nevertheless the only station available for service in North and central Wales. Most of the population of Wales lives, however, on the North side of the Bristol Channel. The West Regional Station will be located so as to serve all South Wales and cover by far the greater percentage of its population, at the same time giving good service to Bristol and the West. It would seem that when the Scottish and West Regional Stations are complete, only 4 per cent. of the population will be unable to get any alternative, and about 80 per cent. of the population should be in receipt of an alternative by the use of the simplest type of receiving apparatus. It is hoped to start building the Glasgow station in a few months' time; Manchester is already building; London and the Midlands are complete.

It is impossible to give a forecast of time taken for completion, but it is fair to give 2½ years more before everything is as it is planned to be.



A VIEW OF THE NEW LONDON REGIONAL STATION AT BROOKMAN'S PARK, TAKEN FROM ONE OF ITS AERIALS

G O O D

ERNEST NEWMAN

wrote in the *Sunday Times* of December 2nd, 1928, as follows:—

I have done a good deal of intensive listening-in this week. Some of the results have been quite astounding; what I have heard has been nearer the real thing than anything that has come my way before. A few more years of progress at the rate of that of the last three years or so, and the average music lover, I fancy, will be even less inclined than he is now to leave his fireside for the concert-room. . . .

Even from foreign stations, in spite of atmospherics, Morse, fading, heterodyning, and all the other usual troubles, I have had extraordinarily good results, while the London reception has been most gratifying. The best foreign reception I have had was that of Hindemith's second quartet from, as well as I remember, Frankfort. Apart from an occasional fading, this was so clear that not only the composer's general thought but the methods of realisation of it by the different string colours came through.

A. H. FOX STRANGWAYS

the Music Critic of *The Observer*, wrote on May 19th, 1929:—

It is my belief that I listened to the music through a set as perfect as it can at present be, under the best management; and the two together are hard to find. One would guess that those who profess themselves disappointed with wireless music have not as yet had the good fortune to find them both together. . . .

The weak point in what we heard of "Siegfried"—to take that first—was certainly the tuttis. With the full orchestra, all one really heard was brass, percussion, and flute; strings and wind were obscure, almost wasted. But when the orchestra came down to chamber music level, it was another matter. Each instrument, when it had room to sound, was distinct, and, what is more, individual. The tone was unmistakable, except that the double reeds lost something of their nasal quality, and the tuba something of the leadenness which distinguishes it from the trombone. The bass is still weak, but stronger than a year ago. The voices were far too powerful and too much alike; we heard the breathing and the mechanism of the note; that almost every word was distinct was of little advantage, since we had the score.

RECEPTION

Elsewhere in this book will be found articles dealing with Receiving Sets, Loud-speakers, Selectivity, etc.

On the opposite page the words of two well-known London music critics are quoted as evidence of the musical capabilities of the modern loud-speaker and receiving set.

Every listener should realise that on well-designed apparatus and with a modern loud-speaker it is quite easy to get *good natural reception of speech and music* within the service area of a broadcasting station.

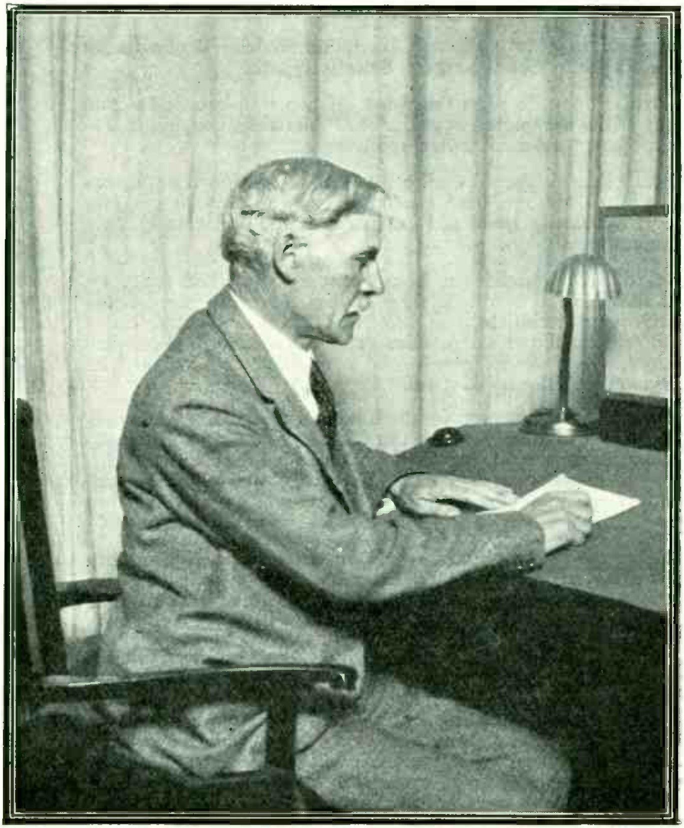
The B.B.C. is anxious to help listeners to get good reception and realise what standard that implies. For this purpose the B.B.C. issues technical pamphlets from time to time. A list of these will be found on p. 460. The Corporation's Technical Journal, *World Radio*, also contains regular technical articles carrying the authority of the B.B.C.

It is necessary, however, for the B.B.C. to maintain strict impartiality in all matters affecting the wireless trade, and in no circumstances can any advice be given concerning the relative merits of the products of particular manufacturers. The B.B.C. recommends purchasers to obtain a demonstration of apparatus before they decide to buy it.

Where the listener wishes to obtain the best possible quality at the lowest cost he should concentrate on receiving his nearest station and not spend money on sensitive long-distance receivers.

The range of musical frequencies which are transmitted in their correct proportion by the modern broadcasting transmitters is 30 cycles per second to 8,000 cycles per second. This corresponds to the complete range of musical notes from C_3 to C^3 together with their correct overtones. If a receiver does not reproduce overtones in their correct proportion, the effect will not appear realistic, as the human ear has come by experience to associate various overtones with different musical instruments.

When a listener is situated within the service range of a modern British transmitter, such as 5GB or the new high-power London Regional transmitters, it is possible for him to obtain a reproduction which to the majority is hardly distinguishable from the original.



THE PRIME MINISTER, MR. RAMSAY MACDONALD, IN THE STUDIO

THE BROADCASTING OF POLITICS

BROADCASTING played an important part in the General Election of 1929. With its constituency of more than twenty million people, the B.B.C. brought the election issues to at least one house in every three in the country. The election of 1924 had a wireless audience less considerable, although even then estimated as representing one house in every six or seven. There were only three political broadcasts in the General Election of 1924, and of these only one was definitely successful.

With the removal of the ban on political controversy in February 1928, the possibilities of the regular broadcasting of politics became a subject of active interest. The B.B.C. had offered on several occasions to broadcast the Budget speech from the House of Commons. Representatives of the three parties tried to devise a mutually acceptable plan whereby politics would find a regular place in the programmes. The main point at issue was whether the Government should enjoy an advantage. Were there three distinctive bodies of opinion in the country with equal claims to this national rostrum? The Liberals and the Labour Party maintained that there were. The Government, taking the other view, claimed the right to reply to each Opposition address. Eventually, it was agreed—although under protest from the Liberal and Labour Parties—that the Government should give four broadcasts before the Dissolution, and the Opposition Parties two each. Before the series began there was an interesting and successful experiment in a new form of presentation. This was a series of consecutive addresses on one evening on the subject of the Local Government Bill. Even then, however, the Government—on the right to reply—got in the last word. This form of discussion was greatly appreciated. The subsequent election broadcasts also attracted much interest, naturally increasing as the date of the election itself drew nearer. The names of the speakers and the dates of their addresses were as follows:—

April 8th	Sir Laming Worthington-Evans	(Conservative)
April 11th	Mr. Arthur Henderson	(Labour)
April 16th	Sir Austen Chamberlain	(Conservative)
April 19th	Mr. Lloyd George	(Liberal)

April 22nd	Mr. Baldwin	(Conservative)
April 25th	Sir Herbert Samuel	(Liberal)
April 30th	Mr. Winston Churchill	(Conservative)
May 3rd	Mr. Philip Snowden	(Labour)

The actual election period began with special Talks for women broadcast by women representatives of the Parties:—

May 13th	Miss Megan Lloyd George and Mrs. Wintringham	(Liberal)
May 15th	Miss Margaret Bondfield	(Labour)
May 17th	The Duchess of Atholl	(Conservative)

Each Party provided a leading spokesman for the final broadcasts:—

May 27th	Sir John Simon	(Liberal)
May 28th	Mr. MacDonald	(Labour)
May 29th	Mr. Baldwin	(Conservative)

The limitation of the time available, and the careful preparation in advance, gave to these political broadcasts a conciseness, a compactness, and a logical order, which on the political platform are rarely possible. More political information from authoritative sources was, in fact, communicated by broadcasting to the mass of the people in the course of this election than on any previous occasion. Another effect of broadcasting on politics was observed in a new mood of close and silent attention at election meetings—a mood which Lord Linlithgow, in a letter to *The Times*, ascribed to the educational effect of the policy of the B.B.C. It would seem that the increased popularity of broadcast talks has fostered concentration and attentive listening, and this reacted upon political assemblages, making them much freer from noisy and irrelevant interruption than ever before.

Finally, mention should be made of the political broadcasts of a non-party nature, the most notable of which was that on Sept. 2nd, 1929, by Mr. Philip Snowden, the Chancellor of the Exchequer, on his return from the Hague Conference at which the Young Plan was revised in favour of Great Britain. The speeches of Mr. MacDonald and others were broadcast from the League of Nations meeting at Geneva a few days later. In the non-party category also must be included Mr. Churchill's exposition of his Budget of April 1929.

MR. PHILIP SNOWDEN, THE CHANCELLOR OF THE EXCHEQUER, BROADCASTING

THE BRITISH BROADCASTING CORPORATION IS NOT A GOVERNMENT DEPARTMENT

IT IS A SELF-GOVERNING CORPORATION OPERATING UNDER A ROYAL CHARTER AND A LICENCE

ITS ACTIVITIES ARE LIMITED ONLY BY THAT CHARTER AND LICENCE

THE POSTMASTER-GENERAL IS RESPONSIBLE TO PARLIAMENT FOR THE B.B.C.'S OBSERVANCE OF THESE LIMITS, BUT HE DOES NOT DIRECT THE ACTIVITIES OF THE B.B.C.

THE BANK OF ENGLAND IS CONSTITUTED BY CHARTER; THE ROYAL ACADEMY AND OTHER SOCIETIES HAVE CHARTERS; MANY PUBLIC SERVICES IN THIS COUNTRY WORK UNDER ROYAL CHARTERS. THEY ARE NOT GOVERNMENT DEPARTMENTS, NOR IS THE B.B.C.

George the Fifth, by the Grace of God, of the United Kingdom of Great Britain and Ireland and of the British Dominions beyond the Seas King, Defender of the Faith, Emperor of India.

To all to whom these Presents shall come Greeting!

Whereas it has been represented to Us by The Right Honourable Sir William Lowson Mitchell-Thomson, Baronet, K.B.E., M.P., our Postmaster General, that the Broadcasting Committee appointed by him to advise as to the proper scope of the Broadcasting Service and as to the management, control and finance thereof after the expiry of the existing Licence on the 31st day of December, 1926, has after sufficient enquiry and due deliberation recommended that the Broadcasting Service hitherto carried on by the British Broadcasting Company, Limited, should after the expiration of the Company's Licence on the said 31st day of December, 1926, be conducted by a public corporation acting as Trustee for the national interest;

. . . .

And Whereas We believe that it would greatly promote these objects and be for the public benefit if a Corporation charged with these duties were created by the exercise of Our Royal Prerogative:

Now know ye that We being desirous of promoting the establishment and organisation of the said Corporation have by Our Royal Prerogative and of Our special grace certain knowledge and mere motion given and granted and by this Our Charter for Us, Our Heirs

. . . .

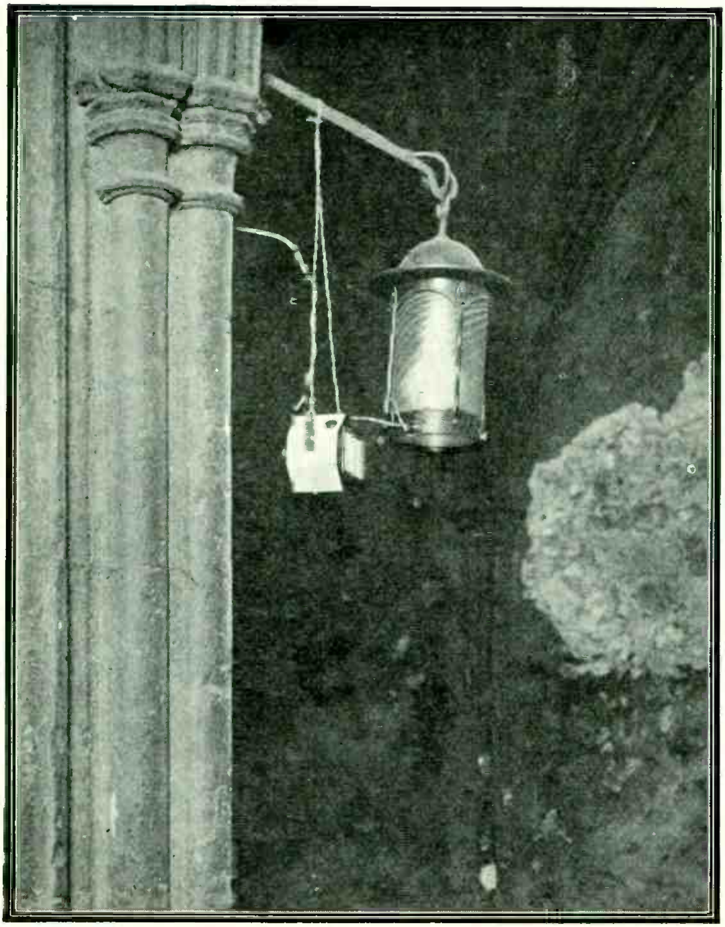
22. Lastly we do by these Presents for Us, Our Heirs and Successors grant unto the Corporation hereby established and their successors that these Our Letters Patent or the enrolment or exemplification thereof shall be in and by all things good firm valid sufficient and effectual in law according to the true intent and meaning thereof and shall be taken construed and judged in the most favourable and beneficial sense for the best advantage of the Corporation and their successors as well in all Our Courts of Record as elsewhere by all and singular Judges Justices Officers Ministers and other subjects whatsoever of Us, Our Heirs and Successors any non recital mis-recital or any other omission imperfection defect matter cause or thing whatsoever to the contrary thereof in anywise notwithstanding. And this provision shall apply to this Our Charter as altered amended or added to in manner aforesaid.

In Witness whereof We have caused these Our Letters to be made Patent.

Witness Ourself at Westminster, the twentieth day of December in the seventeenth year of Our Reign.

By Warrant under the King's Sign Manual.

Schuster.



THE MICROPHONE IN THE CLOISTERS OF CANTERBURY CATHEDRAL

THE FUTURE OF ENTERTAINMENT

STAGE: SCREEN: WIRELESS: TELEVISION

By Charles Morgan

TO obtain by scientific investigation a new power over nature is not of itself a benefit; it does not become a benefit until man, like a child to whom a box of matches has been given, has learned to use it rightly. The mechanical apparatus of entertainment has recently been greatly multiplied. In the field of drama, the theatre once stood alone. Now into that field have entered the gramophone, the silent screen, the talking screen, the wireless and, hesitatingly as yet, television. A new problem has arisen. What is the right use of these inventions? What is their æsthetic relation to one another and to the theatre? When they are being used to create dramatic illusion, what is the nature of the illusion proper to each? Are they allies or enemies? And, commerce being what commerce is, what hope is there that the practice of these inventions will, in fact, be governed by justice and reason?

It is as yet too early to speak in detail of the probable effect of television on entertainment. It is not impossible that the time may come when, without leaving his armchair, a man may be a seeing and hearing member of the audience in any playhouse, cinema or concert hall throughout the world. If this power is ever brought to mechanical perfection, there is little reason, except the desire to be gregarious, that anyone but a few should go in person to any place of entertainment again; from which it follows that, for want of a local audience, theatres, cinemas and concert halls may be closed down and all entertainment be concentrated in studios supported by an international organisation of televisionists. By this gigantic pooling of resources we might obtain the most wonderful entertainment the world has ever seen, but might alternatively, if the control fell into the wrong hands, see all entertainment debased to the level of international millions or used for the vilest propaganda. The same danger, though in less degree, attended the first coming of wireless, and has been averted by raising wireless above commercial competition. The development of television will need to be watched with equal care.

Meanwhile, television being as yet in its infancy, the mutual relations of existing methods of entertainment are of present concern. The theatre, the film and, on occasion, the wireless, all pretend to create dramatic illusion; each has some quality in common with the others; but each—and this is of the first importance in æsthetic theory—has powers and limitations peculiar to itself. The illusion of the theatre is enforced by the contact of man with man, the direct power of one individuality on the psychology of a crowd; but it is limited by being tied to the area of the stage, and by that material earthiness which makes impossible the perfect representation of such plays as *King Lear*, *The Tempest* or *A Midsummer Night's Dream*. The films have a power peculiar to themselves to give a visual illusion of fantasy and of mental states; they have had hitherto the limitation of silence, and have now the remarkable limitation, not yet sufficiently understood, that the more they use their new power of dialogue the more must they sacrifice that magic fluidity which was their unique privilege. The wireless, having the limitation that it strikes its audience blind, has the peculiar power to create in that audience an extraordinary imaginative perceptiveness which springs from, and is the compensation of, blindness.

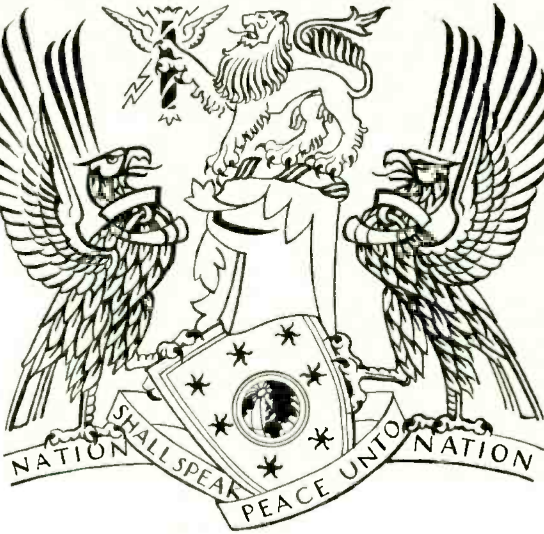
It is fairly clear that, until it is reinforced by television, the scope of the wireless as a vehicle for drama, as drama is now understood, must be a narrow one. Not many plays are suited to it, though the dramatist of originating genius, who will start from the new principles of "imaginative blindness," is by no means an impossibility. Until his coming the wireless may properly be considered as an ally and now and then an invaluable critic of the theatre, not as its rival; and, because wireless plays depend greatly on sound, they may be useful in developing two types of drama—the drama of pure discussion, of which the Socratic Dialogues of Plato are the pre-eminent instance, and the poetic drama in which the sound of words is more than half the battle.

This is not the place in which to pursue at length the now stale dispute between talking-films and the theatre. So great is the magic of actual human presence that it is inconceivable that the talkies will ever oust the play; it is hard to believe that even perfected television would overcome human reluctance to admit mechanical impediment between man and man. Moreover, as has been already shown, the stage and the screen have each powers peculiar to themselves. For a time there will be overlapping and confusion, but in the end the distinguishing æsthetic principles must prevail and the theatre, having sloughed off many of its present follies, will emerge as a purer and stronger medium than it was when tempted towards empty spectacle and show.

All the future depends now upon the speed with which those who control the different departments of entertainment learn and accept their æsthetic limitations and powers. True theory asserts itself soon or late. In face of every sort of stupidity, it was beginning to assert itself on the silent screen; fantasy and pictorial psychology and epic stories of human beings in mass were beginning to prevail over the old subjects and the old methods borrowed from the stage. Now Hollywood has returned to the stage again and must pass through another period of ignorant slavery. But it will emerge some day. We have to be patient while criticism persuades fools to use new inventions rightly; the difficulty being that, when the invention is an aeroplane, death may be patience's only reward. But in entertainment we can afford to wait, using our own methods of criticism, abstaining from the cinema or turning off the wireless when those in control step beyond their own æsthetic province, and learning slowly what the world has yet to learn—that to leave the sources of entertainment in the hands of cynical money-makers is to imperil civilisation, and to imperil it more and more as the facilities of distribution increase. It is bad enough to give matches to an ignorant child; it is the last folly to give bombs to an evil one.

Kreisler in an interview on wireless reported in the press of March 14th, 1929, said—

"We artists really thought at first that few would take the trouble to go to a concert hall when they could enjoy the same concert in all comfort at home. But, paradoxical as it may seem, the opposite thing has happened."



NOT BEING A GOVERNMENT DEPARTMENT OR AN OFFICIAL BODY, THE BRITISH BROADCASTING CORPORATION IS NOT ENTITLED TO USE THE ROYAL ARMS, BUT HAS ITS OWN COAT OF ARMS, A VERSION OF WHICH IS SHOWN ABOVE.

THE successful translation of the B.B.C.'s technical and artistic functions into heraldic language almost justifies the plea that "there is nothing new under the sun." Ancient symbols have been found for the electrical nature of broadcasting (the thunderbolt and lightning flash), the speed of it (eagles), its work of public proclamation (bugles), its scope and breadth (the world and universe) and its ultimate ideal (the motto "Nation shall speak peace unto Nation"). The heraldic description of the Coat of Arms is as follows:—

> "Azure a Terrestrial Globe proper encircled by an Amulet Or, and seven Estoiles in Orle Argent, and for the Crest, on a Wreath of the Colours, a Lion passant Or, grasping in the dexter fore-paw a Thunderbolt proper. Supporters on either side, an Eagle, wings addorsed proper collared Azure pendent therefrom a Bugle horn stringed Or."

The B.B.C. is also entitled to use a badge or device of which the heraldic description is:—

> "A Thunderbolt proper thereon a Pellet inscribed with the letters B.B.C. Gold."

A reproduction of the badge will be found on p. 402 and another drawing of the coat of arms on p. 25.

THE BALANCE SHEET

IN last year's Handbook the main features of the financial side of broadcasting were discussed in general fashion, with reference both to the existing state of affairs and to future developments. The Balance Sheet and Accounts for 1927 were used for purposes of illustration; similarly, this year, the Balance Sheet and Accounts for 1928 are shown on pp. 48–50, and will be referred to in discussing the year's finance.

The outstanding features of the year are the continued steady expansion of the service and the beginning of the realisation of the Regional Scheme. The latter necessarily entails a certain amount of overlapping with the present system of station distribution, and this overlapping is reflected in the accounts for 1928.

With regard to the first point, the expansion of the service, obviously this is possible only if revenue is growing also. The main source of B.B.C. income is, of course, the payments made by the Postmaster-General, based on the number of licences issued. The figure for 1928, £871,763 16*s*. 9*d*., shows an increase of roughly £71,000 over the previous year. In accordance with the provisions of the B.B.C. licence from the Post Office, for the first three months of the year payments were made on the basis of the number of licences in force at 31st March, 1927, and for the remaining nine months on the basis of the number at 31st March, 1928. Under this system of payment in arrear, it is possible to forecast reasonably accurately the income from this source for some time ahead. It is already evident that for 1929 the rate of increase in licence income will be maintained, and this in spite of the fact that the B.B.C. gets a "diminishing return" on licences as the numbers increase. Licences in force, which at March 1927 numbered 2,269,595, had risen to 2,482,930 by March 1928, and at March 1929, stood at 2,731,968. Included in these figures are the numbers of licences issued free to the blind, which, at the dates given, amounted to 5,750, 12,234, and 14,505, respectively. The amounts per licence issued handed over to the B.B.C. (in arrear, as already explained) in respect of the figures of licences paid for are approximately as follows:—On March 1927 total, 7*s*. 3½*d*.; on March

1928 total, 7*s.* 2¼*d.*; and on March 1929 total, 7*s.* 1*d.* The two-and-three-quarter million mark has since been passed.

The next chief source of income is the Net Revenue from Publications. Here also there was in 1928 a considerable improvement on the previous year. At £120,635 8*s.* 11*d.*, the 1928 figure exceeds that for 1927 by roughly £27,000. It may be interesting to note in this connection that the Revenue Expenditure for 1928 amounted to £879,324 6*s.* 2*d.*, while Licence Income, as already stated, was £871,763 16*s.* 9*d.* That is, Licence Income was insufficient to meet even the necessary Revenue Expenditure. To cover the deficit, and provide for current and future capital expenditure, the profit on publications was essential; without it the due development of the broadcasting service could not be maintained.

Revenue Expenditure presents no new features, except in so far as it reflects the overlapping of the two systems, referred to above. Otherwise, the effects of normal development are evident in the larger figures under the chief headings. The cost of programmes, for example, rose from £487,728 8*s.* 6*d.* in 1927 to £538,990 16*s.* 8*d.* in 1928; and it must continue to grow (as far as funds allow) so long as increased expenditure means improvement in the service. A comparison between the two years on the basis of the percentage of the expenditure under the various headings to total expenditure is given below:—

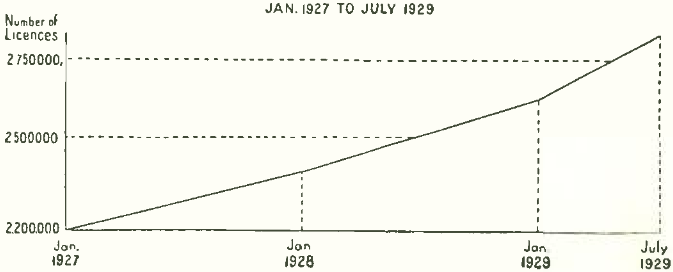
	1927.	1928.
Expenditure on Programmes	63·07	61·30
Maintenance of Plant, Power, etc.	16·95	18·25
	80·02	79·55
Rent, Rates, etc.	8·18	8·87
Administration Expenses	6·58	6·39
Provident Fund Contributions	1·02	0·96
Governors' Fees	0·79	0·69
Provision for Depreciation	3·41	3·54
	100·00	100·00

The greatest differences are to be found in the case of Rents, Rates, Taxes, etc., and Administration and allied expenses. It is in the former that the effects of the change-over to the Regional Scheme have so far been greatest, and the 1928 percentage is therefore the higher. Administration and allied expenses, on the other hand, follow the trend of previous years in showing a percentage decrease. The amount reserved for Depreciation is bound to show an upward tendency for some time in view of the additions, normal and for the Regional Scheme, to the assets on which it is calculated. What may be called the "Prime Cost" of the service—the programme and engineering expenses together—shows little percentage variation at roughly 80 per cent.

Coming now to Capital Expenditure, the most noteworthy feature of the year's finance is that the actual expenditure on the Regional Scheme has begun. In 1927, £100,000 was reserved out of Revenue for this purpose. During 1928, some £30,800 of this reserve was actually spent on the Scheme. That is only a beginning, of course; there will be a rapid "crescendo" for a year or two until the Scheme is wholly in being. At the end of 1928 a further £100,000 was reserved, bringing the net reserve at that date to £169,145 4*s*. 4*d*. The amounts shown under appropriate headings on the assets side of the Balance Sheet include Regional Scheme as well as normal expenditure.

The year's finance has resolved itself, therefore, into the nice adjustment, in relation to income, of provision for normal expansion, the Regional Scheme, and the unavoidable overlapping of the two systems. And that, in effect, will be the B.B.C.'s financial problem for a year or two to come, until the period of transition is over.

GRAPH SHOWING THE GROWTH OF WIRELESS LICENCES IN GT BRITAIN
JAN. 1927 TO JULY 1929



BALANCE SHEET,

LIABILITIES.

	£	s.	d.	£	s.	d.
Capital Account—						
Value placed upon Premises and Plant, Furniture and Fittings, Musical Instruments, Music, Stores, etc., taken over (without payment) from the British Broadcasting Co., Ltd.	174,938	0	0			
Appropriated from Revenue to cover Capital Expenditure incurred by the Corporation to date, and to be incurred on the construction and equipment of Regional Stations—						
Appropriated at 31st December, 1927 (per last Balance Sheet)	110,108	1	11			
Appropriated at 31st December, 1928 .	134,167	15	0			
				419,213	16	11
Reserve for Depreciation and Renewal of Premises, Plant, Furniture and Fittings, Etc.—						
Balance at 31st December, 1927, per last Balance Sheet	26,350	0	0			
Add: Further provision during 1928, per Revenue Account	31,150	0	0			
	57,500	0	0			
Less: Book value of Plant and Furniture discarded during 1928	1,592	1	8			
				55,907	18	4
Creditors and Credit Balances—						
Sundry Creditors	69,545	16	3			
Contingency Reserve	40,000	0	0			
Provident Fund Trustees	3,851	15	2			
				113,397	11	5
Revenue Account—						
Balance at credit at 31st December, 1928, carried forward as per Account . .				7,242	4	8
				£595,761	11	4

CLARENDON }
GAINFORD } Governors.
J. C. W. REITH, Director-General.

Report of the Auditors to the Members

We have examined the above Balance Sheet dated 31st December, 1928, obtained all the information and explanations we have required.

The above Balance Sheet is, in our opinion, properly drawn up so as to to the best of our information and the explanations given to us and as shown

5, London Wall Buildings, London, E.C.2.
14th March, 1929.

as at 31st December, 1928.

ASSETS.

	£	s.	d.	£	s.	d.
FREEHOLD AND LEASEHOLD PREMISES—						
Acquired from the British Broadcasting Co., Ltd., as valued by the Corporation's Officials, plus additions made by the Corporation to 31st December, 1927, at cost, per last Balance Sheet	22,405	7	6			
Additions during 1928, at cost . . .	38,076	7	4			
				60,481	14	10
PLANT—						
Acquired from the British Broadcasting Co., Ltd., as valued by the Corporation's Officials, plus additions made by the Corporation to 31st December, 1927, at cost, per last Balance Sheet	102,673	5	9			
Additions during 1928, at cost (*less* book value of Plant discarded during the year) . .	15,912	9	8			
				118,585	15	5
FURNITURE AND FITTINGS—						
Acquired from the British Broadcasting Co., Ltd., as valued by the Corporation's Officials, plus additions made by the Corporation to 31st December, 1927, at cost, per last Balance Sheet	44,497	11	3			
Additions during 1928, at cost (*less* book value of Furniture discarded during the year)	6,393	3	4			
				50,890	14	7
MUSICAL INSTRUMENTS, MUSIC AND BOOKS—						
Acquired from the British Broadcasting Co., Ltd., as valued by the Corporation's Officials, plus additions made by the Corporation to 31st December, 1927, at cost, per last Balance Sheet	15,469	17	5			
Additions during 1928, at cost . . .	4,640	10	4			
				20,110	7	9
				250,068	12	7
STORES ON HAND AND WORK IN PROGRESS, at cost				6,878	13	4
DEBTORS AND DEBIT BALANCES—						
Sundry Debtors	62,354	0	6			
Unexpired Charges	5,920	13	1			
				68,274	13	7
INVESTMENTS—						
£255,000 5% War Loan, 1929/47, at cost (Market Value at 31st December, 1928, *less* accrued interest—£260,964 10*s*. 0*d*.) . .				256,937	17	6
CASH AT BANK AND IN HAND				13,601	14	4
				£595,761	11	4

OF THE BRITISH BROADCASTING CORPORATION.

with the books and vouchers of the British Broadcasting Corporation, and have

exhibit a true and correct view of the state of the Corporation's affairs according by the books of the Corporation.

DELOITTE, PLENDER, GRIFFITHS & CO., Auditors,
Chartered Accountants.

REVENUE ACCOUNT for the Year ended 31st December, 1928.

EXPENDITURE.	£	s.	d.	INCOME.	£	s.	d.
To Expenditure on Programmes (including payment of Artists, Orchestras, News Royalties, Performing Rights, Simultaneous Broadcast Telephone System and Salaries and Expenses of Programme Staff)	538,990	16	8	By Licence Income	871,763	16	9
,, Maintenance of Plant, Power, Salaries and Expenses of Engineering Staff, Development and Research, Etc.	160,455	11	7	,, Net Revenue from Publications	120,635	8	11
,, Rent, Rates, Taxes, Insurance, Heating and Lighting, Upkeep of Premises, Telephones, Etc. (including provision for contingencies)	77,999	11	6	,, Interest and Sundry Receipts (Net)	10,106	4	7
,, Administration Salaries and Expenses	56,211	19	10				
,, Contributions to Staff Provident Fund	8,416	6	7				
,, Governors' Fees	6,100	0	0				
,, Provision for Depreciation and Renewal of Premises, Plant, Furniture and Fittings, Etc.	31,150	0	0				
,, Balance carried down, being Net Revenue for year	123,181	4	1				
	£1,002,505	10	3		£1,002,505	10	3

REVENUE APPROPRIATION ACCOUNT.

	£	s.	d.		£	s.	d.
To Transfer to Capital Account to cover:—				By Balance brought from 31st December, 1927	18,228	15	7
Capital Expenditure incurred during the year (other than upon Regional Stations)	34,167	15	0	,, Balance brought down, being Net Revenue for year	123,181	4	1
Capital Expenditure to be incurred in the construction and equipment of Regional Stations	100,000	0	0				
,, Balance carried forward as per Balance Sheet	7,242	4	8				
	£141,409	19	8		£141,409	19	8

THE YEAR

THE PERIOD OF A YEAR COVERED BY THIS BOOK MAY BE TAKEN AS FROM OCTOBER 1ST, 1928, TO SEPTEMBER 30TH, 1929

Sport and General

H.M. THE KING DRIVING TO WESTMINSTER ABBEY TO JOIN IN THE THANKSGIVING FOR HIS RECOVERY

NOTES OF THE YEAR

BROADCASTING'S greatest opportunity of service in the past year lay in keeping the nation informed of the King's health. For about six months the B.B.C. was able, mainly in special bulletins, to broadcast the latest possible news of the King's illness from all its Stations, and through its experimental short-wave station (5SW) to the world. On July 7th, 1929, listeners were able to hear the Thanksgiving Service at Westminster Abbey; on which occasion some churches substituted the broadcast for their own ordinary Sunday service, by putting up receivers and loud speakers for the purpose. Not since the General Strike of 1926 have the broadcast News Bulletins been followed with such intense interest throughout the country.

❋

The year saw the inauguration of the National Lectures, which are destined to establish a tradition comparable with that of the Romanes lectures at Oxford. It was appropriate that the first lecture should be given by the Poet Laureate, who made a striking contribution to literary thought in his treatment of "Poetry." The second lecture was given by Dr. A. S. Eddington, on "Matter in Interstellar Space." *The Times*, in a leading article entitled "Wisdom by Wireless," remarked, "The Poet Laureate on the spacing of words in poetry, and the Plumian Professor of Astronomy on the space of the stars, spoke on high themes to greater audiences than have ever before simultaneously heard the authentic voice of masters. . . . Remarkable as the first two lectures have been, the membership of the Advisory Board and the great range of subjects in which first-rate original research is being done in this country, are a guarantee that the scheme can be continued on its original high level."

❋

The Listener, now established as an essential auxiliary to the serious side of broadcasting, was received with widespread alarm in the Press and publishing industry. The most strenuous efforts were made to prevent its appearance and, as a natural consequence of all this valuable advertising, the circulation of the new journal began and continued in a very healthy state. Nor has its success had any observable ill effect on any other newspaper or periodical.

The appointment of the Rev. H. R. L. Sheppard, D.D., to be Dean of Canterbury gave the liveliest satisfaction both to the B.B.C. and to listeners generally. Dr. Sheppard has played a considerable part in shaping the characteristic tradition of British broadcasting. With the restoration of health which enables him to take up the new appointment, there comes a confident hope that he will find time to resume his association with the microphone.

❋

It was Dr. Sheppard's predecessor, the present Bishop of Chichester, who, when still Dean of Canterbury, was the prime mover in the organisation of the Canterbury Festival, which took place in August 1929. The B.B.C. was able to co-operate by broadcasting some of the musical performances and by lending the services of its Symphony Orchestra for the occasion. The music could scarcely have found a more inspiring setting. The Orchestral Concerts took place in the Nave of the Cathedral; beautiful Chamber Music, such as Schubert's Octet, in the Chapter House; and the programmes of Serenades in the Cloisters. The hope has been expressed that the Festival may become an annual one.

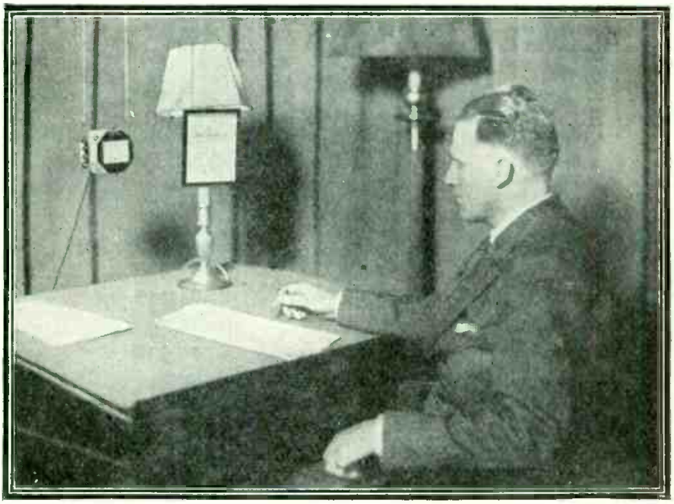
❋

Broadcast drama advanced another stage with the introduction of anonymity. The growing success and popularity of plays especially written or adapted for broadcasting provide convincing justification of the new policy.

❋

There was a steady expansion of the licensed listening public during the year. Post Office returns show that the number of licences in force increased from 2,528,919 on August 31st, 1928, to 2,760,878 on May 31st, 1929. It is estimated that at least twenty million people in the United Kingdom listen to broadcasting regularly or occasionally. It is also estimated that in this country more than one house in three contains wireless receiving apparatus. The corresponding ratio in the United States of America is one in five.

❋



READING THE NEWS

So serious had the evil of "song plugging" become that the B.B.C. decided to take decisive action on its own, following the failure of attempted joint action with music publishers. This meant, for the time being at least, the discontinuance of the announcement of the titles in all dance music programmes except those provided by Jack Payne and the B.B.C. Dance Orchestra. Subsidised "song plugging" may be described as a system in which payments are made by certain music publishing firms to dance band leaders in order that the particular music controlled by such firms may be given preference in broadcast programmes. The result of such "plugging" is that dance music programmes are not broadcast on merit, but entirely according to the desires of the music publishers. A further result is that the programmes, with this system in vogue, tend to become stereotyped in form and to contain the same tunes, programme after programme and day after day. An added evil is that the proprietors of certain dance bands have refused to play music which has not been paid for, this resulting in some of the best theatrical numbers being eliminated from the programmes.

ANALYSIS OF ALTERNATIVE PROGRAMMES

Broadcast from the two Daventry Stations 5*XX* and 5*GB*
December 1928 *to July* 1929

	5*XX* %	%	5*GB* %	%
MUSIC				
Serious . . .	16·774		20·359	
Light . . .	23·567		31·435	
Variety . . .	4·997		14·160	
Dance Bands . .	9·229		10·038	
Gramophone Records	9·693		0·252	
		64·260		76·244
DRAMA		1·664		3·964
TALKS				
Talks and Debates .	8·863		Nil	
Schools Education .	4·560		Nil	
Adult Education .	2·502		Nil	
News . . .	5·070		7·174	
Readings . . .	0·960		0·566	
		21·955		7·740
RELIGIOUS SERVICES .		4·976		1·699
APPEALS . . .		0·142		0·189
CHILDREN'S HOUR .		5·639		8·496
SPECIAL TRANSMISSIONS .		1·364		1·668
		100·000		100·000

NOTE.—The 5*XX* programme is approximately identical with that of the London Station 2*LO*, to which the percentages shown for the former are therefore applicable.

BUILDING PROGRAMMES

EXPERIENCE has shown that the problem of building programmes for broadcasting falls quite naturally into two parts. On the one hand, there is the actual quality of each individual programme, and, on the other, the general balance and lay-out of the whole field of programmes. Taking the week as a unit the programme-builder must so balance one type of programme with another that the final scheme reflects what he takes to be the choice of the majority of the listening audience, without leaving unsatisfied the demand of certain minorities, and without refusing anything which is of particular interest and value in its own field, whatever that field may be. Three years ago the problem was to contract a wealth of material into the rather narrow limits of a single wave-length scheme, but since the opening of 5GB in August 1927 the range of choice has been widened, and the need for contrasts in programmes as well as for consecutive balance has arisen. Since the system of alternative programmes between 5GB and 5XX is the experimental foreshadowing of the Regional Scheme, which is to give a choice of programmes to the majority of the inhabitants of the British Isles, it may be of interest to set out the main lessons learnt in two years' working.

The results of the experiment are visible in their effect on both of the main divisions of the problem mentioned above—the individual programme, and the general scheme. So far as the individual programme is concerned, 5GB has made possible greater concentration in each programme of its own particular elements. In the days when all listeners had to rely on the one wave-length for their broadcast entertainment there was a natural tendency to underline "popular appeal," and to level down all programmes to a lowest common denominator, a process which is inclined to make them characterless. The proper solution is, obviously, to accept a positive criterion instead of a negative one—"The audience which is interested in this programme will find it definitely satisfying," rather than "There is something here for all tastes." The adoption of this solution was made possible by alternative programmes, and helped by the partial raising of the ban on controversy. The year 1928–29 has, therefore, been devoted to a search for more and more programmes with this positive value in them, and particularly to a search for programme material which can be properly handled by broadcasting and broadcasting alone. The search has been successful in the case of plays such as *Squirrel's Cage*, which was written specially for broadcasting, and used a technique which parallels in the world of sound the visual technique of the cinema, and in the case of feature programmes such as *Kaleidoscope* and *The Dominion Day Programme* which used a mixture of words, sounds, and music, which are beyond the scope of any other art. Once the material has been found, the question of production is the next consideration. The microphone is the deadliest enemy of anything which is shoddy—insincerity of thought, vagueness of expression, carelessness or indefiniteness of handling. Enormous pains are taken in rehearsal, whether of individual artists, or of orchestras, or of the control of sound effects, in the hope that it will be possible to say about any programme which is to be broadcast that the material is good of its kind, the workmanship sound, and the handling of it efficient.

So much for individual programmes, which are the bricks with which the architect of programmes in general has to build his structure. He is helped by one piece of knowledge, which six years of broadcasting has contributed. Any programme which is first-rate of its kind has its audience, and since the audience for broadcasting is numbered in millions, even a minority group represents a very large number of individuals. His main preoccupation is to see that the general balance of programmes does reflect the preferences of the main body of listeners, that each individual programme has the setting in the general scheme which will give it its greatest chance of success, and to keep that general system as flexible as practical considerations will allow, so that nothing of importance will be rejected even though it appears at the last moment. In other words, the B.B.C. must attempt to combine the flexibility of a great newspaper with the certainty and accuracy of one of the public services. Naturally this is not wholly possible. Halls and artists must be booked and contracts once made must be honoured; orchestras are made up of human beings who cannot work indefinitely; and a complex system like that which links the broadcasting stations of Great Britain must sometimes make programme arrangements so interdependent that the change of one programme unit at the last moment becomes almost impossible. However, the inclusion in the programmes of such items as the speech of Sir Henry Segrave the moment he landed in England after breaking the world's speed record on Daytona Beach, and the opening scenes of the new season of the Co-Optimists at the Vaudeville Theatre, a broadcast which was suggested and arranged in an hour and a quarter, are some guarantee that rigidity of outlook is not characteristic of the B.B.C.

The general policy which governs the choice of contrasted programmes must by this time be clear to that large body of listeners to whom 5GB already provides an alternative programme. The vast majority of listeners are catholic in their tastes. It is demonstrably true that for every listener who prefers a Vaudeville programme at one end of the scale or a concert of advanced Chamber Music at the other, there are nine who listen consistently to those programmes which range from military band and Promenade Concerts to broadcasts of ceremonies actually taking place hundreds of miles away. Therefore, when a programme has to be chosen which will provide an efficient contrast to a specialist programme of the "highbrow" order, that choice will usually fall on one of the series of "middlebrow" programmes rather than on the "lowbrow" programme at the other end of the scale. One point should be made here—that a slavish adherence to rules of contrast which are supposed to be ideally adequate would defeat its own end. If, for instance, on one wave-length Professor Eddington were to broadcast an extremely interesting but specialised talk on "Matter in Inter-Stellar Space," a vivid description by Sir Henry Segrave of his experiences on Daytona Beach would, in fact, be an admirable contrast for most people, though theoretically to offer speech as an alternative to speech is unwise.

It is hardly too much to say that the fourth article of programme policy is the attitude towards programmes of the general listener. At all events, if this cannot be called programme policy, since it is outside the control of programme-builders, it is of such paramount importance to programmes that it may well be considered here. However well the programme-builder at the B.B.C. does his work, however satisfactory the balance and adequate the contrast between the sets of alternative programmes, he cannot do more for the listener than provide him with an accurate map of the country to be explored. Each individual listener must choose where exactly he wants to go. In other words, each listener must be his own programme-builder, and must choose from the programmes set out before him in the *Radio Times* a selection which will satisfy his own particular ideas of what a week's programmes should give him. To leave a set switched on, in the hope that before the evening is out one will hear something that one wants to hear, invites mental indigestion, or a chaotic state of mind in which one hears a hundred programmes and understands none. It is equally illogical to switch on a set casually and expect that inevitably one will be given that particular form of entertainment which one wants to hear at that particular moment. If a man wants to go to a music hall, and walks down the street and enters the first big building he sees lit up, and finds himself listening to a Symphony Concert, he does not blame the management of the music hall. A listener wishing to make the best use of the many programmes offered to him must take the elementary precaution of finding out beforehand when his favourite programmes are to be broadcast. He should then be certain of finding programmes to his liking, and he will be spared the unnecessary discomfort of listening to something which his neighbour likes, but which is distasteful to himself.

To sum up, the aims of the B.B.C. are to provide a series of programmes each of which is good of its kind and as efficient in its handling as talent and careful rehearsal can make it; to arrange these programmes in a way which will reflect the preferences of the majority of listeners, and will make it possible for listeners to choose the programmes they want; and to adopt every practicable programme suggestion which has positive interest. On the other side of the microphone, the listener must realise that a definite obligation rests on him to choose intelligently from the programmes offered to him. Every listener should be his own programme-builder.

Everything said in this article about 5GB and the choice of programmes it makes possible will apply in an even greater extent to the Regional Scheme when it comes into being.

GOOD LISTENING

MAKE SURE THAT YOUR SET IS WORKING PROPERLY *before* YOU SETTLE DOWN TO LISTEN.

CHOOSE YOUR PROGRAMMES AS CAREFULLY AS YOU CHOOSE WHICH THEATRE TO GO TO. IT IS JUST AS IMPORTANT TO YOU TO ENJOY YOURSELF AT HOME AS AT THE THEATRE.

LISTEN AS CAREFULLY AT HOME AS YOU DO IN A THEATRE OR CONCERT HALL. YOU CAN'T GET THE BEST OUT OF A PROGRAMME IF YOUR MIND IS WANDERING, OR IF YOU ARE PLAYING BRIDGE OR READING. GIVE IT YOUR FULL ATTENTION. TRY TURNING OUT THE LIGHTS SO THAT YOUR EYE IS NOT CAUGHT BY FAMILIAR OBJECTS IN THE ROOM. YOUR IMAGINATION WILL BE TWICE AS VIVID.

IF YOU ONLY LISTEN WITH HALF AN EAR YOU HAVEN'T A QUARTER OF A RIGHT TO CRITICISE.

THINK OF YOUR FAVOURITE OCCUPATION. DON'T YOU LIKE A CHANGE SOMETIMES? GIVE THE WIRELESS A REST NOW AND THEN.

THE LAYING OF THE FOUNDATION STONE OF THE SHAKESPEARE MEMORIAL THEATRE AT STRATFORD-ON-AVON

This was performed with full Masonic ceremonial by Lord Ampthill, Pro-Grand Master of England, the proceedings being broadcast

TECHNICAL PROGRESS

LAST year the article under this heading attempted to show that 1928 was a year of preparation for future progress; 1929 is the first year of definite achievement; 1930 will continue to record changes bringing nearer the completion of the scheme which has been aimed at for years past.

First one must record the successful carrying into effect of a system of working several stations on one wave-length. The scheme has been accepted with so little remark (except in purely technical circles) that its success is patent. It is necessary to use one channel for several stations, chiefly because of the limitation of available wave-lengths. This has been realised for years, but how to do it has not been so easy. Now Britain uses one wave-length for ten stations, freeing the other nine channels for other stations. It was found by experiment that the sharing of a wave between two stations was only practicable when such stations radiated the same programme and were synchronised to a very high degree of accuracy—in practice less than ten parts in a million, using medium waves. Thus it is obvious that waves can only be shared by stations under the same administration, doing the same programme. It was a bold step to attempt to synchronise the frequencies of the aerial currents of quite independent stations to an accuracy of a few parts in a million and expect this accuracy to be maintained under working conditions, but the step was successful. Great credit is due to the Marconi research staff in producing the necessary electrically maintained tuning-fork and to the B.B.C. research staff in adapting the fork to practical use, and finally to the B.B.C. maintenance staff in keeping the apparatus going in practice. The method of single wave-length working bids fair to revolutionise the general implications of the arrangement of wireless broadcasting stations for diffusion of national programmes.

Although the first regional station is not at the time of writing* so complete as to be able to be put into regular service, it has already started its tests. The station is unique in the world. It is designed to afford facilities for the simul-

* September, 1929.

taneous radiation of two different programmes, and hence enables every listener within its range to have a choice of programmes. It is entirely self-contained, the building housing a complete power plant of nearly 1,000 horse-power, a small studio, and two transmitters. It has been the subject of continuous thought over a year's building. It now stands as a concrete sign of the progress of British broadcasting during six years.

The third fact of importance is that the results of research and experiment have now made it possible to predict the service area of broadcasting stations with a sufficient degree of accuracy. A pamphlet entitled "The Service Area of Broadcasting Stations" has been published by the B.B.C., and sets out the whole science of this part of broadcasting as B.B.C. Engineers know it.

One must next record the fact that all the Governments of the nations comprising the European continent, including the Russian Government, have concluded an agreement whereby European stations are allotted specific wave-lengths within the gamut allocated for broadcasting by the world conference of Governments at Washington. It is interesting to note in passing that conditions of listening in Europe are thus better than in the United States of America, where nothing like so comprehensive an arrangement has been come to.

One cannot record much actual progress in the linking together of European stations by wire as this affects Britain, but all the ground is prepared for a considerable increase in the number of exchanges of programmes with the Continent this coming season. Already a great deal has been done on the Continent itself in linking up stations in different countries; it remains to extend the network to embrace other countries, and of course from the B.B.C.'s point of view particularly Britain, in the international network.

A new control room has been built at Manchester. This is an entirely fresh departure in technique. It should teach much for future development. It is worked on the automatic principle, so that the operator has the fewest operations to make personally, and is therefore freed from much responsibility, while the engineer has to keep careful watch that the machine itself keeps in perfect condition. It is too early to say whether evolution should be towards wholly automatic or wholly manual operation, it is probable that finality will be found between the two extremes. The general principle must be quickness and accuracy. Experience alone will decide which of the many methods will be finally used. Much of this work is purely pioneering, and experience can only be gained by practice and fearless experiment.

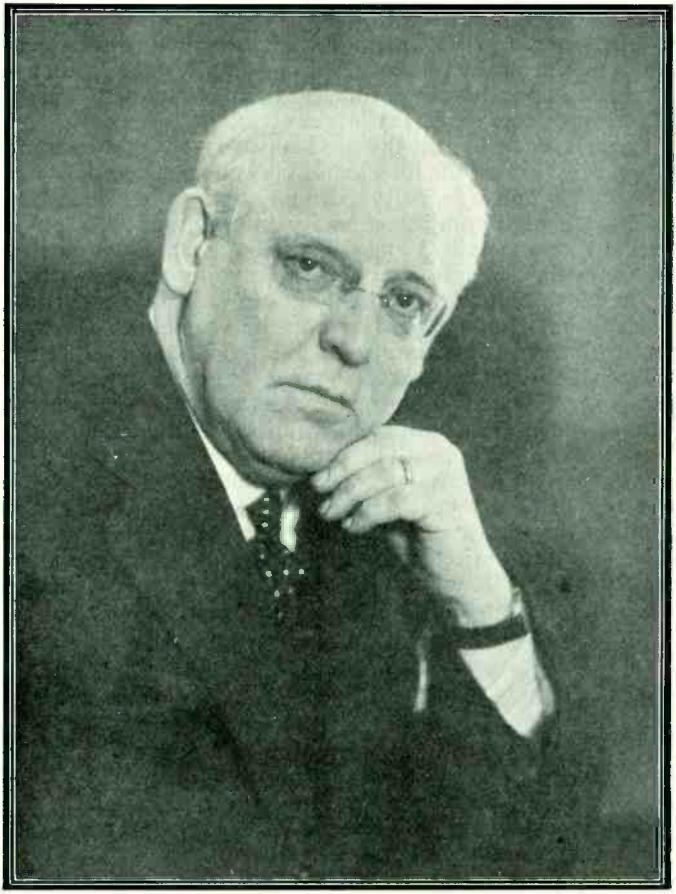
The microphone and the loud-speaker continue to be the weakest links in all the long chain between artist and listener. The B.B.C., however, can record an advance in microphone design. A high quality capacity microphone has passed several severe tests and looks like being a standard for most studio work. The simpler and more robust carbon microphone must still carry the load of outside broadcasts, cruder transmissions, and so on, for some time to come. The loud-speaker improves and improves. It would seem that progress must be rather towards choosing what it leaves out than what it puts in. The qualities necessary seem to lie more and more in the direction of accuracy in what it does than the range it compromisingly covers. The problem can now be stated, the task is to solve it completely, *i.e.* commercially.

A record of the year's progress cannot close without reminding the reader of a reliability record which is remarkable. 5GB, an entirely new and experimental station a year ago, has settled down and is now competing against its older brothers in point of reliability, while keeping its superiority in point of quality.

RELIABILITY FIGURES

Total length of transmission	64,467 hours.
Aggregate length of breakdowns	19 hours 20 min.
Percentage of breakdowns	·03%.

Note.—The above figures do not include the Daventry Experimental Station 5GB, which has a breakdown proportion of ·54%.



PERCY PITT, THE B.B.C.'S MUSIC DIRECTOR FROM 1923 TO 1930

A PANORAMA OF MUSIC

IT is the aim of programme builders throughout the course of each year to cover a wide and comprehensive musical schedule. There are many standard works, such as the Beethoven and Brahms symphonies, concertos, and string quartets, and particular works by Haydn, Schubert, Bach, Handel and Mozart, which have long been recognised as among the world's masterpieces. To students and lovers of music these are the bread and butter of their daily fare —like the Bible and Shakespeare to the lover of literature. The policy of the B.B.C. is to give as many of these established works as possible, so that they may be heard in rotation from year to year, sometimes from month to month, from every station.

In addition, the schedule includes a large amount of interesting music which, though not meriting such frequent repetition, deserves to be heard now and again. Under this heading comes a great deal of classical and romantic music, together with certain modern works which have already established themselves as worthy of a place. In addition, many performances are given of new works by contemporary composers of this and other countries, which may or may not ultimately win for themselves a similar position; but such music has a right to be heard, and until now the public has never had the opportunity broadcasting gives of keeping *au fait* with what is happening in the world of modern music.

Nevertheless, the listener has in the past twelve months had a good opportunity of hearing many representative series of programmes, as the following summary will serve to show. The word "series" is used with reason: for whereas it is frequently impossible for any one programme to be representative of music of an extensive period, even a short series can be designed to achieve this, *e.g.* the much-discussed British Composer concerts of the 1929 "Proms."

FOUNDATIONS OF MUSIC

This, being the most regular of the musical series of programmes, is mentioned first. It has included weeks of such wide divergence as Wolf songs, Handel's harpsichord pieces, Beethoven sonatas, accepted modern works, English madrigals, and thirteen weeks devoted exclusively to Schubert (song cycles, duets, sonatas, etc.). The programme re-arrangement which allowed the extension, as from September 1928, of each evening recital from ten to fifteen minutes has been greatly to the advantage of a series which has a unique educational value.

CHAMBER MUSIC

The policy has been continued of building programmes of three main categories of works: classical, British, and contemporary. In the first category, the main classical repertoire of sonatas, trios, quartets, etc. has been almost completely worked through. In the second, many accepted British works have been played, some several times, and new, or less familiar, works of importance by composers such as Bax, Ireland, Goossens, Bliss, Alan Bush and Gordon Jacob. In the third category come the eight monthly concerts given at the Arts Theatre Club, London, comprising mainly first performances of interesting new works by contemporary composers of international distinction. The artists included the Amar-Hindemith, Brosa, International, Kolisch and Pro-Arte quartets; Steuermann, Gieseking, Marcelle Meyer (pianists), Croiza, Hinnenberg-Lefèbre (singers), and Szekely and Telmanyi (violinists). Bela Bartók gave a recital of his own work; Hindemith played his solo viola sonata, and Hermann Scherchen conducted a Chamber Concert which included a small chorus. In all about fifty first performances in this country were given.

SYMPHONIC MUSIC

As in the case of the Chamber Music, most of the standard works by the great masters were included at least once from every station; either from the "Proms," or from the Queen's Hall Concerts, or from the studios, or the Hallé, or other outside concerts. This includes most of the overtures, symphonies, concertos, suites, etc. by the "great" composers from Purcell and Bach up to Debussy and Ravel—the cream of nearly four centuries' orchestral music.

There were twelve special symphonic concerts given at the Queen's Hall, with Sir Henry Wood, Sir Landon Ronald, Sir Thomas Beecham, Ernest Ansermet, Sir Hamilton Harty, Dr. Granville Bantock, Albert Coates, Von Hoesslin and Albert Wolff as the conductors. Five were choral concerts, the newly organised "National Chorus" taking part and creating a good impression in its first season. The soloists at these concerts included Szigeti, Wanda Landowska, Katharine Goodson, and many British singers.

Eight popular symphony concerts, with British soloists, were conducted by Sir Landon Ronald and Mr. Percy Pitt at the People's Palace, Mile End; five of them devoted respectively to Bach, Tchaikovsky, Gounod and Bizet, Strauss and Elgar, and Wagner.

Sir Thomas Beecham gave a welcome programme of his beloved Delius, and Stravinsky the first concert performances here of two new Ballets of his own. Both concerts were in the Kingsway Hall, the public being admitted to the latter concert at popular prices.

As part of the policy of a musical exchange with Spain, Perez Casas, the conductor of the Madrid Philharmonic Concerts, came to conduct a programme of Spanish music in the London studio in June. It is hoped later to accede to the Spanish Government's invitation to send a distinguished British conductor to direct one of the Madrid concerts.

The many studio symphony concerts included a Russian programme directed by Malkó; a Glazounov programme conducted by the composer; a Sibelius programme; a concert of works by South African composers, directed by Leslie Heward, himself conductor of the Cape Town Orchestra from 1924 to 1927; a concert of new works by the younger generation of composers, conducted by Ansermet; and an evening directed by Hermann Scherchen, the distinguished German conductor (who is now the General Musical Director of the Koenigsberg Broadcasting Station), which included the new Suite specially written for broadcasting by Schrecker—the first of a number of works directly commissioned for broadcasting in Germany.

OPERATIC MUSIC

Twelve "grand" operas were given under Mr. Percy Pitt's direction, either in the studios at Savoy Hill or in the "Parlophone" studio. They included "Maritana" (Wallace), "Pelléas and Mélisande (Debussy), "Samson and Delilah"

(Saint-Saëns), "The Blue Forest" (Aubert), "Lakmé" (Delibes), "Coq d'Or" (Rimsky-Korsakov), "Ivanhoe" (Sullivan), "The Flying Dutchman" (Wagner), "Le Jongleur de Notre Dame" (Massenet), "The Swallow" (Puccini), "Werther" (Massenet) and "Le Roi l'a dit" (Delibes), (the last being conducted by Mr. John Ansell). The librettos of these were published in convenient pamphlet form.

In addition, various performances were relayed from the International Season in May–June 1929 at Covent Garden, and many of the leading operatic singers and conductors of the day were thus available to listeners; performances by the B.N.O.C. and Carl Rosa Company were also relayed.

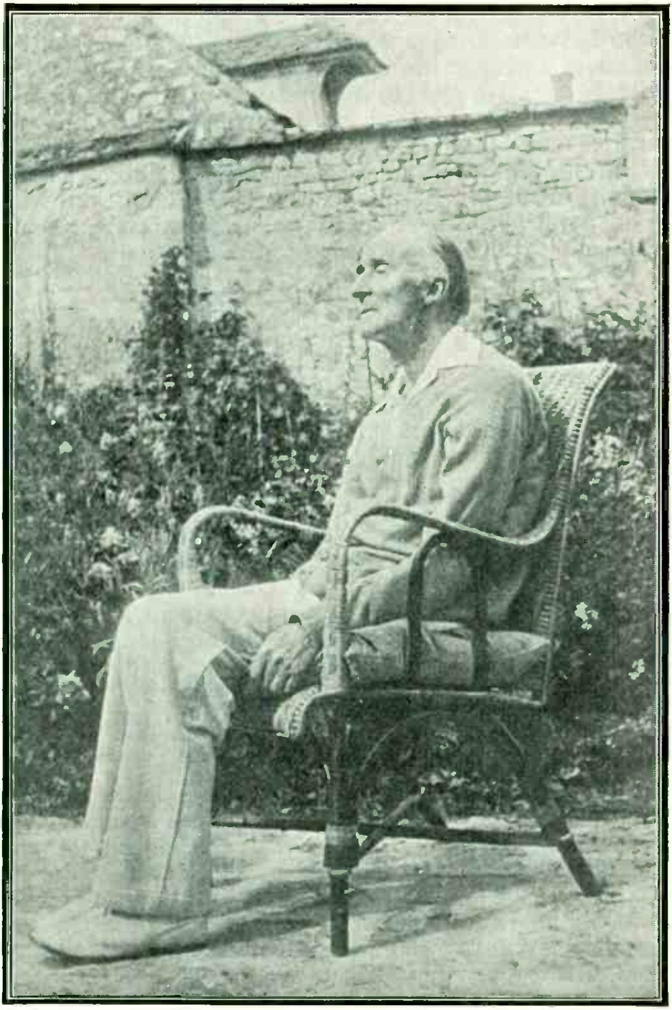
A number of lighter operas and operettas were performed at various stations, including the first performance of a comic opera, "The Fountain of Youth," by Alfred Reynolds, and the first performance, after an interval of over forty years since its composition, of a charming light opera, "A Sea Change," by Sir George Henschel.

SCHUBERT'S CENTENARY

Reference has already been made to the recognition of 1928 as the centenary year of this composer by the devotion of thirteen weeks of the "Foundations of Music" to his work. In addition, the week of November 18–23, as containing the actual centenary date (November 19th), contained three of his symphonies; the complete "Schwanengesang" cycle, given as a duet by Anne Thursfield and George Parker; his octet and quintet for two violins, viola, and two cellos; songs, sung by that greatest of our liedersingers, the youthful octogenarian, Sir George Henschel; and several works specially arranged for the Wireless Military Band by Gerrard Williams, including the "Symphony on French Themes"—piano duet movements intended originally for a sonata or symphony by the composer, but not acceptable to his publishers in the larger form.

BACH CANTATAS

In May 1928 were begun the weekly broadcasts of the Church Cantatas of Bach. They are given if possible on appropriate Sundays, as originally intended (as at Easter and Whitsun), and each is repeated within a few weeks to afford the many



FREDERICK DELIUS

the great English composer, now blind and living in France, a festival of whose works took place in London in October 1919, under the direction of Sir Thomas Beecham enthusiasts interested a second opportunity of hearing it. So far, about half have been given; the 100 remaining cantatas will take over two years to complete. The wide interest taken in this series is evidenced by the many applications from libraries and colleges for advance details of cantatas to be given. All are given in English, many being translated specially for these performances by D. Millar Craig. Many other choral works—sacred and secular, grave and gay—have been included in studio concerts from all stations.

RECITALS AND ARTISTS

Space will not allow of detailed reference to the many solo and duet recitals given by a long array of interesting artists, British and foreign. The following, however, call for special mention: Granados' "Goyescas" (complete), played by Marcelle Meyer; Busoni, played by Petri; Medtner, playing his own works, also Ireland and Scott; harpsichord recitals by Mrs. Woodhouse and Gunther Ramin; organ recitals (César Franck) by the latter and Joseph Bonnet; and violin recitals by Szigeti, Jelly d'Aranyi, Catterall, Sammons, and others. The lieder recitalists have included Henschel, Coates, Schumann, Olczewska, Nissen, Bronsgeest, and many British singers far too numerous to mention here. The wonderful Aguilar Quartet of Lutes, from Barcelona, was a welcome novelty. These and several other excellent Spanish artists were obtained through co-operation with the Anglo-Spanish Chamber Music Society.

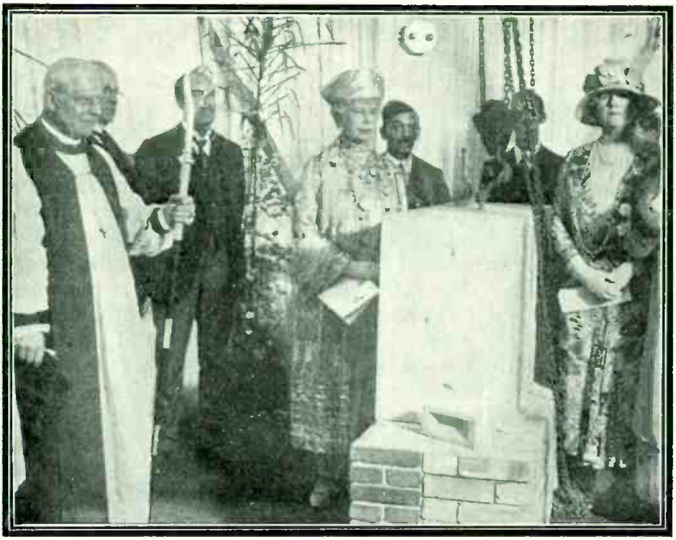
DAY-TIME CONCERTS

The day-time listener has not been forgotten in the matter of good music. From 5XX and 2LO he has had a sonata recital every Friday morning (a gesture, particularly, to music students and schools), and a chamber concert each Wednesday afternoon; and, thanks to the increasing library of excellent gramophone recordings, many symphonies, quartets, and operas, such as "Carmen" and "The Ring," have been broadcast regularly in complete form.

BROADCAST PLAYS

IT would be rash to affirm simply as a matter of fact that 1929 has been the most successful year in the history of radio drama since the inception of broadcasting. This is probably only true because this branch of drama is still in an adolescent condition. Its forms are not yet static; its theory is still being evolved, and therefore, with every year that progress continues, that year must, from the mere nature of things, be more successful than its predecessors, owing to the continual gains arising from varied and different experiences in technique. But 1929 has been no more uniformly successful than any other year. From the point of view of broadcast plays it can only be said that 1929 has been consistently interesting. The standard aimed at may have been a little too high. Achievements have certainly in various cases fallen short of endeavours and of hopes. Complete satisfaction cannot be claimed, but equally that there has been any tendency towards retrogression can be definitely denied.

The series of Twelve Great Plays inaugurated in 1928 has been concluded, and it is possible to say something of the series as a whole. It is doubtful whether the Great Plays entirely justified themselves in performance. They were distinguished for extremely competent production. Each one was, of course, interesting in itself as an example of a specific national drama and for undoubted literary qualities. From the point of view of programme value they were less satisfactory; though naturally they achieved a certain prescriptive precedence above other wireless plays, although they were indubitably directed to a minority audience. Several—for example "Sakuntala," "Minna von Barnhelm," and "The Cherry Orchard"—were simply unsuitable for broadcasting. Perhaps the most satisfactory were "There are Crimes and Crimes," and "Electra": the former for its human interest and the emotional grip of its story; the latter for its poetic value and classic purity of outline. That radio drama should present classics at reasonable intervals, choosing plays that fit the peculiarities of the microphone, is unquestionable. To establish another such series with practically no criterion but literary and traditional reputation would be a far more dubious proposal. True balance of production between sheer popularity from the point of view of programme entertain-



Topical

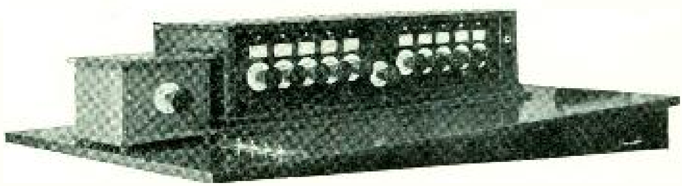
THE QUEEN LAYS THE FOUNDATION STONE OF THE Y.W.C.A. CENTRAL CLUB IN LONDON

ment and the demands of good taste is rendered almost impossible if the choice is bound by such a series as the Twelve Great Plays. The case of "St. Joan," which was produced with great success in April and was notable for magnificent production by Mr. Cecil Lewis and a superb performance in the name part by Miss Dorothy Holmes-Gore, is a good example of the classic and literary play making the best possible programme value into the bargain. This play of Mr. Shaw's was certainly far more popular than any of the series of Twelve Great Plays.

Much has been written in *The Radio Times* and elsewhere on the subject of the value of adapting novels for microphone treatment. In 1929 there have been two outstandingexamples of this type of radio play—"Carnival" and "The Prisoner of Zenda"—both adapted by Mr. Holt Marvell from the novels by Mr. Compton Mackenzie and Sir Anthony Hope. Both these were most interesting productions. The former was in some respects the high-water mark of radio dramatic achievement. It was difficult to decide whether the adapter or the producer—in this case Mr. Creswell—deserved more credit for what it is not too much to call a brilliant achievement. The technique of multiple studios was perfectly employed and a human emotional note was struck which has yet to be repeated in broadcast drama. "The Prisoner of Zenda," under the direction of the same adapter and producer, was comparatively a failure. For some reason the same multiple studio technique failed to function with the same smoothness or effect; the story did not go over clearly, and casting left something to be desired. The production was interesting, but it was expected to be a success and it was not. However, "Carnival" and "The Prisoner of Zenda" were definitely an encouragement to persevere in the adapting of novels for the microphone, and in the comparatively near future we are promised further experiments in this direction, such as the adaptations of "The Passionate Elopement," Mr. Buchan's "Greenmantle," Conrad's "Typhoon," and "The Case of Sergeant Grischa" by Zweig.

When we turn to plays written specially and directly for the microphone the record is one of definite interest and promise: of less definite achievement. Head and shoulders above any others during this year stands out Mr. Tyrone Guthrie's "Squirrel's Cage." Here was a definite case of a new medium dealing with a story after a fashion which no other medium could have employed. The multiple studio technique was combined with an aural expressionism which was quite astonishingly effective. The author handled his own play with very great skill, and had his ingenuity and talent been applied to a plot less symbolically platitudinous, he might have achieved a real work of art as opposed to a *succés d'estime*. No one who is interested in radio drama will fail to listen to the second play which Mr. Guthrie has written and which will be produced before long.

In the category of specially written plays it would be invidious to omit reference to "The Dumb Wife of Cheapside," Mr. Ashley Dukes' contribution to the microphone. In this case we had the inestimable advantage of the services of an author who is an expert on drama as a whole, and whose gift for natural, unforced, well-written dialogue is so obvious that it would be absurd to compliment him upon its possession. This play may be said to have aimed at a certain target



THE NEW DRAMATIC CONTROL PANEL AT THE MANCHESTER STUDIOS

and to have hit that target in the very middle of the bull's-eye. The target was not, however, set at extreme range. Similarly, Mr. Jefferson Farjeon's melodramatic thriller, "Up the Stairs," achieved most precisely what it set out to achieve. In both these cases absence of any pretentiousness no doubt added tremendously to popularity.

Mr. Cecil Lewis has so identified himself with the beginnings of radio drama that it was unfortunate that his only contribution during this period should have been his adaptation, in "Ultimatum," of a rather indifferent novel. This production contained much of the pretentiousness referred to above, whilst at the same time it neither broke new ground technically nor contained in its story anything particularly worth the telling.

Mr. Norman Venner, in "A Taste of Life," made an attempt to bring the innocent type of farcical comedy, so beloved by readers of Mr. Wodehouse, to the microphone, but with very indifferent success. The weakness here lay, frankly, with the script. The anæmia of the dialogue was not compensated for by any brilliance of character drawing, and it is an interesting fact that the production of this inconsiderable piece of work was as complicated from the production angle as that of "Carnival."

It is difficult to determine whether Mr. Sieveking's "Kaleidoscope the Second" can properly be considered as a specially-written radio play. Its form was dramatic. It was undoubtedly a multiple studio production on the largest scale. In its symbolism and its crudity of plot it approximated nearer to "Squirrel's Cage" than to anything else except to the same author's "Kaleidoscope the First." At the same time these "Kaleidoscopes" depended principally for their merit on the insertion into the script of various classical pieces of poetry, prose, and music, rather than upon the author's own invention. "Kaleidoscope the Second" did not compare favourably either with its own predecessor or with "Squirrel's Cage." Its story and its symbolism were too near to "reading without tears." Its technical production seriously overweighted what was being produced. On the other hand, in "Ingredient X," by L. Du Garde Peach, technical production reached what is probably its highest level in the history of broadcast drama, and an author was found with an almost uncanny sense of the appropriate balance of writing for the microphone. Apart from one or two small blemishes and an anticlimactic ending which should have been altered, this play, with "Carnival" and "There are Crimes and Crimes," can be selected as the best of the year.

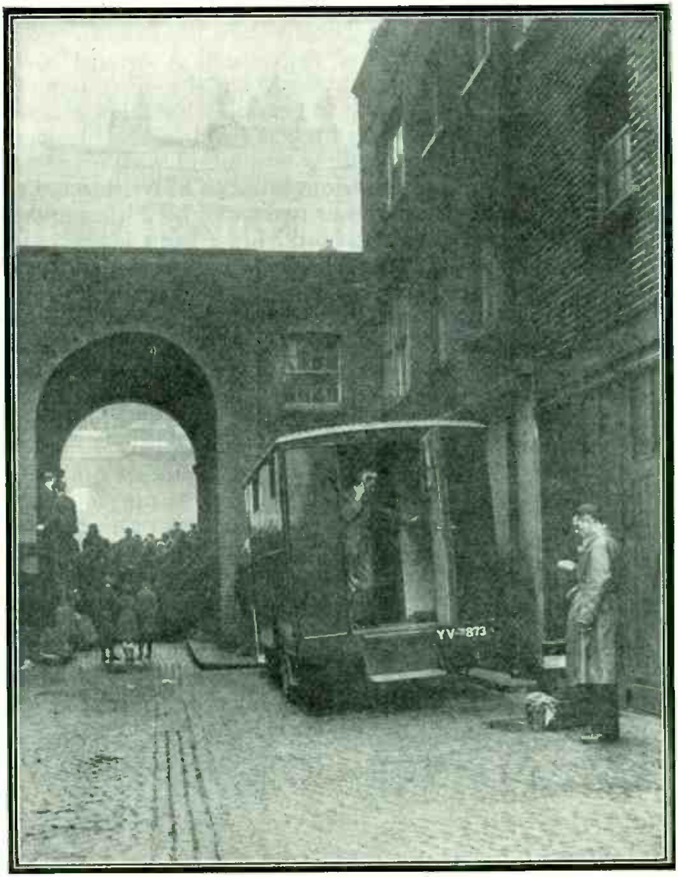
In addition to these, modern poetic drama was well represented by Mr. Drinkwater's "X=O" and John Masefield's "Good Friday," both performances of quiet distinction; both admirably produced by Mr. Howard Rose.

Apart from the Twelve Great Plays, plays of the theatre proper were rather meagrely represented, but the broadcast of "Beggar on Horseback," by George Kaufman and Marc Connelly, achieved a success which the stage play had been denied some years ago at the Queen's Theatre. This play had an interest of its own, as its form as it was originally written was curiously adapted for microphone production, the dream episodes being far more convincing aurally than under the glaring limelight of the theatre.

To summarise briefly: it has been a year of continual activity and experiment in every direction, containing failures and successes in almost equal proportion, but with indubitable hope and promise for the future.

PLAYS FOR BROADCASTING

The B.B.C. will be very glad to see original plays or sketches written specially for broadcasting. MSS., which should be typed, will receive careful consideration by the Productions Department, to which they should be addressed.



BROADCASTING THE SILENCE

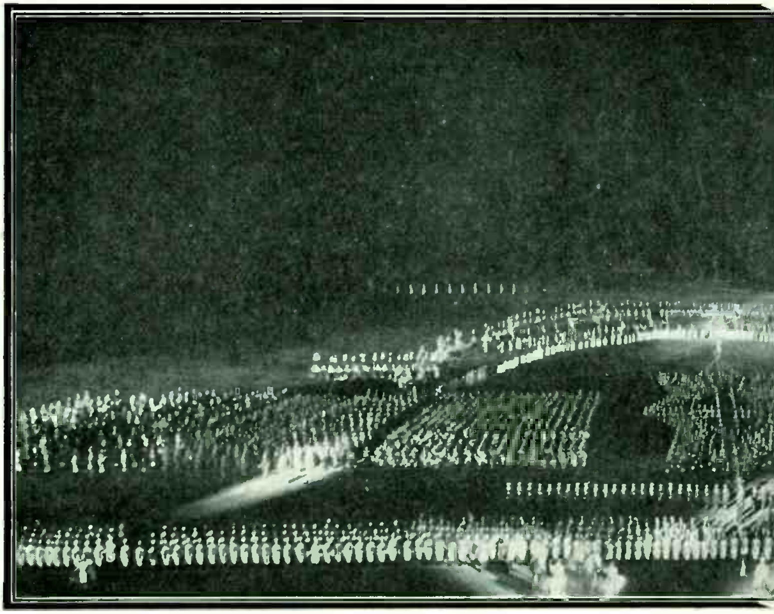
November 11th, 1928

OUTSIDE BROADCASTS

OUTSIDE Broadcasts have occupied an increased percentage of the total programme in the year under review, and have covered a wider field of activity than in the preceding year. Improvement in technique has been most noticeable in relays requiring the use of numbers of microphones in separate circuits; for instance, the operatic relays from Covent Garden, musical comedy and variety from theatre stages, and ceremonial broadcasts of the military tattoo and the Keys (Tower of London) type. It will be realised that whatever improvement there may be in apparatus, the purely human factor is of first importance in dealing with programmes of this nature, because the placing of microphones and "slickness" in operation of "fade units" require very considerable experience, skill, and concentration, and the broadcast is therefore made or marred by the manner in which it is presented.

O.B.s (as they are colloquially referred to at Savoy Hill) include such mixed fare as church and cathedral services (referred to elsewhere), Bach Cantatas, speeches, some of the debates and talks, concerts of all kinds, operas, dance music, organ recitals, commentaries on sporting events, ceremonials, and theatre and music-hall excerpts. It is only possible to touch upon the more outstanding of these in this article, but nearly all require their own detailed organisation, which is unlike that of studio broadcasts.

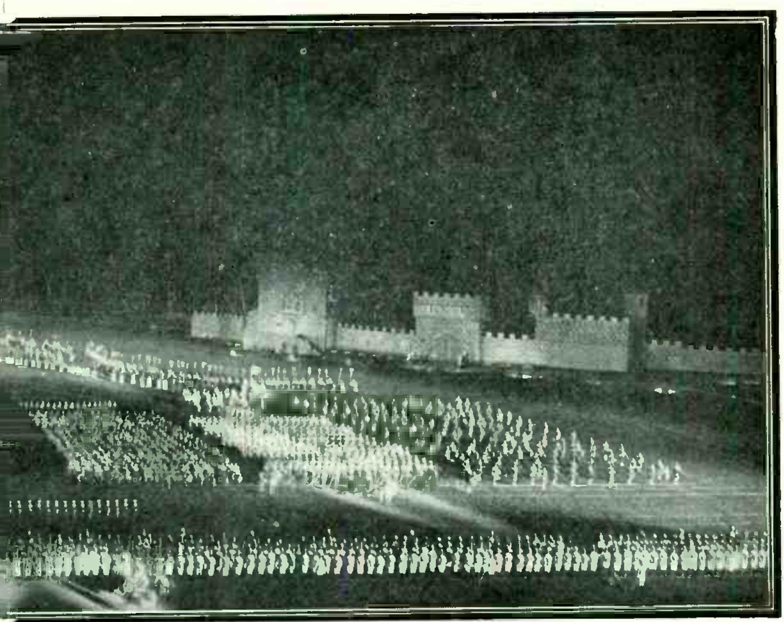
Broadcast religious services have included special events at Canterbury, York and Liverpool Cathedrals. The two enthronement services of the new Archbishops were technically among the most complicated ever undertaken. The Cenotaph Service on Armistice Day was transmitted from all stations for the first time on November 11th, 1928, being carried out entirely without any of the technical arrangements being visible, a condition of first importance in view of the solemnity of the event. This broadcast brought forth a greater volume of appreciative correspondence than for any previous Service. On July 7th the Service of Thanksgiving for the recovery of H.M. the King was relayed from Westminster Abbey to an audience which fittingly extended to the limits of the Empire.



THE GRAND FINALE AT A

Before his illness the King was heard on his visit to Newcastle on October 10th; the Queen for the first time on December 12th (Tower Hill), and again on June 25th (Y.W.C.A. Central Club); the Prince of Wales' speeches at the Mansion House (February 18th), Guildhall (March 19th), East Coast Exhibition (May 14th) and Nottingham (May 29th); the Duke of Gloucester at Bournemouth (March 19th); Prince George at the Royal Academy Dinner (May 4th); Princess Mary at Belfast (October 12th).

Other interesting personalities who have "appeared" before the microphone outside the studio are Sir William Bragg (September 5th), Lord Birkenhead (September 29th), Mr. Baldwin (October 11th, 26th, 30th, November 9th and April 23rd), Lord Derby and Lord Crewe (November 14th), Lord Lytton (November 31st), Sir Austen Chamberlain and Mr. A. B. Houghton (December 5th), Mr. George Bernard



Gale and Polden

SHOT TORCHLIGHT TATTOO

Shaw (December 7th), Archbishop Lord Davidson (December 19th), Sir Gerald du Maurier (January 18th), Lord Hewart (February 7th), Miss Sybil Thorndyke (February 22nd), the Poet Laureate, Mr. Robert Bridges (February 28th), the Marquis de Merry del Val (March 7th), Sir William Joynson Hicks, now Lord Brentford (March 15th), Mr. Lloyd George and Mr. Compton Mackenzie (April 19th). Sir James Barrie was a newcomer to the microphone. The Prime Minister, Mr. Ramsay MacDonald, spoke at a dinner of the United Associations of Great Britain and France on November 14th. Last, but not least, Sir Henry Segrave, fresh from his American exploits, broadcast a talk from Southampton—fifteen minutes without a note—within an hour or so of his landing on April 12th.

Among musical relays may be singled out the series of operatic excerpts from Covent Garden during the season, the

Bach Cantatas from the Guildhall School of Music, the Contemporary Chamber Music concerts at the Arts Theatre Club (not everyone's meat, these!), Popular Concerts from the People's Palace, and, of a different kind, from the Kingsway Hall and Central Hall. The Leeds Musical Festival (October 4th), a Schubert Centenary Concert under Sir Thomas Beecham (November 19th), the Glasgow Orpheus Society (April 13th), the British Women's Symphony Orchestra (April 10th), and a Sunday League Concert (January 6th) may also be mentioned, and of course the Promenade Concerts.

In the category of lighter entertainments other than the stage relays dealt with in another article, may be included the following Surprise Items: a performance by theatre queue "buskers" (October 12th), the "shooting" of "Piccadilly" at the British International Studios at Elstree (November 16th), the departure and remarks of the audience of "That's a Good Girl" at the Hippodrome (November 30th), a performance by the Cambridge Footlights at their club (June 7th), and an informal concert by variety artists (May 3rd).

The broadcasting of ceremonials appeals, it would appear, to a very wide circle of listeners. Perhaps it is the only activity of the B.B.C. to attract an audience drawn almost equally from all grades of the listening public. The difficulty is, of course, to find events which are suitable and at the same time practicable from the broadcast point of view. The three military tattoos at Aldershot, Tidworth and York, a commemorative ceremonial by the 2nd Norfolks at Aldershot, the Empire Day Festival in Hyde Park, the Remembrance Day Festival at the Albert Hall, the Air Force Display, and the ever-popular Ceremony of the Keys at the Tower of London may be quoted to represent the year's activities in this direction.

Among sporting events the old favourites, the Grand National, the Derby, St. Leger and the Boat Race broadcasts were repeated, as were the Rugby Internationals at Twickenham, Edinburgh and (after the lapse of a year) at Swansea. Mr. Allison broadcast commentaries on some of the Association matches, including an International from Glasgow. Two important boxing championships at the Albert Hall were described, as was the final tie of the King's Prize at Bisley, and the more important tennis matches on the Centre

Court at Wimbledon. The commentary on the Schneider Trophy race introduced a new branch of sport to the listening public, and was certainly the most popular outside broadcast of the year. The series of eye-witness accounts of the Cup Tie Final, broadcast from a flat outside the main stadium entrance on April 27th, which for various reasons had to be carried out in the way indicated, seems to have appealed to the imagination of listeners not only, as they say, because it gave them an extremely good idea of the state and progress of the game, but also because they took a personal interest in the efforts of the various eye-witnesses to beat each other's records from the stadium to the microphone. It was all rather in the manner of the ride from Ghent to Aix. To obtain a right view of the game, note the work of the various players, detach themselves from their wedged-in positions in the crowd, and sprint from the stadium exit to the microphone—a distance of about a quarter of a mile—and there give out a correct description of the game, required a quite remarkable fitness and enthusiasm.

The B.B.C. is ready and anxious to receive suggestions and new ideas from listeners. All that is asked is that these ideas should be practicable. They will always be given the most careful consideration both from the programme and technical points of view.

A SALE OF OLD MASTERS AT CHRISTIE'S

Broadcast on June 28th 1929

LORD BADEN-POWELL, THE CHIEF SCOUT

A photo taken at the World Jamboree at Arrowe Park, Birkenhead, from which speeches by the Prince of Wales, the Duke of Connaught, and Lord Baden-Powell were broadcast on August 2nd, 1929.

EDUCATIONAL PROGRESS

THE chief events of 1929 in the realm of educational broadcasting were the births of the Educational Councils, but this has been described in a special article under that title. (See page 223).

The regular routine of the work at Savoy Hill has had to go on in the meanwhile, and the entry upon the scene of the two Councils may be compared to slipping the clutch into machinery already hard at work.

The early programmes of 1929 were wholly the work of the B.B.C.; the final programmes for 1929 were mainly the work of the Councils or of their Executive Committees, though naturally at this very early stage of the Councils' existence a good part of the programme consists in reappointments of speakers who have been successful in the past. While the new bodies are gathering experience, there must naturally be a period of transition. This is working, so far as the B.B.C. is aware, with complete smoothness. The Schools Council has taken the responsibility for some important new decisions, described on page 228. The old hands of the Education Department may have been a little disturbed at the possibility of their losing some of their clients when mentions at the microphone and correction of essays had to cease, but it is hardly possible to see how this feature of the work could have been continued much longer in view of the growing number of schools listening to wireless. The reading of long lists of names at the microphone is not, in truth, a proper use of the microphone time, even though every name on that list may interest two or three score of people. It seems inevitable that as wireless grows in range it must to a certain extent lose some of its more intimate contacts.

The two prize-givings of 1929 went off very successfully. There were admirable speeches by Lady Clarendon and Dr. Percy Nunn, who gave away the prizes. It is hoped that this very pleasant form of contact twice a year will continue.

An investigation into the number of schools actually using wireless in any particular term is now proceeding. It might be explained that the figures of school clientèle as given in the past have been derived from a card index. The larger one gives a total of over 5000, and contains the names and addresses of all schools which have been in contact with the B.B.C. in one way or another through correspondence. This is not a wholly inclusive list. The smaller card index, which includes 3000 odd names, consists of those who have quite recently indicated through correspondence that they are actually taking one or more of the school courses. To draw up a really accurate inclusive list is a difficult task, but it is being attempted afresh. The B.B.C. headquarters know that nearly 1000 new schools joined up during the course of 1929, but they do not know, and probably never will know, how many schools dropped off.

All that has been said of the inauguration of the Schools Council is equally true of the Adult Council. It was somewhat of a blow to the B.B.C. and the Council when their Chairman, Lord Sankey, was forced to resign on his appointment to the office of Lord Chancellor. He had already done admirable work for broadcast adult education, and had shown wonderful powers of courteous and lucid chairmanship. Area Councils are now in being, or about to be completed, in the West Midlands, the North-west and North-east regions. These will be centres of local activity, and will help to make the services of adult educational broadcasting known to listeners, organised or unorganised, in those areas.

In Kent a new adult educational experiment is being started; the Hon. W. E. C. James is the Chairman of the Local Organising Committee. The Carnegie United Kingdom Trustees have provided a grant of £400 for the purpose of the experiment, and the funds are to be held in trust by the Kent Education authority. With this nucleus sum a number of loan sets will be installed throughout the country for special experiments in group-listening. Some forty centres have promised their co-operation.

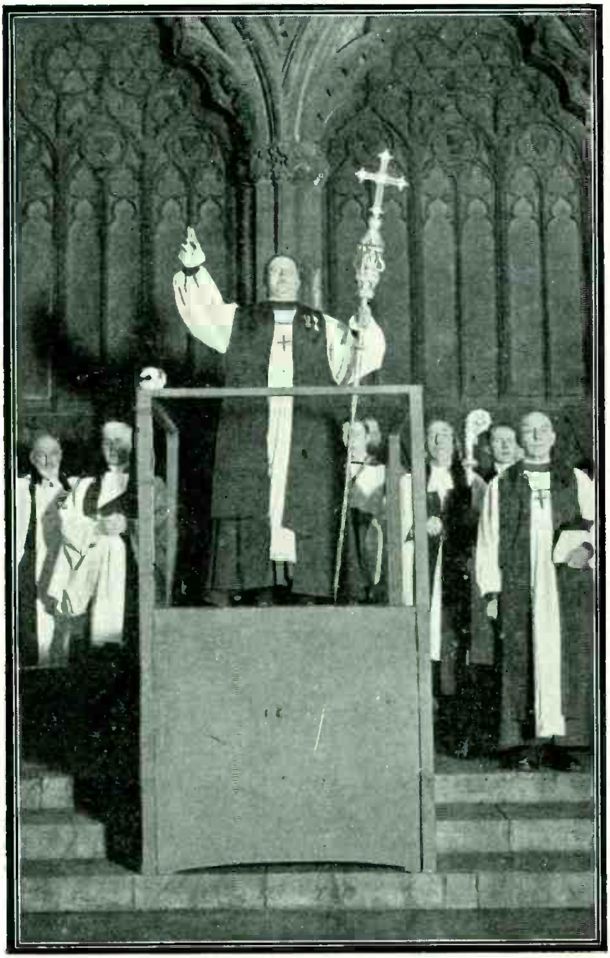
In January an important event occurred, namely, the birth of the B.B.C.'s new educational journal, *The Listener*. There was considerable agitation and excitement in the Press concerning this new departure, the objects of which were misunderstood. The paper has now taken its place permanently on the bookstalls as an extremely readable weekly for the general reader, and, in addition, serves as a valuable medium of communication between the B.B.C. and its educational listeners.

Ever new areas of co-operation are being sought by the B.B.C., or are invoking the Corporation's aid. Experiments and *pourparlers* for co-operation have been made with the Air Force, the War Office, and H.M. Prison Commissioners. An Army Order has gone out from Whitehall to Army Education Officers everywhere instructing them to make definite experiments in the use of wireless for discussion groups among soldiers in the evening. The long and detailed series of lectures on China were the fruit of co-operation with the missionary societies.

The number of listening groups reported to B.B.C. headquarters in the winter of 1928–29 totalled 160. It was not to be expected that there would be any increase during the summer months, and there has been, in fact, an inevitable decline in numbers. Few of the Adult Educational organisations have any meetings during the summer. There have been a great number of propaganda meetings all up and down the country, generally accompanied by demonstrations, and an important conference is planned for September 28th at Newcastle, at which the chair will be taken by Viscount Grey of Fallodon.

An important and very interesting new development was the training course for group leaders at Hull. Here the students not only practised the conduct of group discussions under expert instruction from Professor Searls and others, but also received some technical advice in the manipulation of sets and practised their own powers of broadcasting on a miniature installation.

Some contribution to the relief of distress in areas particularly affected by the troubles of the coal industry has been made possible by a generous grant in aid from the Carnegie Trustees. In association with the National Council for Social Service, the Central Council has installed fifteen sets in isolated centres in South Wales, and similar provision is to be made for Durham and Northumberland in the autumn. There is already evidence of the appreciation and good use made of these sets, which may be the nucleus of far-reaching developments in local educational activities in the future. Here once again it would seem that broadcasting may blaze the trail which others may consolidate later on.



The Times

THE NEW ARCHBISHOP OF YORK (DR. TEMPLE)

blessing the crowd outside York Minster after his enthronement

RELIGIOUS ACTIVITIES

THERE are no very great changes to be recorded in the B.B.C.'s religious system in the year under review, except that the progress of the Regional Scheme has meant fewer local broadcasts. "Fewer and better" has, however, been the policy of the B.B.C. in regard to Sunday services for many years. Seven years experience in this field has enabled the B.B.C. to compile a list of acceptable broadcast preachers, and they tend to return to those who have proved their ability to speak in the style or styles which are agreeable to the microphone.

Of course this applies chiefly to the Studio Service, and, as a matter of fact, the trend of development during the past year has been away from the Studio Service and in favour of the outside broadcast service from well-known places of worship. Curiously enough, broadcasting in the U.S.A. has taken an opposite turn. There, outside broadcasts are practically non-existent; most services broadcast in the States are organised by the "Bishop of Radio," Dr. Parkes Cadman, and his Committee.

Among the places of worship from which services have been broadcast, mention might be made of the Woodall Memorial Church, Burslem; the Birmingham Parish Church (Canon Guy Rogers); St. Mary's Abbey, Buckfast (Roman Catholic); the Westminster Congregational Church (Dr. Campbell Morgan); Wesley's Chapel, City Road; Watford Parish Church; Bradford Cathedral; House of the Sacred Mission, Kelham; the Kingsway Hall (the Rev. Ira Goldhawk); Manchester Cathedral; Canterbury Cathedral (farewell address of the Archbishop of Canterbury, and installation of the new Archbishop); St. Andrew's Parish Church, Plymouth; St. Columba's, Pont Street (Dr. Archibald Fleming); Chester Cathedral; Liverpool Cathedral; St. George's Chapel, Windsor; Whitefield's Tabernacle (Dr. Belden); All Hallows, Lombard Street; St. Cuthbert's Parish Church, Edinburgh (the Rev. C. H. Ritchie); St. David's College, Lampeter; All Saints, Ennismore Gardens (Canon A. C. Deane); Sheffield Cathedral; Our Lady of Victories, Kensington; Lincoln Cathedral; St. Nicholas Cathedral, Newcastle-on-Tyne; Holy Trinity Church, Brighton (the Rev.

R. J. Campbell); a Drumhead Service from the Castle Park, Colchester, was also taken, and of course St. Martin-in-the-Fields once a month.

In the studio there have been Mr. H. T. Silcock, of the Society of Friends, who conducted a Quaker Service; the famous Indian missionary, the Rev. C. F. Andrews; in connection with the Bunyan Tercentenary, the Rev. C. Bernard Cockett, of the Bunyan Meeting House, Bedford; Canon Garfield Williams, Secretary of the Missionary Council of the National Assembly of the Church of England; the Rev. Father C. C. Martindale, S.J.; General Higgins, of the Salvation Army; the Rev. Dr. Henry Gow, of Manchester College, Oxford (Unitarian); the Rev. Dr. Henry T. Hodgkin.

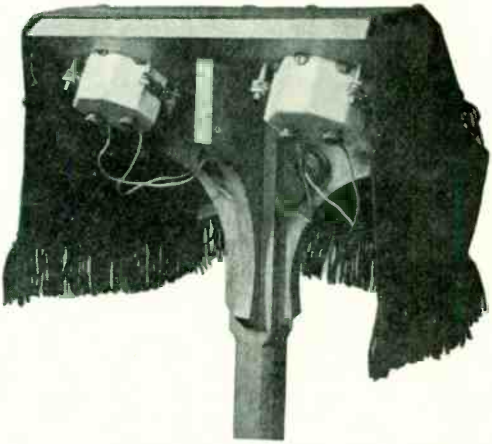
Looking back over the whole period of seven years, it is astonishing to find how the B.B.C. has been able to secure such a list of representative preachers of all denominations.

It is probably the daily service, instituted in January 1928, which elicits the greatest volume of appreciative correspondence. This service is still conducted anonymously. As samples of the correspondence received, the following might be quoted:

> "We suggested to the maids that they should come in if they wished, and now, for several months, the family and the maids and gardener meet in the dining-room at 10.15 and take part in the service. We always stand for the Lord's Prayer and the Gloria, and join in the singing when we can. We have also, when suitable opportunity arises, suggested to others the same practice. There is no need to answer this, but we thought you would like to know that here in Dorset is a part of your regular congregation, and that the reading, singing, and general conduct of the services are much appreciated."

And this:

> "As an aged lady of eighty-four to whom from the very beginning the Wireless Religious Service—"Gigantic Family Prayers"—is the point of Rest and Refreshment in the twenty-four hours, I venture to say what a great gift and privilege is yours to bring aged and invalid folk



THE TWO MICROPHONES CONCEALED IN THE LECTERN USED FOR THE CENOTAPH SERVICE ON ARMISTICE DAY

into daily communion with God by means of Prayer and Thanksgiving. The latter last Tuesday and to-day was especially comprehensive and beautiful. We are so apt to forget to say "thank you" for answers to our prayers. There is a freshness and spontaneity in your prayers and thanksgivings for your myriad listeners that appeal wonderfully. You have been called to a great work for which you have special gifts, and you won't mind the thanks and blessing of one who after a long life finds special help and uplifting in the services you conduct."

It was recently reported to the B.B.C that the Sunday eight o'clock service did not meet the needs of hospital patients, because they were not allowed to listen after 8 p.m. The B.B.C. sent a circular letter to more than a thousand matrons or superintendents of hospitals, and have had a most encouraging response, from which it was overwhelmingly clear that the majority of hospitals make very good use indeed of broadcast religious facilities, and that the patients in large hospitals where headphones are attached to each bed are allowed to listen until the end of the service, if not later, and do so with great profit and enjoyment.

The monthly missionary talks on Sundays at 5.15 p.m. continue to be of great interest. Among these travel talkers the most conspicuous have been the Rev. W. H. Jackson, of

Burma, Sir Wilfred Grenfell, Dr. Alexander Hetherwick, Dr. Alicia Linton of Persia, the Bishop of Yukon, the Rev. H. E. Hyde of Western Australia, and Dr. Edith Brown of India.

Children's Services continue to be broadcast alternately from St. John's, Westminster (the Rev. Canon C. S. Woodward), and elsewhere. They have included a service from Glasgow, conducted by the Rev. Robert Nelson, one from Leeds, conducted by the Rev. C. H. Luckman, one from St. Martin's Parish Church, Birmingham, conducted by Canon Guy Rogers; and a studio service from London, conducted by the Rev. J. Shepherd of Islington.

An important development in Scotland is that St. Cuthbert's Church, Edinburgh, has, after some hesitation, developed into a Scottish equivalent for St. Martin-in-the-Fields; special services are arranged there at 8 p.m., and preachers introduced from other churches. For this, the B.B.C. is greatly indebted to the Rev. G. F. McLeod.

The weekly Evensong from Westminster Abbey has continued to meet with commendation for the beauty of its music.

A Book of Studio Prayers, which was printed experimentally two years ago, has been revised and put into order by Canon Dwelly of Liverpool Cathedral. It has still to undergo final revision by the Central Religious Advisory Committee before publication. It is expected that this book will lead to an improvement in the order of studio services, and that these will again become prominent on the wireless service list.

Sunday afternoon readings at 5.15 or 5.30 p.m. are by tradition alternately Bible Readings or something else of a literary character. In this series there have been two outstanding successes: a series of dramatised readings from Bunyan's *Pilgrim's Progress* in connection with the Bunyan Tercentenary, and a series entitled *English Eloquence*, which included a certain number of famous sermons of the past. In August the Bible will again take its place. A new series has been designed to tell the life story of St. Paul as revealed in the book of the Acts. The Lenten Addresses in 1929 were given by the Rev. Eric Southam, from the Bournemouth Studio, on Thursdays, under the title of *Teach Us To Pray*.

Epilogues are specially referred to opposite.

The Religious Advisory Committee has been strengthened by the inclusion of the Rev. Father C. C. Martindale, S.J.

EPILOGUES

THERE has been no vital change in the method of constructing Epilogues during the past year, and no apparent call for any change. To judge by correspondence, this ten-minute close to the Sunday evening programme continues to be one of the most popular features of British broadcasting.

As before, the Epilogues have been arranged in a consecutive sequence of many weeks under one guiding thought. In July 1928 began a series of ten Epilogues founded on the Beatitudes, or the Nine Blessings. There followed in October a series of fifteen of the most familiar of the parables, only interrupted by special Epilogues for Armistice Day and Advent. During the critical weeks of His Majesty's illness, the Epilogue always concluded with God Save the King sung softly, as a prayer. At the end of January, a new series called Attributes of God provided sixteen consecutive Epilogues, and on the 9th of June, a sentence from St. Paul's Epistles to the Galatians (Chapter V, vers. 22–23) provided a course of Epilogues with the general title, The Fruit of the Spirit, or The Christian Virtues, Love, Joy, Peace, Longsuffering, Gentleness, Goodness, Faith, Meekness, and Temperance. There was a recurrent demand from listeners that they should be provided beforehand with the references of the hymns and Bible passages contained in the Epilogue in order that they might look up the words in their Bible and hymnbook. On the other hand, the B.B.C. were assured that many listeners preferred that the Epilogue should come to them with a sense of mystery or surprise, unannounced. The B.B.C. went some way to meet the former by printing the title of the Epilogue in the *Radio Times*, so as to give a clue to its general purport. Later on they took the further step of publishing the references in the *Radio Times*, but on another page, so that those listeners who wished not to know the details in advance could easily avoid it. This compromise is believed to be popular

A P P E A L S

THE Appeals Advisory Committee have continued to put in a great deal of hard work and specialised knowledge in sorting out the multitudinous requests for a place on the list of the Week's Good Cause. Applications are considered under four headings: Health, National Services, Children, and Social Service, and an attempt is made to preserve a fair balance. Among the most successful appeals given from London since August 1928 are:—

Date	*Cause*	*Speaker*	*Amount Received*
June 17th	Dr. Barnardo's Homes	Mr. William McCall	£5,630
July 29th	Women's Holiday Fund	Canon C. S. Woodward	£3,500
Aug. 12th	Greater London Fund for the Blind	Sir Beechcroft Towse	£3,136
Dec. 23rd	Friends of the Poor	The Hon. Mrs. Sydney Marsham	£4,300
Mar. 10th	Royal London Ophthalmic Hospital	Mr. A. J. Alan	£4,600
Mar. 31st	Housing Associations	John Galsworthy	£2,227

On Christmas Day, 1928, the Prince of Wales made a striking appeal on behalf of the Miners' Distress Relief Fund. It is impossible to estimate what proportion of the assistance subsequently received by the Fund was directly attributable to this broadcast, but there is no doubt that the Prince's appeal was of paramount influence in the enlistment of public sympathy. Over £350,000 was subscribed in a few days.

Although, apart from the Prince of Wales's appeal, the year under review does not contain any great outstanding appeals like Lord Knutsford's bumper appeal for the London Hospital (over £19,000), yet the average level has kept high, and is rising. The number of regular subscribers to the appeals who send a donation, preferably in multiples of 52, thus inviting the B.B.C. to act as their almoners, has grown to 180, the sum thus available for distribution week by week being £19.

The total amount collected for charity under the heading of the Week's Good Cause during 1928 was £64,000 as compared with £40,000 during 1927.

A DAY IN THE LIFE OF AN ANNOUNCER

I. THE PROGRAMME SHOULD BE STUDIED BEFOREHAND

J. B. Walson, Edinburgh

THE DUKE OF YORK UNVEILS STATUES OF WILLIAM WALLACE AND ROBERT BRUCE AT THE GATEWAY OF EDINBURGH CASTLE

Broadcast on May 28th, 1929

S C O T L A N D

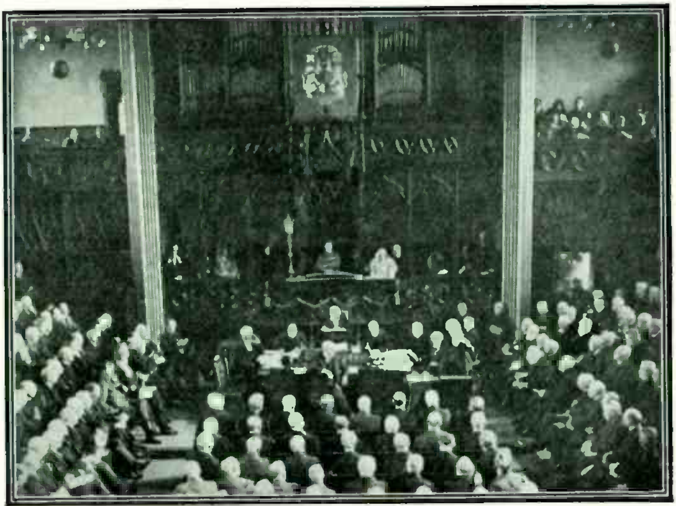
DURING 1929 there has been broadcast every week a special programme originating in one or other of the four Scottish studios and transmitted to all Scots listeners. The bulk of these "group programmes" have come from Glasgow, while Edinburgh and Aberdeen have contributed their fair share. Among the most interesting of them have been the following:—

A composite evening provided by the Students at Edinburgh, Glasgow, and Aberdeen, consisting of excerpts from their annual entertainment;
A concert given by the Glasgow Orpheus Choir, The Scottish National Players, and Mr. Webster Gibson in aid of the Scottish Miners' Relief Fund;
A concert provided by recent winners in the various Scottish Musical Festivals;
A broadcast of the winning play in the Scottish Community Drama Festival, and
The "Burns" Nicht Celebrations, broadcast from Poosie Nancie's Inn at Mauchline, including the proposal of the toast of the Immortal Memory by Dr. Joseph Hunter.

In addition to regular half-hour transmissions of Gaelic Song and Story from Aberdeen Station there have also been broadcast special performances by the Glasgow, Dundee, Greenock, and Inverness, Gaelic Choirs.

Among the feature programmes which have evoked special comment may be mentioned: "Caller Herrin'" (which concerned the life of the fisherfolk), and "Bang goes Saxpence," from Aberdeen; "Kinmont Willie," a programme of Border song and story, and the "Ceilidh" from a Highland Shieling, from Edinburgh; William McCulloch's "Old-fashioned Smoker," and the revival of "Doon the Watter," from Glasgow.

In the sphere of Scottish drama perhaps the most interesting features during 1929 have been the production of two Prince Charlie plays—"Count Albany" and "Dawn"; the performance of an adaptation of John Buchan's "Witch Wood"; and a broadcast of J. J. Bell's ever-popular tale, "Wee Macgreegor." Many one-act plays by Scots authors



The Scotsman

THE HISTORIC BROADCAST OF THE GENERAL ASSEMBLY OF THE CHURCH OF SCOTLAND AT WHICH THE UNION OF THE TWO CHURCHES IN SCOTLAND WAS CONCLUDED

have been included in the programme, the most notable perhaps being those by George Reston Malloch.

In the sphere of music, Scottish listeners had the opportunity of hearing the majority of the concerts given by the Scottish Orchestra, under the auspices of the Glasgow Choral and Orchestral Union, while the Glasgow Station Orchestra gave several concerts of work by Scottish composers. A new feature was introduced into the programmes this year in the form of a series of Scottish Chamber Concerts given by the Fellowes String Quartet, the Edinburgh String Quartet, the Falconer String Quartet, the Edinburgh Ladies' Instrumental Trio, and the Scottish Chamber Players. At each of these performances some work was given by a native composer. It is hoped that the opportunities thus provided, which are being increased in the future, will have encouraged Scotsmen to write for choir and orchestra now that the prospects of public performance have become more certain.

The year has seen a considerable extension in the number of schools listening regularly to broadcast lessons. The preparation of a special Syllabus for Scottish Schools, including such eminent names as those of Professor John Arthur Thomson and Dr. J. C. Smith, H.M. Chief Inspector for Schools, has aroused the interest of teachers up and down the country, and we have received many letters from them giving not only their approval of the series, with the accompanying pamphlets, but also making helpful constructive suggestions.

Among the talks arranged in the Scottish Region during the year, the most notable have been the series entitled "Scotland To-day," contributed by best known authorities on Agriculture, Education, the Church, the Press, Art, and Literature, and a series of six talks on "Old Scottish Types," including the Doctor, the Lawyer, the Minister, the Deacon, the Traveller, and the Dominie. Two other series may be mentioned, namely, "Women's part in Village Life," and a group of talks on "The Lesser Ancient Boroughs of Scotland." Two discussions were arranged during this year—one on "Motoring in Scotland and its problems," and one on "Scottish and English University Life." Among those who gave individual talks should be mentioned Lady Margaret Sackville, Robbins Millar, the author of "Thunder in the Air," Professor J. W. Gregory, Colonel Rorie, Sir George Washington Browne, the President of the Royal Scottish Academy, Viscount Dunedin, who gave the sexcentenary talk on Edinburgh, and the Rev. T. Ratcliffe Barnett.

There were not many outstanding outside broadcast features during the year, but the most important were the relays from the Sessions of the General Assemblies on the last occasions when the Churches met separately, and the broadcast from the Castle Esplanade when their Royal Highnesses the Duke and Duchess of York visited Edinburgh to unveil the statues of Wallace and Bruce in connection with the sexcentenary of the capital city.

Throughout 1929 contact has been maintained with the Scottish Women's Rural Institutes, and the activities of the Musical and Community Drama Festivals, and more than one talk has been arranged to make public the admirable work undertaken by the Association for the Preservation of Rural Scotland.

THE NORTHERN WIRELESS ORCHESTRA AND ITS CONDUCTOR, MR. T. H. MORRISON, IN THE NEW STUDIO AT MANCHESTER

The studio has a visitor's gallery from which this photo was taken

THE NORTH OF ENGLAND

ONLY those who live in the North and see the course of its life day by day and year by year can realise the collective efforts which are being made in that part of England to overcome the aftermath of the War in industry, in the arts, and in social life. It may be that the contribution of the North to national life will yet return to that dominating importance which it had assumed before the War. With the gradual revival of industry, the cultural activities are rapidly returning. Despite all that is said about "industry moving South" and despite the problems and difficulties encountered by the great productive undertakings, significant movements have been made in the last twelve months to rationalise and co-ordinate Northern industries, especially those relating to the supply of coal and cotton. Contemporaneously, there have been signs of a revival of interest in the arts, and notably in drama, and there has been an exceedingly marked development of interest in civic life. Side by side with these new activities, broadcasting in the North has developed on wider lines with the consolidation of the grouping of interests represented by the Manchester, Liverpool, Leeds-Bradford, Sheffield, Hull and Stoke-on-Trent studios.

The North Regional Offices at Manchester, from which city the region has now been controlled for nearly two years, moved into their new premises at Broadcasting House, Piccadilly, early this year. Moreover, all the Northern studios are now linked together continuously by land-line, and a liberal interchange of studio programmes throughout the group during the day-time, and of a limited number at night, has been effected. In particular, the regular contributions to these studio programmes by the Northern Wireless Orchestra, playing under the musical direction of Mr. T. H. Morrison, in the large studio at Manchester have aroused general acclamation. Among some of the principal studio concerts, in which this orchestra has played under guest-conductors, have been the performance of Coleridge-Taylor's version of "Hiawatha," conducted by Sir Henry Coward, who brought over his Choral Union from Sheffield, the concert conducted by Sir Hamilton Harty on August 7th, including the performance of his concerto for violin and orchestra, and a concert of Josef Holbrooke's works, conducted by Julius Harrison, on July 5th. Children's Hour activities have been concentrated at Manchester and Leeds, each of which centres supplies the Children's Hour to the region on alternate afternoons; a number of the old artists, familiar to the children at the various centres, taking part in these.

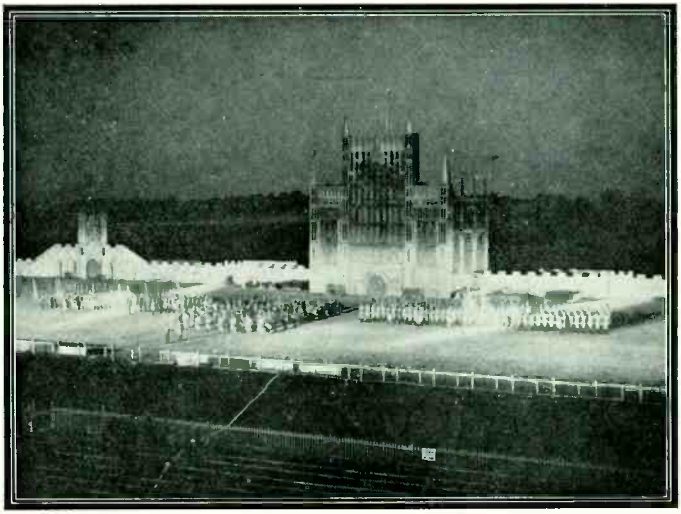
A definite endeavour has been made to attract attention to important industrial and civic events. The 35th Anniversary of the Manchester Ship Canal was celebrated on January 1st of this year with a special concert in Ship Canal House, in which the Northern Wireless Orchestra and the Manchester Ship Canal (Latchford) Male Voice Choir took part, while special talks were given on the history and commercial value of the port. Some weeks later listeners had the opportunity of hearing the claims of Hull put forward in speeches at a Port of Hull Banquet, which took place on March 18th, and during which the High Commissioner for New Zealand made a notable speech on the commercial relationships of that country with the Motherland. During the twelve months under review, the Five Counties Coal Scheme has made considerable progress, and the aims and objects of this scheme were explained by one of its promoters, Mr. A. W. Archer, speaking from Leeds on January 22nd. Some discussion has been going on in Lancashire and Yorkshire as to the advisability of promoting a Northern Industrial Exhibition, and in this matter a lead was given by Lieut.-Commander J. M. Kenworthy, M.P., in a regional talk from Hull on March 26th. Finally, during the spring of this year the whole field of Northern industrial problems was tackled by leading experts in the textile, steel, coal and other industries, in a series of evening talks broadcast from all Stations of the grouping. Among the speakers were Professor A. M. Carr Saunders of Liverpool University, Sir Ernest Thompson, the then President of the Manchester Chamber of Commerce, Professor Aldred F. Barker of Leeds University, Sir Robert Hadfield, Bt., Mr. Herbert Shaw, Secretary of the Newcastle Chamber of Commerce, and Professor Henry Clay of Manchester University.

The year under review has been fertile in civic events and meetings in the North of various national associations. Leeds and Liverpool held Civic Weeks in the autumn of 1928 and Bolton has added to the number of Civic Weeks this year. The Leeds Triennial Musical Festival took place in October 1928, with Sir Thomas Beecham and other well-known conductors visiting the city. A number of Annual Meetings have been held in Manchester, including the deliberations of the British Medical Association in July of this year, while Birkenhead was singled out for the world-wide Boy Scouts' Jamboree in Arrowe Park, during the early part of August. All these events have inevitably figured, in one way or another, in the regional programmes, while some of them have found an echo in the national programmes as well.

There has been a distinct revival of interest in art. A lead was given to exhibitions in London and elsewhere with the opening of the Dutch Exhibition, in the Art Gallery at Bradford, on September 28th, 1928, by Mr. Ramsay MacDonald, M.P. His speech on this occasion was broadcast throughout the region, as also was that of Sir Archibald Salvidge, who opened the Autumn Exhibition in the Liverpool Art Gallery on September 29th, 1928. To keep listeners in touch with the large number of exhibitions held subsequently in the North, periodical reviews were given in talks by the Curator of the Manchester Art Gallery.

The repertory play movement in the North has gathered force, and the work of the Leeds Art Theatre, the Leeds Civic Players, the Liverpool Playhouse, the Sheffield Repertory Players, and the Little Theatre at Hull, has been much to the fore. The chief features of this work have been a concentration on modern continental plays and plays of northern interest. The B.B.C.'s studios in the North have been put at the disposal of these organisations from time to time, and some interesting contributions to dramatic broadcasting activities have thereby been obtained. The aims of the repertory movement were described in a talk by Mr. William Armstrong, the Director of the Liverpool Playhouse, on January 5th. Plays of Northern life and dramas written by Northern playwrights have figured prominently among the performances of the Manchester Studio Repertory Players.

In the world of music, listeners to the national as well as the regional programmes have again been offered the opportunity of hearing some of the principal concerts of the Halle



THE NORTHERN COMMAND TATTOO

One of the military ceremonies broadcast by the North Regional Station

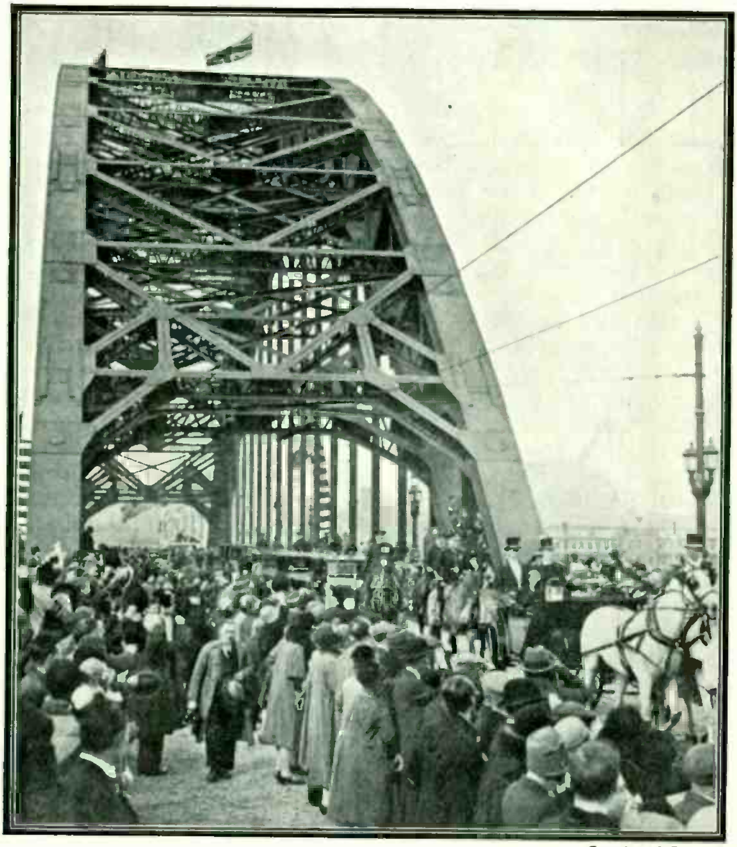
Society in the Free Trade Hall, Manchester, and of the Liverpool Philharmonic Society in the Philharmonic Hall, Liverpool, while several of the concerts by the Leeds Symphony Orchestra have been broadcast to regional listeners from the Leeds Town Hall. The Manchester Tuesday Mid-day Concerts Society continues to make a gallant fight for existence, and has had one of the most successful seasons in recent years. The majority of its concerts have been broadcast throughout the region, and the Northern Wireless Orchestra has appeared in four of them. During the summer months listeners have been able to spend afternoon and evenings "via the ether" at some of the principal Northern resorts, such as Scarborough, Harrogate, Blackpool, Buxton, Llandudno and Southport, from which orchestral music, band concerts and entertainments have been relayed.

The North is rich in cathedrals and historic places of worship, and these have supplied services and religious music through the Northern grouping to the national programmes. Yorkshire choirs and orchestral musicians were heard in the render-ing of "The Messiah" from York Minster on Christmas Sunday, 1928, and a party of German singers, who visited Manchester Cathedral on Sunday, October 10th, gave a performance of Chorales by Old Masters, which was relayed and broadcast. Services have also been taken from Liverpool, Sheffield, Chester and other cathedrals, and from Roman Catholic and Free Church places of worship. The Enthronement of Dr. Temple as Archbishop of York was broadcast on January 10th. Another interesting religious event, relayed for the first time to listeners in the North of England on the morning of June 12, was the Heckmondwike Lecture, a part of the unique preaching festival of the West Riding, the origins of which date back to 1754. Having in view the early establishment of the New Regional Station as such, it was decided to replace the old Religious Advisory Committees, which have done much good work in the past at the various relay station centres, by a Regional Religious Advisory Council, representative of the whole region and of all Christian denominations. For this purpose a special meeting took place at Broadcasting House, Manchester, at the end of September, and the Advisory Council has now been established under the Chairmanship of the Bishop of Wakefield.

Sporting events have found their place in the programmes with a service of news broadcast on Saturday evenings throughout the winter months and with regular sports talks by Mr. Stacey Lintott. Commentaries were again broadcast this summer from the Lancashire and Yorkshire cricket matches, while an eye-witness account was given of the Tourist Trophy Races in the Isle of Man in June, and a description from the spot of the Sheep Dog Trials in August in the Vale of Rydal, Westmorland. Other events and ceremonies which have figured in the programmes have been the Royal Agricultural Show at Harrogate, the May-Day Festival at Knutsford, the 800th Anniversary of the Conferring of Freedom on the Townsmen of Beverley, which was celebrated in Beverley Minster, the Trooping of the Colours in the Fulford Barracks, York, the Northern Command Tattoo, the National Eisteddfod of Wales at Liverpool, the Brass and Military Band Contests at Bellevue, Manchester, and the Catholic Emancipation Centenary Celebrations of the Liverpool Arch-Diocese. By arrangement with the Ministry of Agriculture, a weekly *résumé* of prices obtaining at the principal markets in the North has been rendered available to farmers on Thursday evenings, and a special bulletin, applicable to Northern gardens, is now prepared by the Royal Horticultural Society.

There are definite signs that the North intends to make the best possible use of the educational opportunities offered by Broadcasting. During the past year the number of schools in the region listening to School Broadcasting has risen to over 800, and several of the leading Education Authorities, including those of Liverpool, Leeds, Blackburn, Stockport and Barrow, have made grants of one kind or another for the installation of wireless in schools in their areas. Following the publication of the Hadow Report on Broadcasting and Adult Education, an important conference of Northern educationists took place at York in October of last year, at which addresses were given by Dr. Lang, then Archbishop of York, Sir Henry Hadow, Vice-Chancellor of Sheffield University, and Sir John Reith, Director-General of the B.B.C. As the result of subsequent meetings and deliberations, two Councils of Broadcast Adult Education, to work in conjunction with the Central Council in London, have been established. The first meetings of these took place in October. The North-Western Area Council represents educational interests throughout the counties of Lancashire, Cheshire, and Westmorland. The Yorkshire Council covers all the Ridings of that county. Some fifteen Adult Education Listening Groups have been formed in the North, and one of the most interesting experiments carried out in connection with this side of our work was the first session of a week-end school, organised by Hull University College, for the training of group leaders.

The activities of the region during the past year have more than shown the value of the future regional scheme and the fact that the second wave-length will be a much-needed medium for giving expression to the varied life and interests of the Industrial North. Exhaustive investigations of the Pennine country have resulted in the selection of a site for the regional transmitters on the moorland to the west of Huddersfield, so that, while the chief offices and studios serving the region will be centralised in Lancashire, the transmitters will stand on Yorkshire soil, a fitting consummation of the B.B.C.'s desire to deal comprehensively with the claims of Northern listeners.



Sport and General

H.M. THE KING OPENING THE NEW TYNE BRIDGE

One of Newcastle Station's broadcasts

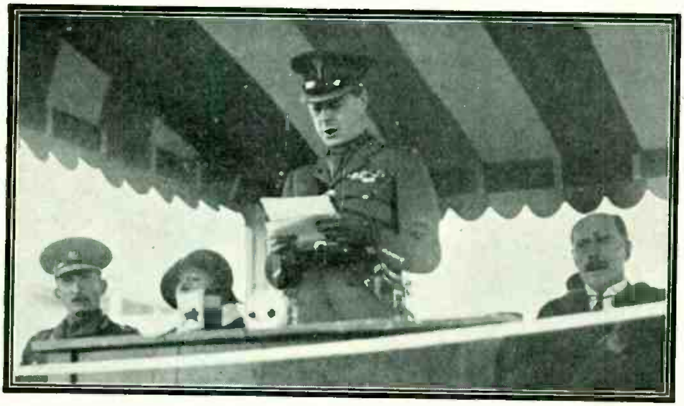
NEWCASTLE AND THE NORTH-EAST COAST

NEWCASTLE-ON-TYNE, the famous shipbuilding and industrial centre, has been very much in the public eye during the last year owing to the North-East Coast Exhibition which was held there during the summer months. This great undertaking, which was brought into being for the purpose of promoting trade generally and on the Tyne in particular, was opened on May 14th, 1929, by H.R.H. the Prince of Wales, the ceremony being broadcast. Naturally an exhibition of this character attracted widespread interest, not only throughout Great Britain and the entire British Empire, but in many other countries, and visitors from all over the world visited Tyneside in large numbers with the sole purpose of inspecting it. Such an event could not but be reflected in the activities of the local broadcasting station, and, in addition to relaying the opening ceremony, many other interesting events, such as the opening of the various Empire Exhibitions, orchestral and band concerts, and music from the New Zealand War Memorial Carillon, have been conveyed to listeners through the microphone. Speeches calculated to promote closer trade relationships were broadcast from the Exhibition by the Sultan of Zanzibar; Sir Francis New, the High Commissioner for Southern Rhodesia; Sir Atul Chatterjee, the High Commissioner for India; Sir Louis Souchon, Commissioner for Mauritius; Mr. Patrick Hogan, Minister of Agriculture for the Free State of Ireland; Mr. G. F. Woods, representing the Government of Northern Ireland; and Mr. W. Bevan, Acting Trade Commissioner for Cyprus. The Newcastle Broadcasting Station has thus been instrumental in conveying to a wider public the purposes of the Exhibition, and incidentally promoting a deeper interest in the neighbourhood in which it stood.

Apart from the Exhibition, listeners were enabled to participate in numerous other local events on the North-East Coast, such as the opening of the new Tyne bridge by H.M. the King in October 1928; the Historical Pageant at Richmond (Yorks); the reception to Major Sir Henry Segrave, the famous racing motorist who broke the world's speed record; the Northumberland Plate, popularly known as the Pitmen's Derby, and the Baltic and International Chamber of Shipping Conference.

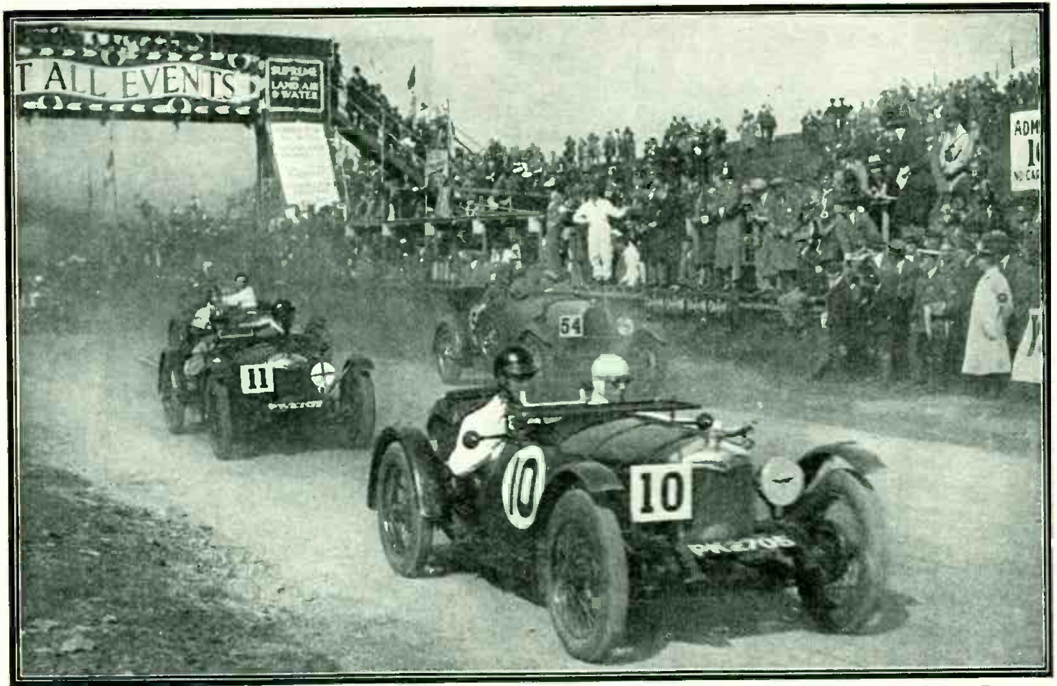
Local activities were further fostered by the broadcasting of a series of programmes dealing with important towns on the North-East Coast, such as Berwick-on-Tweed, Carlisle, Darlington, Sunderland, Stockton, Middlesbrough and West Hartlepool, these having an historical as well as an industrial interest. Opportunities were also afforded listeners of hearing performances of many of the most popular musical combinations on Tyneside, such as the Newcastle Philharmonic Orchestra, the Newcastle Bach Choir, the Prudhoe Gleemen, the Darlington Male Voice Quartet, and several others, not to speak of the brass bands drawn for the most part from the colliery districts for which Northumberland and Durham are famous.

Speaking generally, the use of broadcasting as an important factor in holding fast to great national traditions while at the same time making the march of social and industrial progress more vital and significant, has been well exemplified in the year's activities at Newcastle.



Sport and General

THE PRINCE OF WALES OPENING THE N.E. COAST EXHIBITION



Belfast Telegrap

A VIEW OF THE R.A.C. TOURIST TROPHY RACE IN ULSTER

An eye-witness account of which was broadcast on August 17th, 1929

RTHERN IRELAND

924 the B.B.C. extended its activities to Ulster, and the past five years the Imperial Province has enjoyed distinction of being the only portion of the Empire erseas which is included within the B.B.C.'s service ea. Northern Ireland is not a Dominion, like the Irish Free State, nor is it a colony. Though it enjoys a large measure of self-government, it yet retains a very close link with Westminster, and sends thirteen members to the Imperial House of Commons. The Ulster Broadcasting Station, situated in Belfast, radiates to its listeners most of the important London programmes, and on occasions programmes are relayed from Scotland, Wales, and the North of England. Thus the broadcasting service reflects the sentiments of the people, who have always retained a lively sympathy with, and an unswerving loyalty to, British ideals and British culture. The chimes of Big Ben are heard as clearly in County Tyrone as they are in the County of Middlesex, and the news of the day emanating from the London Studio is received simultaneously in Balham and Ballymacarret.

But when all is said and done the Belfast Station's chief activities are concerned with programmes originating from its own studios at 31, Linenhall Street. The studios and offices are accommodated in a large building which was at one time used as a linen warehouse, and has since been transformed into a broadcasting station. The studios are two in number, one large enough to contain an orchestra of sixty or so. The other is smaller, and is used for talks, plays, etc. A permanent Station Orchestra of thirty is employed, and on special occasions this combination is very materially increased by local and other musicians. For instance, in November 1928, when Sir Henry J. Wood conducted the orchestra at the Ulster Hall, its size exceeded eighty.

There is no permanent orchestra in Northern Ireland other than this one. It follows that the B.B.C. plays a specially important part in the musical life of the province. There is, for instance, a great deal of co-operation between the Belfast Philharmonic Society and the B.B.C., to their mutual advantage, five of the Society's excellent concerts having been broadcast between October 1928 and March 1929. Similar co-operation has been established with the Lisburn Choral Society, again with a musical society operating in the Counties Tyrone and Fermanagh. The Ulster Summer School of Music, an annual enterprise sponsored by the Ministry of Education, has invoked the assistance of the B.B.C., and this year, on July 30th, a special Symphony Concert was given for the benefit of the school in the Great Hall of Queen's University.

Orchestral performances in public concert halls, particularly before enthusiastic audiences, convey a certain "atmosphere" to the wireless listener, and for this reason the Belfast Station has arranged many such public performances during the year under review. Sir Henry Wood's appearance on November 2nd, 1928, was the first of the season, then followed two concerts in the Wellington Hall, and in February a further concert in the Ulster Hall in aid of the Musicians' Union Benevolent Fund. Towards the end of the season it was decided to extend activities to other centres. February and March saw concerts in the Town Hall, Ballymena, and the Guild Hall, Londonderry, respectively. All these performances have been under the baton of Mr. E. Godfrey Brown, who holds the two positions of Musical Director to the B.B.C. and Conductor of the Belfast Philharmonic Society.

Another enterprise of special interest was a performance of Elgar's "The Kingdom" in the Belfast Cathedral on Good Friday, before a congregation of 1600 persons.

Of the programmes performed in the studio itself, it is possible to mention but a very few. It will interest the reader to know that several eminent men in the musical world have recently conducted the orchestra in the studio. Amongst these may be mentioned Sir Hamilton Harty (a native of County Down), Sir Henry J. Wood, Colonel Fritz Brase, late musical director of the Prussian Guard, and now Director of Music to the Irish Free State Army School of Music, Sir Ivor Atkins of Worcester Cathedral, and Mr. Julius Harrison, Conductor of the Leeds orchestra.

Belfast Station, which maintains a large chorus, has made a speciality of choral works, of which the following are a few recent examples: "The Voyage of Mældune" (C. V. Stanford), "A Sea Symphony" (R. Vaughan Williams), "The Master Mariners" (Dr. Thos. Wood), "Carmen" (Bizet), and "Genevieve de Brabant" (Offenbach).

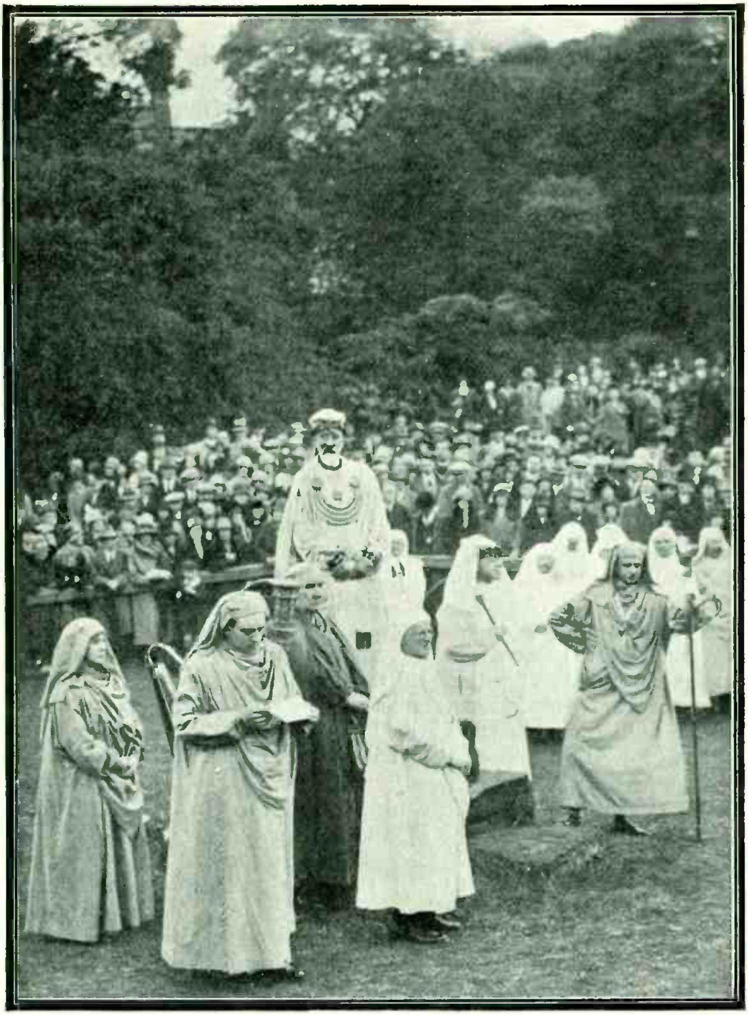
Throughout the last year the Station Military Band, comprising thirty musicians, has broadcast about once a week. It is generally conducted by the Musical Director, or the Deputy Conductor, Mr. Harold Lowe, but on occasions others have wielded the baton, such as Mr. B. Walton O'Donnell, of the B.B.C. Headquarters' Staff, Captain Miller, of the Grenadier Guards, and Mr. Orde Hume.

Chamber Music has found frequent place in the programmes, three string quartets of a high standard of ability being regularly employed at the Station, and many interesting broadcasts have taken place. In this connection a special feature has been the occasional introduction of wind instrumentalists, and the performance of chamber works written for strings and wind.

The Station's activities have been by no means confined to music. Drama, Variety and Revue, under the direction of Mr. John Watt, have been given a fair share of programme time. Ulster has a drama of its own and a humour of its own, and the essential Ulster element is not lacking in a great deal of this work. Many original revues have made their first appearance at Belfast, amongst which "Four-in-Hand," "Le Cabaret au Lapin Qui Saute" and "All Right on the Night" are worthy of special mention.

On frequent occasions the microphone has been used to transmit events of public importance. A complete running commentary was undertaken on the International T.T. Motor Race held on the Ards Circuit on August 18th, 1928. This was followed on September 3rd by a similar broadcast of the Ulster Grand Prix. During the winter Rugby Internationals were transmitted from Ravenhill Park. On July 25th, 1929, the Station broadcast the Dedication of the historic bells of Londonderry Cathedral, after their being re-cast.

The religious activities of the Station conform to the Corporation's general policy. Some services are taken from St. Martin-in-the-Fields, others from St. Cuthbert's, Edinburgh. There are also frequent relays of services from various parts of the British Isles, and dovetailing into all is a scheme of local services most of which originate either from St. James's Parish Church or from Fisherwick Church, Belfast. Thus a balance is preserved between the local and the universal aspects of religion.



The Times

THE EISTEDDFOD

THE ARCHDRUID IN THE GORSEDD CEREMONY

Broadcast on July 2nd

WALES AND THE WEST COUNTRY

THE Archbishop of Wales, in distributing prizes at Llandovery College on July 29th, 1929, said:—

"If Welsh nationality, a noble sentiment, is to be true to its ideals, it must concentrate its energies on drawing out the very best talents of Wales and drawing in the very best help from other quarters. That is the spirit which is spreading to-day. Combination is alive and possesses the industrial world. The hope of the world lies in that spirit which demands for the welfare of all the very best of each."

That might be taken as a statement of the ideals of the Broadcasting Stations in Wales. All the most talented of Welsh artists have broadcast from the Cardiff and Swansea Stations, and constant search has brought to light many promising young artists. In addition to the weekly interludes spoken in the Welsh language, weekly programmes of a Welsh character have been broadcast, and have enabled Welsh people to hear their favourite singers, and West Country people to appreciate more fully the "Land of Song."

The Welsh broadcasts have covered Orchestral, Choral and Band Concerts, including unpublished works by local composers and many "first performances" in Wales, as well as plays written and performed by local people. Rapid strides have been made by the Welsh Drama movement, and with the coming of the Regional Scheme it is hoped that it will be possible to broadcast more Welsh plays.

Particular attention has been given to the development of interest in the Welsh Arts and Crafts, and the kind co-operation of Curators of the National Museum of Wales has made it possible to bring listeners into contact with the leading authorities on Welsh culture, and to illustrate the talks with excellent photographs.

If an average Welshman were asked to arrange various features of the broadcast programme in order of preference, it is certain that the monthly religious service in Welsh would figure high up on the list. The popularity of these services is remarkable. Letters of appreciation, addressed in the main to the minister, are numerous and cover a wide field.

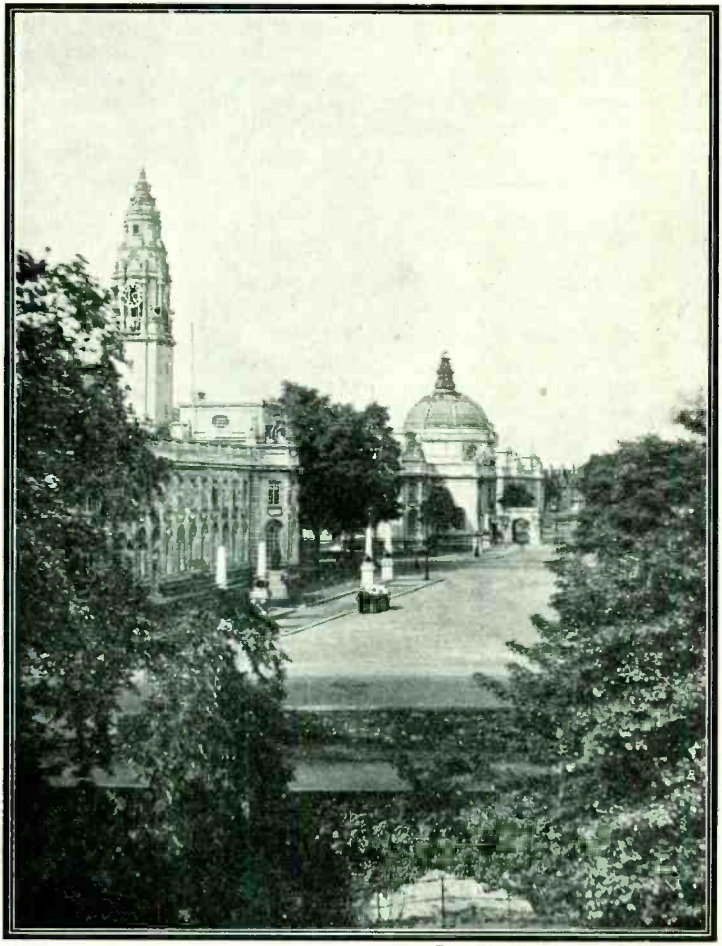
Perhaps one of the most cheering of such messages was that which reached a veteran Welsh preacher from an unknown ship at sea the morning after he broadcast. It consisted of one word:—*DIOLCH* (Thanks). The Silent Fellowship, broadcast weekly through the West Region and monthly through Daventry, has still further increased in popularity, and over six thousand letters from new listeners have been received this year.

The possibilities of the use of wireless as a means of education are rapidly being realised by existing organisations. Fourteen wireless sets provided by the Carnegie Trustees have already been installed in the distressed mining areas and are greatly appreciated, and close co-operation is being effected with organisations interested in Adult Education.

But probably the most important of the developments in the West Region is the progress of the National Orchestra of Wales, conducted by Mr. Warwick Braithwaite. This Orchestra has been in being for only a year and a half, but it has already acquired the status of a great orchestra. Financed so far entirely by the B.B.C., it has been much helped by the authorities of Cardiff City, the National Museum of Wales, and the National Council of Music. An appeal has been made for £2000 a year to enable the orchestra to continue its work in the future, and of the £1400 so far subscribed for this year Cardiff City has given £500.

It is often hurled as a reproach against Britons that they stifle their emotions, but exceptions must certainly be made in the areas where the Celtic spirit predominates. To one who has seen musical audiences all over the world, the attitude of the Welsh audience at Llanelly during the Gorsedd Proclamation Concert on July 2nd came as a revelation.

The last item on the programme was German's "Welsh Rhapsody," and when the bass drum and tympani in the bar preceding the majestic Men of Harlech tune were heard, all the people in the crowded hall stood on their feet and shouted. After a while the shouting subsided and the orchestra went on, the audience having seated themselves, until the final two pages. Then this vast audience could not be restrained any longer. Without exception they stood up and shouted themselves hoarse with the most intense and vital emotion imaginable. It was the first time that mass enthusiasm on a large scale was experienced by the N.O.W. It was indeed an experience never to be forgotten.



By courtesy of the Cardiff Corporation

CARDIFF CITY HALL AND THE NATIONAL MUSEUM, IN WHICH THE NATIONAL ORCHESTRA OF WALES PERFORMS

On another occasion the Orchestra visited Merthyr, and after the performance of Wagner's overture to "Tannhauser" the audience again created this peculiarly intense atmosphere which seems indigenous to Wales. The whole audience was visibly swayed by emotion, and in the final statement of the pilgrim theme given out by the trombone they could not control their feelings.

THE WEST COUNTRY

One of the difficulties of the B.B.C. is that the West Regional Station at Cardiff has to cater for the taste of the West Country as well as for Welsh listeners. It is true that one finds the same spirit of romance on both sides of the Bristol Channel, but the expressions of it diverge in many ways. If music has been stressed in Wales, prominence must here be given also to the traditions of the West, and particularly to the old merchant venturers. Broadcasts have been given of Sailors' Concerts aboard historic ships in the Bristol Docks. The most recent was given from the "Flying Fox," moored near the spot where the famous old frigate the "Saucy Arethusa" was built.

The Bristol Advisory Committee has been an active link with the West Country, and many suggestions for novel broadcasts have been discussed at Rotary House, where the meetings are held. The Clifton Arts Club, Bristol, has been used for successful broadcasts, including a Clifton Arts Club Hour and a Somerset Programme; and Bristol University Madrigal Singers have given a concert of madrigals and folk songs from the University.

At Bath, the Pump Room and the theatre, Citizen House, have both featured in the programmes on several occasions. Citizen House holds a Summer School of Dramatic Art for a fortnight in August each year, and students attend from all parts of the Kingdom. Several one-act plays are broadcast from the theatre, and thus all the students, whether chosen for the relays or not, get some insight into microphone technique.

The late Mr. Fred E. Weatherly, the song-writer, again arranged several programmes in honour of the West Country. His death in September, 1929, ended a long and friendly association with the Cardiff Station.

BIRMINGHAM AND THE MIDLANDS

IT is now two years since 5IT gave way to 5GB and Birmingham was promoted to be the broadcasting centre of the Midlands, East and West. The new transmitter has performed a double function; not only has it carried forward and developed the tradition of 5IT in the Midlands and beyond, but it has also participated in the experiments of providing programmes contrasting with those of London (2LO). With the inauguration of the new London twin-wave service from Brookman's Park it will be possible for 5GB to pay still more attention to its regional duties.

During the past year 5GB has drawn from the artistic resources of Birmingham in music alone 47 symphonies, 65 concertos, 7 complete operas which included the first broadcast performance of "Tess" by Frederick D'Erlanger, and 25 complete choral works. In these figures are included five first performances of new works, and 25 first broadcast performances. Outside the studio, the civic music of the Midlands has found a place in the programmes, contributing, during last winter, the City of Birmingham Orchestra's Symphony Concerts relayed from the Town Hall, and the summer programmes of the Birmingham Police Band each Saturday from Cannon Hill Park. Leamington has also contributed musically by relays of its Military Band Concerts from the Jephson and Pump Room Gardens. Nottingham too has maintained a place in 5GB broadcasts, for in addition to occasional visits to the Birmingham studios of local artists, there have been successful relays of religious services from St. Mary's Church and the Albert Hall, and a very notable outside broadcast of the opening of the new Nottingham Exchange by H.R.H. the Prince of Wales in May 1929. Another notable addition to the resources of 5GB has been that of St. Chad's Roman Catholic Cathedral in Birmingham, from which religious services are now relayed at intervals.

Progress has been made in broadcast education during the last year. Many new schools have installed sets in order to take the school programmes, and in some cases sets have been lent to schools for experimental purposes. Demonstrations to Local Education authorities and school teachers have been given at Wolverhampton, Walsall and Coseley.

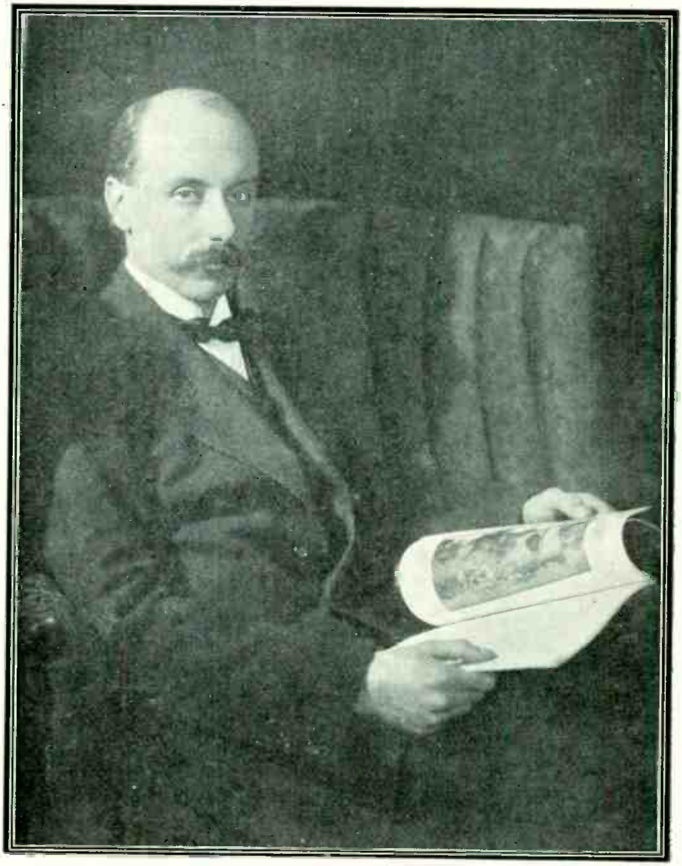
Broadcast adult education has advanced still more rapidly. The West Midlands Area Council, a body representing all the principal associations interested in Adult Education, has been formed and held its first meeting on June 11th under the presidency of Dr. P. D. Innes, Chief Education Officer for Birmingham, the vice-president being Professor W. Cramp, M.Sc., D.Sc., of Birmingham University. Some 70 study groups have been formed in the West Midlands and with few exceptions have proved to be very successful, particularly at Coventry, where a large study group has been working for about eighteen months. Appreciation of the broadcast lectures is growing rapidly, particularly in the Midland Adult School Union, and the Co-operative Union, Y.M.C.A. and W.E.A., are also forming groups in this area together with the Rural Community Council in Herefordshire. It is hoped in the coming winter, with the aid of a grant from the Carnegie Trust, to start an extensive experiment in broadcast adult education in the West Midlands.

Much has been done on the dramatic side of broadcasting at Birmingham. During the first half of 1929, 38 plays, varying from twenty-five minutes to an hour in length, were broadcast from the Birmingham studios. These included the first broadcast performance in this country of Luigi Pirandello's play, "The Man with the Flower in his Mouth."

Numerous light entertainments provided by the Revue Company at Birmingham have proved extremely popular, and letters of appreciation have been received from as far afield as Sweden, the Rhine, and Cairo.

The Radio Circle members of the 5GB Children's Hour have increased in numbers during the past twelve months to the extent of 10,000, and have continued their collection of silver paper so assiduously that since January this year another £75 has been added to the fund from this source alone. Last October saw the culmination of the children's effort to endow a cot in the local Children's Hospital, and a cheque for £1,000 was handed to the Lord Mayor for this purpose—and now, only nine months later, another £400 has been collected towards the second £1,000 which 5GB's enthusiastic Radio Circle Members have set out to amass.

Such, briefly, is the year's broadcasting in the Midlands.



ADRIAN BOULT

late conductor of the City of Birmingham Orchestra, who succeeds Mr. Percy Pitt, the B.B.C.'s Music Director

A YEAR'S SURPRISE ITEMS—

1928

July 13 Three Co-optimists—Stanley Holloway, Wolseley Charles and Davy Burnaby.

20 Three H's—Aubrey Hammond, A. S. Hibberd and V. H. Hutchinson.

27 Aida Sharaf and George Metaxa—a small cabaret intime.

Aug. 3 Sketch about Zeebrugge by "Seamark."

10 Broadcast from Signal Box at King's Cross Station.

17 Return from Africa of Muriel George and Ernest Butcher.

24 John Pennar Williams, the Welsh Eisteddfod 1st Prize winner, and the Morecambe choir boy, Frederick Firth.

31 Morecambe choir boy singing from Birmingham studio, with the Birmingham Studio Orchestra and Chorus.

Sept. 7 Criticism of a broadcast play by Hannen Swaffer and James Agate.

14 Jack Hobbs saying "Au Revoir" on the eve of the England XI's departure for Australia. He introduced many of the Test team, including Sutcliffe, Duckworth, Hammond, and Leyland.

21 Marian Anderson.

28 Well-known Continental artist, Bilboquet.

Oct. 5 A. J. Alan.

12 Street singers of London (theatre queue).

19 Georges Carpentier.

26 Beachcomber (*Daily Express*) programme.

Nov. 2 Round the Provincial Stations, including 200 canaries from West Bromwich Roller Canary Club.

9 Tommy Handley.

16 Round the studios at Elstree.

23 "Why is the Bacon so Tough?" programme (*Daily Mail* song).

30 Round London theatres at night, terminating with the curtain, cloakroom and traffic noises at London Hippodrome.

Dec. 7 A Night Club, including Dwight Fiske.

14 "The Spirit of Piccadilly" from early days to present time. To celebrate the opening of the new Piccadilly Tube Station.

21 Christmas wishes. Wireless Orchestra and Chorus in "Roll Away Clouds" from Virginia.

27 Popular Choruses by Stuart Robertson and Wireless Chorus.

31 New Year's Eve Party. Davy Burnaby as host and many theatrical people.

1929

Jan. 12 Winners of *Evening News* competition to discover what people would do if they were given five minutes before the microphone.

18 The Nelson Sisters, from Canada—three phenomenal children.

24 Scene from" Journey's End."

31 Cyril Shields in problems and puzzles.

A POPULAR WEEKLY FEATURE

1929

Feb. 6 First Artists chosen by General Theatres Corporation at auditions in Liverpool.

15 "Egg" programme, based on the *Daily Express* British Eggs Campaign. Raymond Newton and Tommy Handley.

21 "Lucky Girl," including Roy Royston, Charles Heslop, Billie Hill, Marie Picquart.

26 Ellen Terry Anniversary programme, including record of her own voice reciting the "mercy" speech from "Merchant of Venice."

Mar. 9 "Fashion," excerpts from Kingsway Theatre play, including old-fashioned songs.

14 Three Cockney sketches by Charles Pond, the modern Dickens, given by Morris Harvey, including "On Stroke"; "Who'll 'ave a Blood Orange?"

22 Variety. Una Beyr, Ronald Frankau, Carroll Gibbons, Alma Vane, Paul England and the Cambridge Quinquaginta Dance Band from the University (night before Boat Race).

28 Scene in the fo'c'sle of a tramp steamer, introducing sea shanties, etc., arranged by Victor MacClure.

Apr. 5 Excerpts from "Charivaria" with Dorothy Dickson, Claude Hulbert, etc.

12 High-speed tabloid revue—Austin Melford, Leslie Sarony, Donald Mather, Elsie Ottley, Norah Howard.

19 Gramophone records played backwards.

25 Bob and Muriel, popular cabaret entertainers from Café de Paris.

May 3 Broadcast from Concert Artists' Association, Cranbourn Street, at a breaking-up smoking concert prior to their departure for summer engagements.

10 Vernon Bartlett on Broadcast Drama and how it is done.

17 Hungarian Orchestra under direction of Barnabas von Gezcy.

24 Tommy Handley on the General Election, followed by the "Saucer Burial" from "Porgy," including negro spirituals and prayers.

31 Revue and Burlesque of "Kaleidoscope." Austin Melford.

June 7 Round London Theatres.

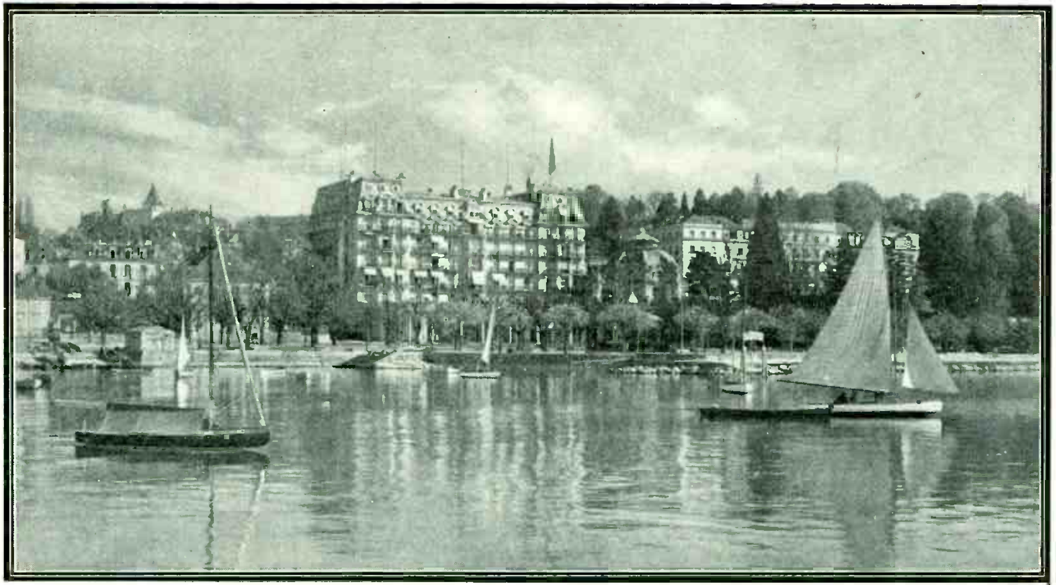
14 Cornelia Otis Skinner, the American *diseuse*, in two sketches—"Homework" and "Saying 'Good-bye' to a friend at the Docks."

21 A thriller by a Labour M.P., "The Wrong 'Bus."

26 A Roman News Bulletin.

July 5 Informal Celebration of the King's Recovery.

12 The 1st Anniversary. Edgar Fairchild, Robert Lindholm, Olive Groves, from Café de Paris.



Ryffel

THE HÔTEL BEAU RIVAGE, OUCHY

One of the meeting places of the Union Internationale de Radiodiffusion

PROGRESS IN EUROPE

IN the twelve months ending with August 1929 the international side of European broadcasting has outweighed the national in the scale of importance. Not that the latter has been insignificant—on the contrary, in several of the countries where political and other difficulties have hitherto hindered progress, 1929 has marked a definite advance towards regularisation, while in those already more happily situated progress has been constant. But the outstanding event of the year has unquestionably been the Conference of Prague, with its antecedents and consequences. The technical work of the Conference is dealt with elsewhere—here we are concerned with broader and more intangible issues.

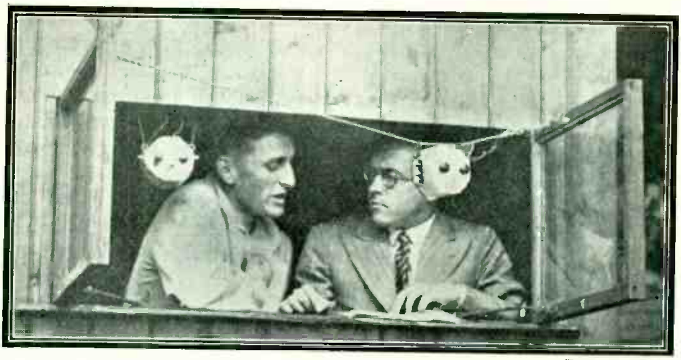
Hitherto the Geneva Union had been constituted as an unofficial body of such exploitants as chose to adhere to it, and a rather considerable number of broadcasters (notably Governments interested in broadcasting) had held aloof in spite of various efforts to bring conflicting interests into line. Polish and British initiatives, however, interpreting a more and more evident necessity, smoothed the way at last towards a situation in which the Governments assembled at Prague could settle the Union's status and responsibilities by unanimous agreement.

Under the Protocol of Prague (which was followed by appropriate revisions in the Union's statutes) several highly important steps were taken towards the co-ordination of European broadcasting. The Union's plan of wave-length allocation was adopted officially by the Governments, with only such modifications as negotiation always produces. The work of watching developments was formally committed to the Union, and inter-Governmental conferences are in future only to be called when a majority of European Governments so demands. Provision was made for all actual broadcasters, whether State or private, to join as members, and for Governments (whether themselves broadcasters or not) to send representatives to all meetings of the Assembly, the Council or the Committees. Various technical recommendations of the Union were approved and included in the Protocol. And lastly—in the executive field—the Union's frequency-checking station at Brussels was made the master-regulator for Europe, by the neat diplomatic formula of inviting the Belgian Government to nominate "an organ chosen by itself" for the purpose.

It must not be imagined from all this that the effect of the Prague Conference has been (in the bad sense of the word) to officialise the Union. Rather it is expected that the outcome will be the unionisation of the officials—and certainly the annual meeting at Lausanne under the new régime was marked by the same frank and human way of doing business and sharing views as was characteristic of the old "private" Union.

Next year's activities can, therefore, be faced with a confidence, that last year was but a hope, of fruitful co-operation. Many problems still remain. There is not yet entire peace in the ether. Wave stabilisation has not ceased to be a current problem. Single-wave working, the development of alternative programmes, short waves, higher power—these questions will give the Union technicians plenty of work for years to come, not to mention problems of electrical interference, wireless exchanges, line relays and so on. And behind all this is the great field of international co-operation in programme and administrative matters. It is not only broadcasters who have formed international linkages. Copyright-holders, the Press, cultural and political movements, and the hundred and one activities of human society that impinge in this way or that on broadcasting—all are, or are becoming, internationalised. On many of these relations considerable work has already been done in the Union, though, of course, this work has necessarily been less definite and spectacular than its achievement in the more urgent matter of regulating the waves. But much more remains to be tackled.

Of the unsurveyed field of the future it seems likely that the first piece to be taken under cultivation by the Union will be that of international line relaying. A considerable amount of regular relaying has already taken place between the East European centres, and the West does not mean to be left behind. In the course of the last few years there has been much rebuilding of the telephone system of Europe, and nowadays the requirements of broadcasting are almost always taken into account in deciding upon the characteristics and route of an important cable.



Express Photos

THE GERMANY *v.* ENGLAND ATHLETIC MEETING

Lord Burghley speaking to Germany by land line. On the right the German commentator. *(See pp. 144–5.)* *A good example of one aspect of the international possibilities of broadcasting*

Turning now to events in the several countries of the Continent, the general trend towards national-service broadcasting has made progress in several of the States in which hitherto it has been competitive and commercial, and there has been a good deal of interesting legislation. There is no sign of any movement in the contrary direction.

In *France* the hitherto chaotic situation has been brought appreciably nearer to solution by the Bill of 1929, which seems much less likely to arouse opposition than previous drafts. The régime contemplated is a mixed one, consisting of "state" stations for which programmes are provided either from headquarters or by local associations; and "private" stations, in which the concessionnaire is responsible both for programmes and for transmission, under a detailed specification of standards. Both Government and private stations are to be under the authority of a Higher Council, responsible directly to the Prime Minister, and consisting of representatives of the interested Ministries and personages of the world of culture and art. Finally, licence revenue is to be made a reality and devoted to broadcasting.

In *Belgium* a draft law tending to a national organisation of broadcasting was passed by the Chamber in the summer, but at the time of going to press still awaits confirmation by the Senate.

In *Holland*, on the contrary, the available facilities are still to be divided up amongst various political and religious propagandist organisations.

In *Spain* a central junta has been created to supervise and on general lines to direct the various privately-owned broadcasting concerns, among which "Union Radio" is more and more definitely acquiring primacy.

In *Switzerland* a thoroughgoing reorganisation of the present haphazard system is being taken in hand. The nucleus of a central control has been created. The location of the future national transmitters, however, is still a matter of internal controversy.

In *Yugoslavia* there are now stations at Ljubljana and Belgrade, but, on the other hand, the pioneer Croatian station of Zagreb is financially in a much weakened position. Manifestly, national broadcasting waits upon the settlement or appeasement of the political difficulties which at present divide the house against itself. *Roumania* has begun broadcasting in earnest with its Bucharest station. In *Czechoslovakia* and *Hungary* there are no formal changes to be mentioned, but a tribute should be paid to the directors of broadcasting in both countries for their steady effort to work on friendly and co-operative lines in an acutely difficult political situation.

In Scandinavia broadcasting in *Denmark* and *Sweden* continues to enjoy good health and to put on weight. Denmark claims the maximum proportion of listeners to population in the world. *Norway* has in hand schemes for a greatly improved service. In the countries of the other Baltic shore no special features stand out for record in the period under review. *Finland* alone has developed broadcasting on a large scale so far.

In *Italy* the number of licensed listeners continues disproportionately small, but it is generally believed that the real popularity of broadcasting is far wider than the figures would indicate. There has been some important legislation, interesting because of its bold affirmation of the character of broadcasting as an indispensable public service. One law is designed to accelerate the abolition of spark transmitters, and another provides that theatre, opera or concert organisations may not refuse any reasonable request of the broadcasters for permission to relay their performances.

Finally, the broadcasters of *Germany*, *Austria* and *Poland* can look back on a year of not merely steady progress, but of acceleration. The items of this progress do not lend themselves to description within the limits of a short article. But even in such a survey as this allusion must be made to the spectacular increase that has taken place in the number of German licensed listeners. Germany and Great Britain are now running neck-and-neck for the 3,000,000 mark—a race in which Germany has the advantage in population but the handicap of a much higher licence fee than our own. One other feature of German broadcasting should be mentioned —nowhere has the art-world displayed so critical and creative an interest in the special problems of broadcasting as there. Every week one or another keen critic or suggestive thinker tackles some fundamental question, such as psychological response in the listener, the artistic limits of the use of "noises" in radiodrama, or the like. And this year the famous musical festival at Baden-Baden has been given over to works that leading modernists such as Hindemith have composed specially for broadcasting and the other new media.

As regards European *Russia*, the Soviet Government participated in the Prague Conference and the Russian broadcasting waves were formally included in the European scheme. But the most remarkable event of the year is the part assigned to broadcasting in the five-years' national development programme recently adopted by the Government. It is intended that there shall be in the territory of the U.S.S.R. some 12,000,000 sets for transmission and reception, and all possible stress will be laid on developing the communal loud-speaker and the "wireless exchange" system (central receiver with lines to separate premises) for distributing the output of the great transmitters.

Topical

A LIVING MESSAGE

The King's words traced in torchlight at the Aldershot Tattoo

TABLE OF WIRELESS LICENCES FOR VARIOUS COUNTRIES

EUROPE.	No. of Licences.	As at	Approx. % of Licences to Population.
Austria	356,532	June 1929	5·4
Belgium	300,000*	(Under system of April 1929)	3·9
Czechoslovakia	244,035	June 1929	1·7
Denmark	265,905	,, ,,	7·7
Esthonia	14,261	End of 1928	1·3
Finland	73,836	May 1929	2·1
France	—	New licence system when Bill is passed	—
Germany	2,826,628	June 1929	4·5
Holland	131,641	,, ,,	2·9
Hungary	168,453	End of 1928	2·1
Irish Free State	25,381	June 1929	0·84
Italy	70,000*	,, ,,	0·17
Latvia	23,982	February 1929	1·2
Lithuania	11,838	December 1928	0·6
Norway	64,102	June 1929	2·3
Poland	189,481	May 1929	0·7
Roumania	26,000	,, ,,	0·14
Spain	16,000	February 1929	0·07
Sweden	412,115	June 1929	6·7
Switzerland	75,720	,, ,,	1·9
Turkey	55,000	May 1929	0·4
U.S.S.R.	201,000†	,, ,,	0·19
Yugoslavia	1,523	,, ,,	0·01
Great Britain	2,791,717	July 1929	6·27
OVERSEAS.			
Australia	298,551	June 1929	4·98
Canada	215,650	May 1929	2·4
India	60,000	January 1929	0·02
New Zealand	41,285	June 1929	3·07
South Africa	16,764	May 1929	0·2
Japan	592,399	June 1929	0·7
U.S.A.	11,000,000*	,, ,,	10·4

* Estimated number of sets.

† Under the U.S.S.R. 5 years' scheme of development, it is hoped to have 12,000,000 receiving sets in use by 1934.

IN THE DOMINIONS AND THE U.S.A.

OUTSIDE Europe, three countries with well-developed broadcasting systems have been undergoing constitutional crises of much the same kind as the old countries have had to traverse in the past. In one of the three, namely Australia, the new system has actually come into force; in the second, the United States, it is legalised but only painfully being brought into effect; and in the third, Canada, it is still at the time of writing the undisclosed secret of a Royal Commission.

AUSTRALIA

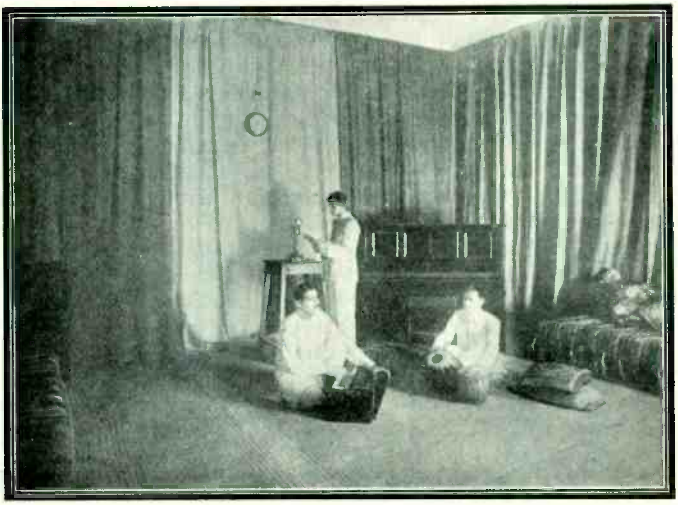
The new régime in Australia is based on a compromise between British, German and American methods. There is now an Australian Broadcasting Service under Post Office control, with the dual function of erecting and running the stations and of supervising the conduct of the programme business, which itself has been ceded, after examination of competitive tenders, to the "Australian Broadcasting Company," which is a grouping of established theatrical interests, but is obliged by the terms of its concession to conform to governmental standards in programme building, provision for educational and purely cultural services, and encouragement of local artistic talent. The Government will be aided in its task of regulation by numerous local committees. The concessionnaire has undertaken to give a satisfactory programme service for a payment of 12*s*. per licensed listener: the whole licence fee is 24*s*., but this has to cover not only cost of collection, but that of the engineering branch.

THE UNITED STATES

In the United States the year has been one in which constitutional difficulties and problems have bulked large. It did not suffice, after all, to set up the Federal Radio Commission, as that body was not only given no dictatorial powers to clear up the "chaos in the air," but its constitutional position was occasionally called into question. One indication will suffice to show the difficulties that broadcasting can cause by intruding itself upon a well-ordered pre-radio world. In a senatorial committee, that was investigating the subject, the President of the National Broadcasting Company was told that if he claimed to be a "public utility" it followed that he would have no right to decline any programme matter offered to him by a member of the public! And it is still rather doubtful in practice whether broadcasting can be kept under Federal (as distinct from State) control otherwise than by regarding it as a branch of "Inter-State Commerce." While these difficulties of principle remain unsettled, and while no means acceptable to the American public's sense of equity have been provided for the expropriation of unwanted stations, broadcasting in the United States must still continue in a state of unsettlement. Meanwhile, however, the programme departments remain as active as ever. The "Columbia chain" has extended its links and is competing here, coordinating there, with its bigger rival the N.B.C., and lately there have been signs of an extension of the activities of both into Canada. Other groupings are coming into existence on a smaller scale. A noteworthy event of the year was the great part played by broadcasting in the Presidential election campaign. The two chief parties between them are said to have spent $2,000,000 in "buying time on the air," and this although some of the "high spots" of the campaign were broadcast by the N.B.C. as non-sponsored programmes at its own expense. The appeal of political broadcasting to the woman voter at home has been said by some to have been one of the main causes of President Hoover's success. In the spring of 1929 the B.B.C. had the pleasure of a visit from Mr. Aylesworth, the President of the N.B.C., with whom the many points both of identity and difference between British and American broadcasting were discussed in a spirit of friendliness and frank mutual understanding.

CANADA AND OTHER COUNTRIES

In Canada, where broadcasting has hitherto been disjointed and exceedingly unequal in performance, a Royal Commission was appointed, under the chairmanship of Sir John Aird, to study the conditions of Canada and the operations of other broadcasting systems. The Commission visited Europe and spent some time with the B.B.C. authorities, therein following the example of Mr. H. P. Brown of the Australian Post Office in the previous year. At the time of writing the report of the Commission has not been issued.



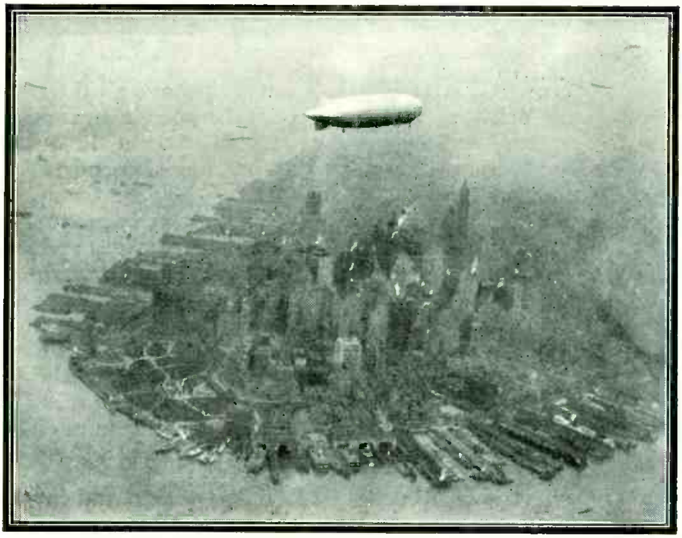
BROADCASTING IN INDIA, IN THE CALCUTTA STUDIO

In India, from a variety of reasons, and above all the complexity of the broadcasting problem in a country that is really a heterogeneous continent, the actual progress of the I.B.C. was not maintained, and at one point a crisis occurred in which the former B.B.C. officials employed by the Company resigned in a body and returned home. The Bombay and Calcutta stations continue to operate, on a somewhat reduced basis, but the future cannot be foreseen with any certainty.

In New Zealand and Ceylon, healthy local broadcasting continues to prosper and the difficulties inherent in the position of small communities are gallantly faced and overcome. In South Africa, on the contrary, in spite of the co-ordination of all stations in one interest, it cannot be said that popular support is, so far, on a level with the output of effort.

EMPIRE BROADCASTING

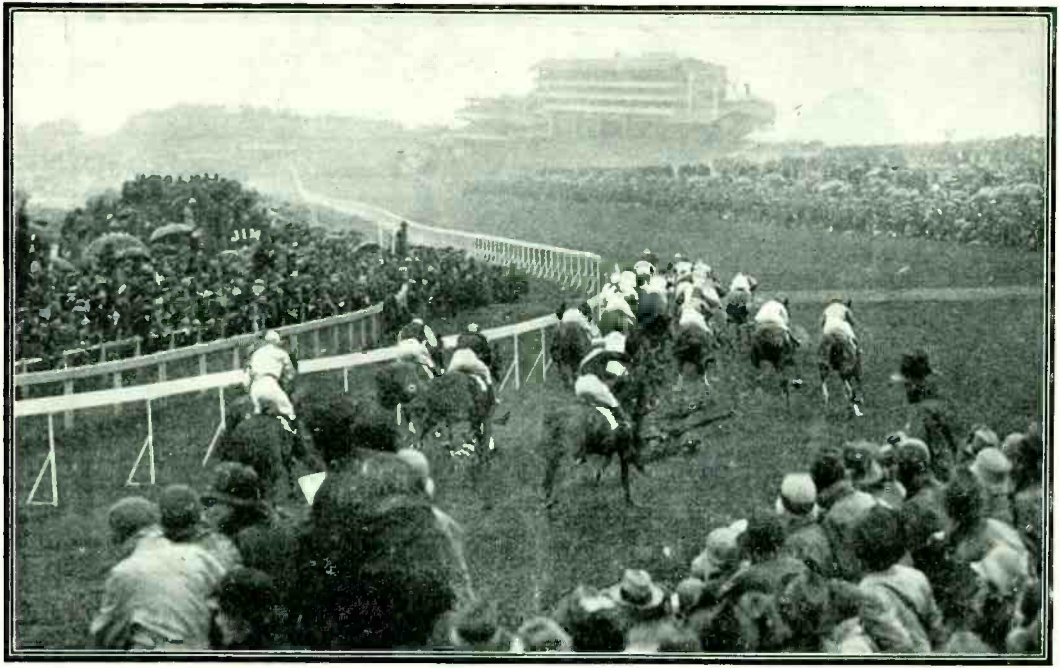
Finally, a word as to inter-oceanic broadcasting and in particular "Empire" broadcasting. The B.B.C. transmitting station at Chelmsford, and the receiving stations at Terling and Keston have continued their experiments throughout the year; partly by broadcasting material from the Daventry programme, partly in two-way transmissions in concert with the United States. Although interesting and suggestive conclusions have emerged, much remains to be done before it can be finally decided whether, and in what forms, to initiate a regular programme service. Meanwhile, the opportunity has been taken again and again to relay to the world events of national or international significance in which the listener's interest (psychological, sporting or other) is so far secured in advance that the still inevitable technical shortcomings are of minor importance. Amongst such relays may be named the Armistice Day ceremonies, the Derby, the Thanksgiving Service for the King's recovery, and the Schneider Trophy race. Relays from overseas transmitted to British listeners by B.B.C. stations included a message from the English cricketers in Australia, President Hoover's inaugural address, and the landing of the Graf Zeppelin at Lakehurst, New Jersey.



THE GRAF ZEPPELIN OVER NEW YORK

The landing at New Jersey was broadcast in America and picked up by the B.B.C. and re-broadcast in the British Isles

A DAY IN THE LIFE OF AN ANNOUNCER
II. POLITENESS TO ARTISTS IS ESSENTIAL



Sport and General

THE DERBY, 1929

"Kopi" falls while rounding Tattenham Corner

THE YEAR'S SPORT

THE microphone is as ubiquitous as a newspaper reporter at sporting events of all kinds, although occasionally the B.B.C. is, for some obscure (and surely illogical) reason, denied the access granted without question to any newspaper.

The various outdoor events lend themselves in different degrees to broadcasting, but the fact that some events are less suitable for commentaries than others has not deterred the B.B.C. from putting them before listeners; but in such cases the alternative method of "eye-witness accounts" is used. Cricket, for instance, has usually been dealt with in this way, and golf scarcely admits of any other method. On the other hand, it is arguable that listeners to a running commentary on a race like the Grand National get a fuller idea of the race than most of the spectators on the course; and, while for the enthusiast there is no such thing as a substitute for the real thing, the commentator manages to convey to listeners a great deal of the excitement and movement of, for instance, a football match.

In a short chronicle of the sporting broadcasts of the year, it is convenient to deal with the various branches of sport separately and disjointedly without tracing the year's events in chronological order. The purpose of this record, and the accompanying illustrations, is merely to draw the reader's attention to the wide field covered by these broadcasts in the hopes that he may, when unable to watch the actual event, remember that the microphone provides a good substitute.

Sport and General

THE GRAND NATIONAL

Jumping Becher's Brook

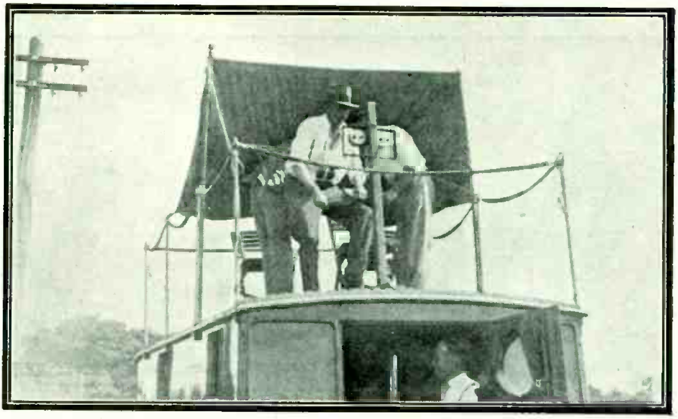
RACING

An article headed "Racing" should begin with horse-racing as being, at any rate up to the present time, "racing" *par excellence*. The Grand National was described on March 22nd, the Derby on June 5th, and the St. Leger on September 11th. All these broadcasts proved as exciting and engrossing as usual. During the year under review the B.B.C. has broadcast descriptions of almost every other form of racing except dog-racing which, even its warmest admirers will admit, hardly lends itself to a running commentary. An effort was made to describe dirt-track racing in 1928, but it is doubtful whether the broadcast was successful in conveying to listeners the many thrills which provide the chief enjoyment of this form of sport. Another form of motor race dealt with by an "eye-witness" account on the day of running was the R.A.C. Tourist Trophy Race, which took place on August 17th in Ulster and was won by the German, R. Carraciola, in a Mercedes-Benz car. The Tourist Trophy Races in the Isle of Man were also described by an "eye-witness." Earlier in the year the microphone had welcomed Sir Henry Segrave on landing in England after breaking the world's

Sport and General

AT COWES REGATTA

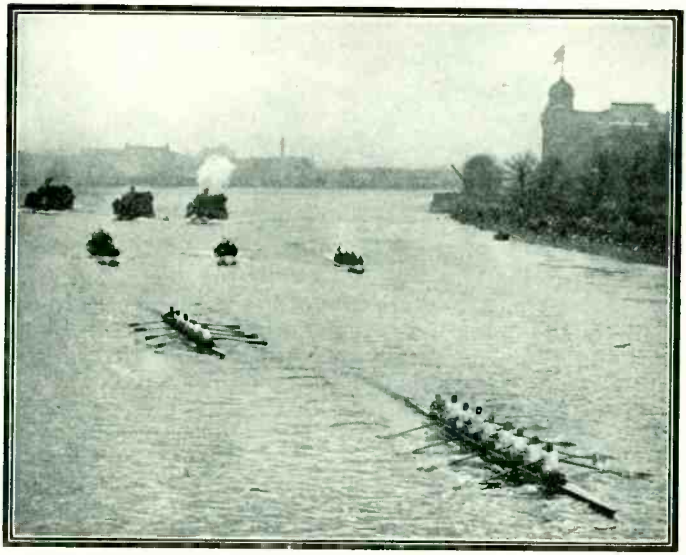
speed record in America. Another event connected with speed racing was the description of the seaplane race in the Solent for the Schneider Trophy which was described on September 7th, a completely successful described which met with universal appreciation. The annual 'Varsity Boat Race provided a poor race but a good broadcast, it being generally agreed that the description was interesting and exciting in spite of the result of the race very soon becoming a foregone conclusion. Another form of racing on water was provided by the Cowes regatta, an "eye-witness" account of which was broadcast from Bournemouth Station. A description of a water-polo match was broadcast on September 28th.



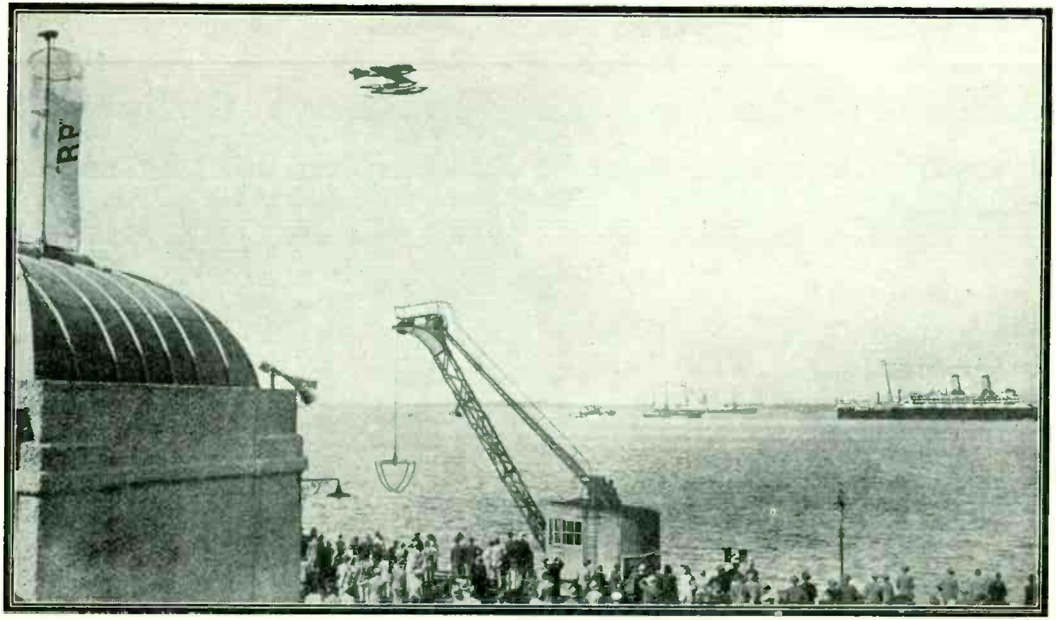
Gale and Polden

DESCRIBING THE SHOOTING AT BISLEY

The B.B.C. van and a telephone pole providing the means



THE VARSITY BOAT RACE OF 1929



Express Photos

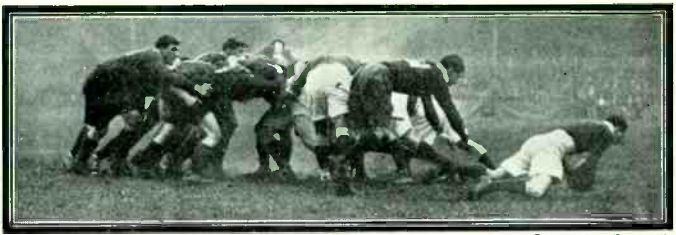
THE SCHNEIDER TROPHY RACE IN THE SOLENT

A most successful commentary was broadcast on September 7th

Sport and General

GENERAL VIEW OF THE F.A. CUP FINAL

at Wembley Stadium

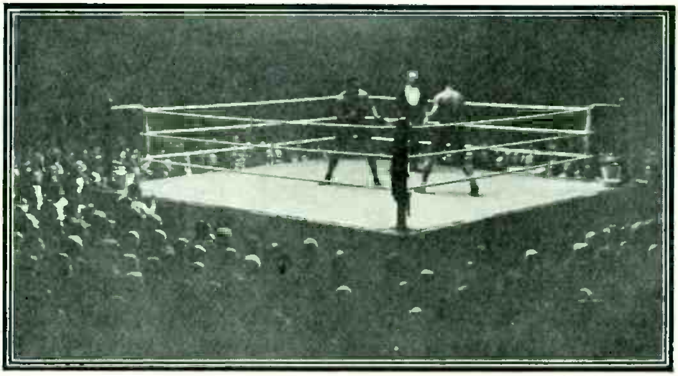


Sport and General

FOOTBALL

The past year has been chiefly notorious for the refusal of the Football Association to allow the Cup Final to be broadcast except on the payment of a large fee, the amount of which they refused to state. The B.B.C. offered to pay what it considered a reasonable sum to any charity named by the Association while claiming equal rights of free access with the Press. The Association refused to agree, and in consequence the B.B.C., rather than allow the thousands of football enthusiasts all over the country to miss the broadcast, arranged for it to be carried out from a position outside the stadium by relays of commentators who had paid for their entry to the ground in the ordinary way. This procedure was entirely successful, and the action of the B.B.C. met with general approval. Fortunately, individual football clubs took a more reasonable view, and it was possible to broadcast commentaries on some important matches, such as Arsenal *v.* Aston Villa and Arsenal *v.* Stoke at Highbury.

The authorities in charge of Rugby football, whether under the Union or the League, have always welcomed the opportunity of allowing enthusiasts all over the country to hear broadcast descriptions of their matches. As in previous years, the International matches at Twickenham were described by Captain Wakelam and commentaries were broadcast on other occasions from Belfast, Edinburgh, and Swansea. It is interesting to note that the Welsh Rugby Union changed its mind and allowed a commentary to be broadcast after having forbidden it in the previous year. Finally, although the microphone was not admitted to Wembley Stadium for the Cup Final, it was welcomed by the Rugby League when Wigan played Dewsbury in the final of the League Competition.



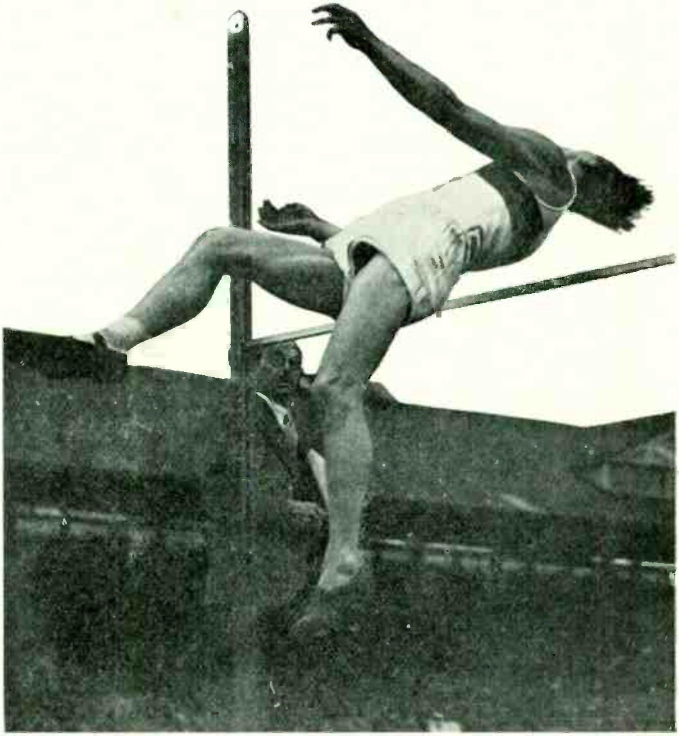
Sport and General

PHIL SCOTT AND TED SANDWINA

BOXING AND ATHLETICS

On January 31st, 1929, another attempt was made to broadcast a commentary on a boxing match. On this occasion Phil Scott was matched against Ted Sandwina at the Royal Albert Hall, Scott winning on a foul in the fifth round. Listeners were able to follow a lively description of the fight by Mr. L. H. Bettinson and Mr. A. St. J. Austin, and the commentary was again successful in conveying, via a ring-side microphone, a great deal of the excitement associated with the sound of blows, the breathing and movement of the boxers, and cautionary words by the referee. Another equally successful commentary on the Light-weight Championship of Great Britain was broadcast on May 2nd.

Athletic meetings generally make a good broadcast as long as the commentary is interspersed with elastic intervals of music from the studio or elsewhere. In the past year commentaries were broadcast on the A.A.A. Championships at Stamford Bridge and the Athletic Meeting on August 24 between Germany and England. This last meeting was dealt with, as far as British listeners were concerned, by an "eye-witness" account, but German listeners were treated to an actual commentary from the ground spoken in German and relayed by land-line to the Continent.



Topical

THE HIGH JUMP: KOEPE (GERMANY) CLEARS 6 FT. 1 IN.

Germany v. England, Aug. 24th, 1929

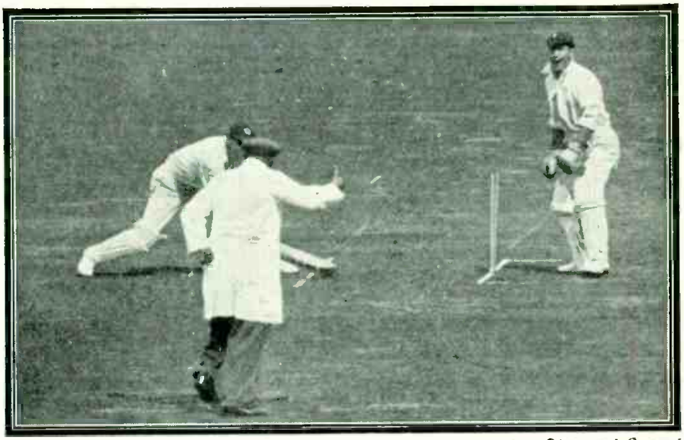
MISS BETTY NUTHALL AND H. W. AUSTIN IN ACTION AT WIMBLEDON

GOLF AND TENNIS

It is only practicable to deal with golfing events by "eye-witness" accounts relayed from the course at intervals during the day or after the day's play. Any kind of commentary is ruled out by consideration of expense. During the year accounts were broadcast of the Open Championships at Muirfield and the Ryder Cup from Leeds.

Tennis, on the other hand, provides excellent material for a running commentary, although the commentators find the strain of following the strokes of rally after rally with an instantaneous spoken description very great. Commentaries were broadcast of the more important matches through the All-England Championships at Wimbledon and met with very wide appreciation. There is no doubt that the excitement and interest of an important tennis match can be conveyed to the listeners and made to hold their interest.

Cricket, in the past year, has mainly been dealt with by means of "eye-witness" accounts broadcast in the evening after the close of the play, and Colonel Philip Trevor described each Test Match in this way. The North Regional Station, however, experimented with the broadcast of a running commentary on the Lancashire and Yorkshire match at Old Trafford on May 20th.



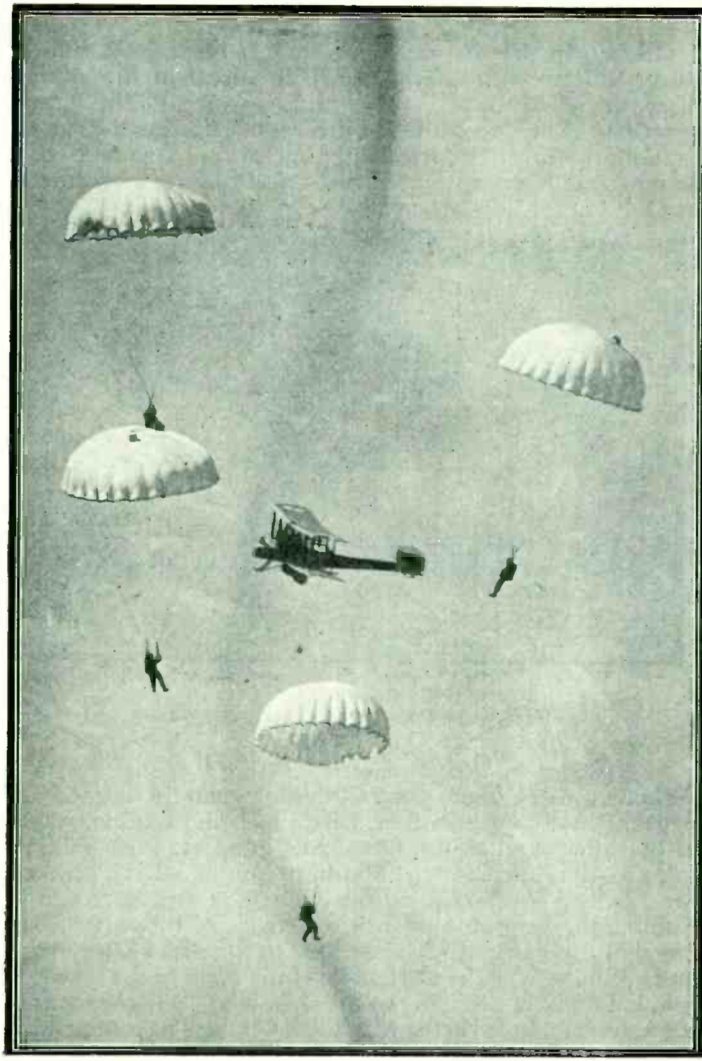
Sport and General

HOW'S THAT?

Hammond is brilliantly stumped by Cameron in the last Test Match

TATTOOS AND PAGEANTS

Although there is no competitive element in tattoos and pageants, they are mentioned here as being outdoor events of the same kind as the broadcasts of sport. Four military tattoos—the Aldershot, the Southern Command at Tidworth, the Northern at York, and the Scottish at Dreghorn Castle, Edinburgh, were broadcast in the course of the season. The Hendon Air Pageant was described to listeners on July 13th, and events such as the Ceremony of the Keys at the Tower of London and the Trooping of the Colour at Fulford Barracks, York, were included in the year's broadcasts. The commentary on the shooting for the King's Cup at Bisley may also be conveniently mentioned here.



Topical

PARACHUTE DESCENTS AT THE R.A.F. PAGEANT

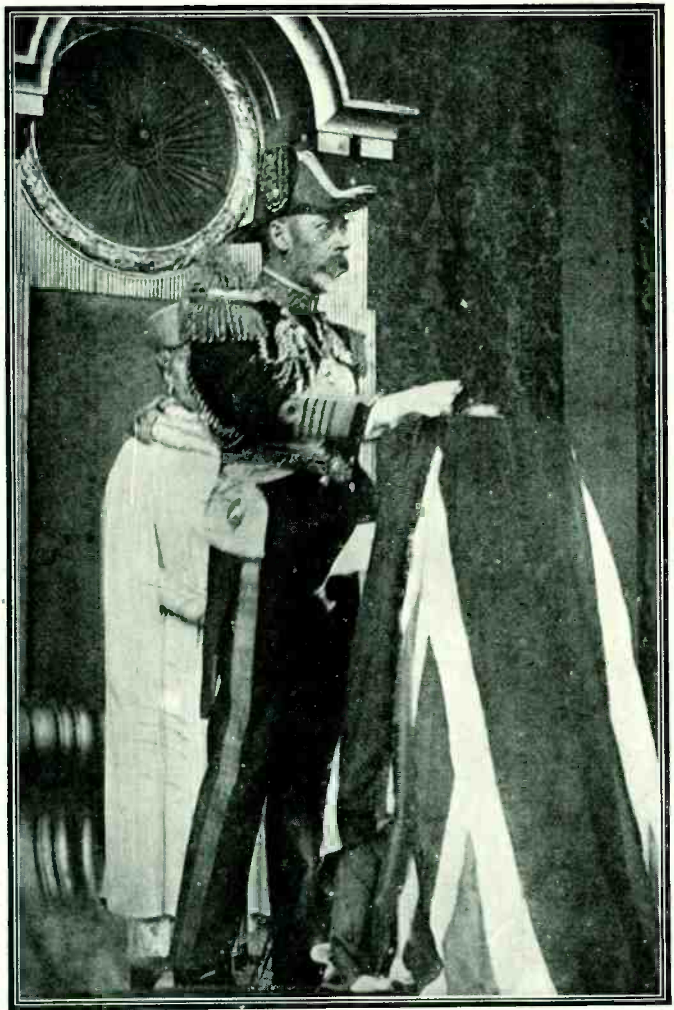
Broadcast July 13th, 1929

THE OLD B·B·C

1922-1926

HISTORY

LIST OF EVENTS



Topical

HIS MAJESTY THE KING OPENING THE BRITISH EMPIRE EXHIBITION AT WEMBLEY

Perhaps the first event to make the general public aware of broadcasting

THE OLD B.B.C.

THE STORY OF THE BRITISH BROADCASTING COMPANY, LTD.

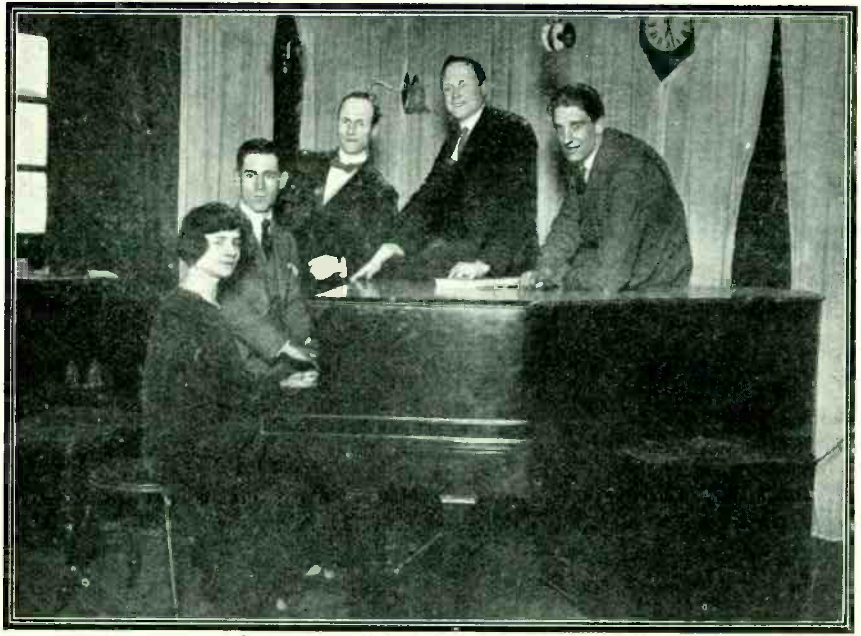
November 1922–*December* 1926.

IT may come as a surprise to many people to hear that in 1922, instead of the lusty child they know, they were nearly presented with twins in the shape of two separately licensed broadcasting organisations in Great Britain. Early in that year broadcasting was carried on by a few industrial concerns, in their research departments, and by a few scientific amateurs, but no service, as we now know it, could be said to exist. In America, however, things were different, and the ether was a chaos of conflicting sounds provided by some hundreds of transmitters without any coordination as to wave-length or programme. It would be true to say that at that time in England we could not hear anything for the silence, whereas in America they could not hear anything for the noise. The number of those interested in broadcasting in this country, however, was steadily increasing, and it was becoming obvious that quite soon a definite step forward in the matter must be taken, the restrictions imposed on the existing broadcasting removed, and some definite system initiated. 1922

On May 4th, 1922, the Postmaster-General, the Rt. Hon. F. W. Kellaway, M.P., announced in the House of Commons that he had decided to permit the establishment of a limited number of broadcasting stations, and that to this end he was calling together a conference of those interested. The first meeting took place on May 18th, was attended by representatives of twenty-four firms engaged in the manufacture of wireless apparatus, and was important in that it recognised the desirability of co-operation between the various firms who wished to have transmitting licences. These firms accordingly went into committee and endeavoured to produce a scheme for the joint conduct of broadcasting in Great Britain; but after many meetings there still remained two schools of thought which appeared to be irreconcilable, with the result that the committee reported that, whereas one organisation appeared to be impossible, it might be that broadcasting could be conducted through two separate concerns.

The Postmaster-General agreed, if necessary, to grant not more than two separate licences, but exhorted the conflicting groups to find a solution in complete agreement. Accordingly a sub-committee was formed of two men, each representing his group as in single combat, and after considerable negotiation they achieved a satisfactory result and reported to their colleagues a basis on which could be formed a single broadcasting company. The Postmaster-General, on receiving from the committee their report, agreed to grant such a company an exclusive right to operate broadcasting stations within the United Kingdom, provided that an adequate service could be guaranteed for a reasonable period of time. This guarantee was provided by six firms, namely, the British Thomson Houston Company, the General Electric Company, the Marconi Company, the Metropolitan Vickers Electrical Company, the Radio Communication Company, and the Western Electric Company, who undertook to finance a service for a period of two years, and thus may be said to be the fathers of British Broadcasting. The authorised capital of the new Company was £100,000, £60,000 being subscribed by these six concerns in equal proportions, the remaining £40,000 being made available, at first to other British manufacturers of wireless apparatus, and subsequently to wireless dealers. Of this sum, £11,536 was actually issued and subscribed, the number of shareholders eventually rising to 1700. Membership of the B.B.C. could be obtained by the purchase of one £1 share, which entitled the manufacturer to the use of the standard mark referred to later.

Each of the six large firms were represented on the board of directors, two further directors were elected by the remaining shareholders, and a ninth, independent, director, Lord Gainford, was elected Chairman. Lord Gainford, who had formerly been President of the Board of Education and Postmaster-General, was Chairman of the Company until December 31st, 1926, when its constitution was altered to that of a Corporation by Royal Charter. The other directors were Mr. Godfrey Isaacs, Major Basil Binyon, Mr. A. McKinstry, Sir William Noble, Mr. H. M. Pease, Mr. W. W. Burnham and Sir William Bull, M.P. On the death of Mr.



A GROUP OF THE ORIGINAL "AUNTS" AND "UNCLES"

'Auntie Sophie" and Uncles "Jeff," "Rex," "Arthur" and "Caractacus"

Godfrey Isaacs, the Rt. Hon. F. W. Kellaway, who as P.M.G. has been instrumental in forming the B.B.C., was appointed a director. The General Manager, originally appointed in December 1922, joined the Board as Managing Director in October 1923. With these exceptions the Board remained unchanged until its task was successfully discharged in 1926.

The British Broadcasting Company, Ltd., was actually formed on October 18th, 1922, was registered on December 15th, and received its licence on January 18th, 1923. It will be seen that the negotiations were protracted and strenuous, but not unduly so in view of the initial difficulties encountered and the many points which had subsequently to be considered. In the scheme finally approved, it was agreed that the revenue should be provided in two ways, partly by the Company receiving half of the receipts derived from 10*s*. Broadcast Receiving Licences, and partly from royalties on sets and components sold by the manufacturers. To provide for the latter it was made a condition of the issue of Receiving Licences that all sets used should be of British make and bear a standard mark, which was to be "B.B.C. Type approved by Postmaster-General." The Company was precluded from using its medium for advertising purposes, and thus deriving a further source of income, and a maximum rate of 7½ per cent. was fixed in respect of dividends. The Company undertook to establish eight broadcasting stations, and provide a regular service to the reasonable requirements of the Postmaster-General. In respect of each station a royalty of £50 was to be paid.

TRANSMITTING STATIONS

1922– It was the aim of the Company to bring the programmes
1923 within reach of the maximum number of people at a minimum cost to all concerned, and accordingly the specified number of stations were sited as far as possible at the centres of thickly populated districts in London, Birmingham, Cardiff, Manchester, Newcastle and Glasgow. Each station, when erected, worked on a power of 1½ kilowatts, and could be heard on an efficiently installed crystal set at a range of between 15 and 20 miles. The dates of opening were as follows:—

London Birmingham Manchester	In operation before inception of service by the B.B.C. November 15th, 1922.
Newcastle	December 24th, 1922.
Cardiff	February 13th, 1923.
Glasgow	March 6th, 1923.
Aberdeen	October 10th, 1923.
Bournemouth	October 17th, 1923.

THE BEGINNING

Although the licence was not issued to the Company until January 18th, 1923, matters were sufficiently settled and in order for a service to be started on November 15th, 1922. The London, Birmingham and Manchester stations were already in existence, and programmes on a regular basis were arranged by three bands of pioneers, one in each city, who worked under conditions of great difficulty and incredible discomfort. The hours were long and without limit, there was no existing precedent or experience for support, and the accommodation was limited to what could be found at short notice. In London, for instance, the combined headquarter and London Station staffs crowded into one office, with a small annexe, in Magnet House, Kingsway, and bore with fortitude the noise and press which increased with each newcomer. The studio was what would now be called a "lash-up" in Marconi House, and being some hundreds of yards distant from the offices, provided the staff, who were mostly executants as well as administrators, with many an enlivening sprint when the programme hour drew near. One survivor of this age tells us that he lived entirely—in the evenings at any rate—on beer and meringues, this exotic diet being presumably the only one available which could both be obtained and consumed in an extremity of haste. These earliest programmes started at five o'clock in the afternoon with a children's hour, started again after an interval with a news bulletin at seven o'clock, and ran with usually an interval of a quarter of an hour after the news, until 9.30, when a second bulletin was read. The second part of the programme concluded at 10.30. The times, with the exception of the two News Bulletins, were not in the first two or three months at all definitely fixed, but it is to the great credit of those responsible that, on an average, four and half hours of programmes were broadcast daily without failure.

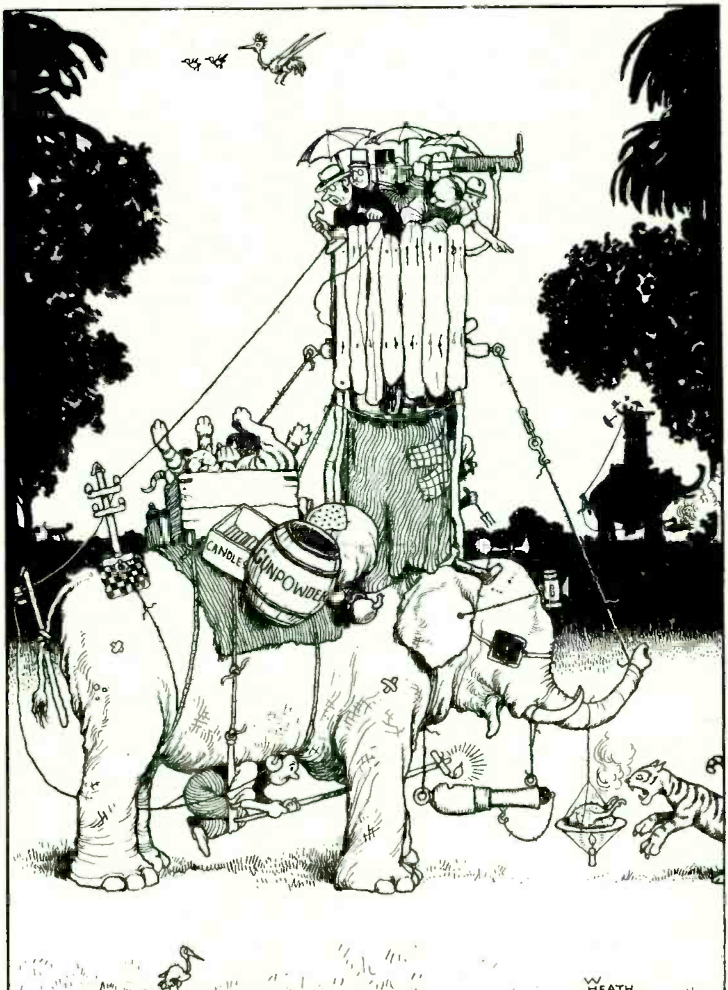
The simultaneous broadcasting of a programme from several stations, by means of connecting land-lines, although contemplated from the earliest days, was not achieved in regular practice until May 1923, when the News Bulletins were read in London and simultaneously broadcast ("S.B.") from all stations. Experimental S.B. transmissions had, however, been undertaken from the end of January. Until simultaneous broadcasting was possible, it had been the practice to dictate the Bulletins by ordinary trunk telephone calls, and all stations had therefore been quite isolated and the programmes independent of each other in a way which it is nowadays difficult to realise. Musical S.B. transmissions were undertaken during the summer, the technical difficulties being considerably greater than in the case of speech alone.

Orchestras were assembled at each station as far as considerations of space allowed. Thus in the case of London, until the new studio at Savoy Hill was opened on May 1st, the orchestra consisted of six or seven players only, and at Manchester also nothing more could be managed until a move was made to the Dickinson Street premises in the summer. The programmes in the studio were, therefore, from the orchestral point of view, strictly limited during the first six months, perhaps the most ambitious work attempted in London being Schubert's "Unfinished" Symphony, which appears in programmes in December, January and April. Played by such a small orchestra there can be little doubt that it lived up to its name.

Chamber music combinations and solo artists were not affected so adversely by the cramped surroundings, and were therefore free to do justice to their subjects as far as their own microphone technique and the technical advance of the period would allow. In spite of the size of the studio in Marconi House, the Band of the Irish Guards appears to have fitted in, though if the number of musicians present was that of even the smallest military band, their playing must have been extremely cramped. It may be interesting to note here that when an instrumental combination was employed, the balance between the various instruments or sets of instruments

THE FIRST BROADCAST OF BIG BEN, FROM A NEIGHBOURING ROOF

(Shortly afterwards the microphone was fixed inside the clock tower itself)



"HOW TO CATCH A TIGER"

The somewhat unexpected title of the second talk broadcast in this country was obtained by distributing to each set a microphone, and varying the sensitivity. A few months later the present practice was adopted of placing the different instruments at suitable distances from one common microphone.

The first talk appears to have been given on December 23rd, 1922, but the subject is not recorded. The second talk, however, on January 27th, from its character of everyday utility, was obviously the forerunner of the modern Household Talks and Agricultural Bulletins; it was entitled "How to Catch a Tiger." The Musical, Dramatic, Literary and Film Criticisms were started in February, these talks then being weekly. Other talks were arranged, averaging one every two days at 7.15, and between January and the beginning of May the names of Admiral of the Fleet Sir Henry Jackson, Mr. J. C. Squire, Professor J. A. Fleming, Sir Oliver Lodge, Lord Robert Cecil, the Bishop of London, Major-General Sir Sefton Brancker, Mr. Heath Robinson, Lord Curzon, Lord Birkenhead, and Princess Alice, Duchess of Athlone appear.

EARLY DIFFICULTIES

The programmes for the first few months of 1923 show 1923
developments of considerable interest. Apart from a progress which is as constant as it is rapid, there are indications that difficulties were encountered at the outset of a very disconcerting nature. In the first place, nothing in the way of news appears in the programmes before 7 p.m., and then only the Bulletins provided by the four News Agencies approved by the Postmaster-General in December 1922. This arrangement held until December 31st, 1926, and was not one arrived at in negotiation by the Company, but was largely dictated by the terms of the original licence. Secondly, the frequent appearances in the studio of artists from the theatres and music-halls came practically to an end in April 1923, while Broadcasts from theatres, excluding operatic performance, practically ceased, numbering as they did ten in February, March and April, and only five in the remaining eight months of the year. A third point is not so obvious, but it is the complete absence from the studio programmes of certain concert artists owing to barring clauses in their contracts

with booking agencies, and the refusal, until the autumn of 1924, of the great concert-giving organisations to co-operate with the B.B.C. in any way. From its earliest days, therefore the Company was opposed by theatrical, musical, and booking organisations in such a way as to impose an almost comprehensive ban. There were, however, certain exceptions to this policy of exclusion, most noteworthy perhaps being the British National Opera Company, whose performances have been broadcast from theatres both in London and the Provinces at frequent intervals since January 8th, 1923, when the first "outside broadcast" was undertaken, and Mozart's "Magic Flute" relayed from the Royal Opera House, Covent Garden. A special tribute here is due to the B.N.O.C. artists themselves who, in these opera relays and in many studio programmes, had the courage and foresight to resist these attempts to boycott the B.B.C.

With regard to copyright, the Company was able to conclude working agreements with the Performing Right Society and the Music Publishers Association, whose repertoires included the majority of musical works required for the programmes; and in most cases where these bodies were not concerned individual negotiations were concluded successfully. Even here, however, the dead hand of the ban followed the Company; for example, none of Rudyard Kipling's works were available for broadcasting, nor, until 1926, were any selections from operas by Gilbert and Sullivan.

In addition, therefore, to finding its way along an unexplored and difficult path, the B.B.C. met with opposition in many places where that path ran near land already inhabited.

SYKES COMMITTEE

1923 The method by which the B.B.C. revenue was derived has already been outlined as being a dual one, money being obtained partly from the broadcast receiving licences issued to listeners, and partly from royalties on sets sold by British manufacturers. On July 27th, 1922, the Postmaster-General had stated that provision would be made under which amateurs who constructed their own receiving sets would be allowed to use them, the view then held by the

A DUET IN THE EARLY DAYS—OLIVE STURGESS AND JOHN HUNTINGTON SINGING INTO SEPARATE MICROPHONES

Post Office being that if an applicant were sufficiently skilled to make his own apparatus, he would have sufficient knowledge to make proper use of an experimental licence which was free of the restriction inserted in the broadcast receiving licence as to the type of apparatus to be used. On the strength of the P.M.G.'s statement, firms began to place on the market ready-made parts, both British and foreign, and the resulting home-assembled apparatus paid little or no contribution to the B.B.C. and was considerably cheaper than the approved complete sets. This at once caused the B.B.C. a considerable loss in revenue, and the point was raised as to whether people making such sets were really entitled to the status of "experimenter" and the consequent issue of an experimental licence. In response to representations by the B.B.C., the Post Office, in January 1923, agreed to issue experimental licences only to persons with unquestionable qualifications, applications from other persons being held over for further consideration.

An *impasse* was reached when the B.B.C. claimed that while rigorously carrying out their part of the agreement, the Post Office was not fulfilling its duties with respect to the licence question. The Post Office, on the other hand, held that it had become practically impossible to enforce the existing regulations and take action against the large number of persons who were using home-made sets without a licence, there being, in fact, no licence which the Post Office could issue applicable both to the person and the set.

The Postmaster-General, in view of the very serious situation which had arisen, appointed a Government Committee under the chairmanship of Major-General Sir Frederick Sykes, on which the B.B.C. was represented, with the object of investigating thoroughly the whole question of broadcasting as now exemplified in practice. This Committee first met on April 24th, 1923, and in thirty-four meetings examined thirty-two witnesses representing the various interests directly concerned, and took written evidence from several other sources.

Their report was submitted in August 1923, confirmed the policy and achievement of the Company, and recommended that the scheme under which the Company had been formed and was then operating should be considerably modified. The Committee considered that while the broadcasting service should not be operated by a Government Department, it should be entrusted to a body working under a Government licence and responsible to the Postmaster-General, who should have, to assist him in the administration of the service and to advise him on important questions, a Broadcasting Board established by statute. With regard to the actual point which had created such an urgent situation, they recommended that one single licence be substituted for the existing experimental and broadcast licences, that this licence cost 10*s.*, and that as much as 75 per cent. of the proceeds go to the B.B.C., subject to a sliding-scale under which the payment per licence would decrease as the number of licences increased. The Committee was unable to make any recommendations for the protection against foreign competition of the manufacturing industry, and further recommended the discontinuance of the derivation of revenue by the Company through royalties from this source and the admission as shareholders of British wireless dealers or retailers. It further advocated the removal of certain restrictions on the Company as to broadcasting hours and wave-lengths, an extension of the news service, and the admission, in return for a broadcast acknowledgment, of provided programme material. Lastly, it recommended that as its scheme called for alteration in the existing agreement under which the service was maintained, the B.B.C. be given an increased share in the necessary licence fees and an extension of their own licence (until December 31st, 1926), provided that they agreed to the immediate application of the scheme and certain alterations in their Articles of Association, but with the retention of the limitation of Dividends.

The Postmaster-General found himself unable to put into immediate operation all the recommendations of this Committee, but their report resulted in the following steps being taken.

The Company was empowered to accept programmes provided by other concerns who wished to obtain publicity through the medium of broadcasting. The hours during which programmes might be broadcast were extended considerably and this, coupled with an increase in revenue, permitted of midday and afternoon transmissions. The dependence of the B.B.C. on the wireless trade was reduced, and a date fixed for the ultimate disappearance of all revenue from this source (July 1st, 1924). Four wireless licences were instituted to meet the existing situation, and 75 per cent. of all revenue therefrom was allocated to the B.B.C., the four forms of licence being as follows:—The Experimenter's 10*s*., the Constructor's 15*s*., the Broadcast 10*s*. and the Interim 15*s*. The first and third forms were those already in existence, the second was to apply specially to the enthusiast who wished to make his own set and who had to sign a declaration that he would not wittingly use foreign components and material, and the last was designed to meet the case of the enthusiast who had already constructed his own set, and which did not comply with the previously existing regulations with regard to origin of material and the B.B.C. stamp. With the disappearance of the payment of royalties to the Company in 1924, one single form of Receiving Licence was substituted for the Broadcast, Constructors, and Interim Licences costing 10*s*. This licence was substantially the same as that issued to-day, and all stipulations as to the origin of sets and material was omitted. Although coming somewhat later, this move was a direct outcome of the Sykes Committee's report.

Lastly, the Company was empowered to extend the existing service, from the eight stations originally planned, by the erection of lower-powered Relay Stations in other populous districts, and thus approach more nearly the ideal of bringing the entire population into easy range.

EARLY PROGRESS

1923 In April 1923, the new Headquarter Offices were brought into use at Savoy Hill, and on May 1st the new studio was completed, so that for the first time the offices and the studio and amplifying gear were housed in the same building. The first Symphony Concert was broadcast in June, and the first long play, "Twelfth Night," in May, both being the beginnings of a long chain of development.

With adequate office space, organisation grew apace, though the strain of the early months began to tell on the original staff during the autumn and winter.

The Music Department set about building up a library, now one of the most extensive libraries of music in the world, and to enable the provincial stations to have a fair choice of orchestral music, began to circulate large hampers of orchestral scores. These hampers looked uncommonly like washing baskets, and it is said that on one occasion when a hamper was due at a station the day before an important programme and was urgently required for rehearsals, an extremely assorted collection of towels, sheets, underclothing and a naval white cap cover was revealed to the anxious eyes of the musical director. Artists were also toured round the stations, and the Music Department became expert in the use of time tables.

Plays were handled for the most part by outside producers, and sound effects in this first year of broadcasting were still in a rudimentary stage. The microphone was rather baffling at this time, for to produce certain of the effects, something so totally unexpected had to be done that for a long time many had to be left to the imagination of the listener. Noises like the shovelling of coal on steel floors when the scene was laid in a forest with a breeze swaying the trees, or the continuous crash of broken glass when two statesmen were conversing near a fountain, were, to say the least, confusing. The best sound effect in 1923 was at Glasgow, when during a play a dog was heard to bark. It was decided that, as any artificial dog bark would sound grotesque through the microphone, and as no live dog could be induced to bark just once and at precisely the right moment, the script should be altered slightly to suggest to the listener that a dog had barked. The weather was extremely hot, and the studio windows were wide open, so that, at the crucial moment, when the words "Listen, isn't that a dog barking?" were coming, the deep-throated bay of an obliging but unknown fox terrier in the square outside fitted exactly into the play and was distinctly heard all over Scotland.

JOHN HENRY

The first successful wireless comedian

In the autumn of 1923 a second studio was opened in London, which was considerably larger than the first, and thus made easier, and acoustically better, the transmissions involving large orchestras and a chorus. Ambitious programmes were now being regularly arranged, notable among which were a dramatised version of Scott's novel "Rob Roy" at Glasgow, which, as a combined reading and play, was something quite new, and unique to broadcasting, a series of operas at Birmingham, some long plays at Manchester, and the first broadcast performance of Mendelssohn's oratorio, "The Hymn of Praise," at Newcastle.

The need of some means of stating the Company's policy and announcing news of forthcoming events, in addition to publishing full details of the weekly programmes, had for some time been felt, and the result was *The Radio Times*, the official organ of the B.B.C., which was first published in conjunction with Messrs. George Newnes in September.

EXPANSION

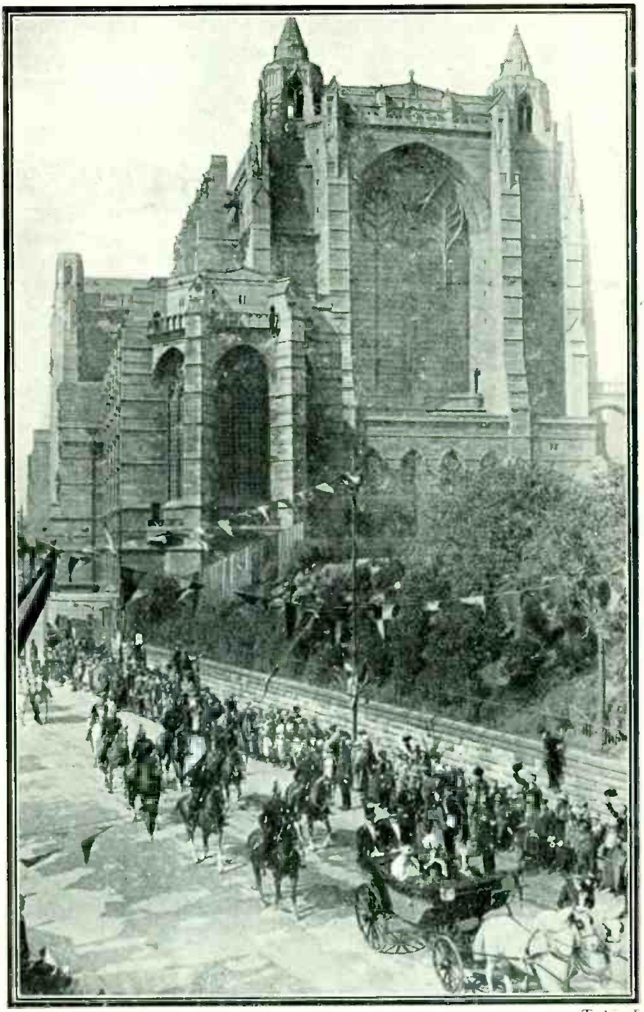
1924 While the first year of broadcasting was one of pioneering, the second year was one of consolidation, further development and definite expansion.

The Relay Station programme, started on November 16th, 1923, with the opening of Sheffield, was completed in 1924 with the opening of nine further stations as follows:—

Plymouth	March 28th.
Edinburgh	May 1st.
Liverpool	June 11th.
Leeds–Bradford . . .	July 8th.
Hull	August 15th.
Nottingham . . .	September 16th.
Stoke-on-Trent . . .	November 21st.
Dundee	November 12th.
Swansea	December 12th.

These stations worked on a power of 200 watts as compared with the power of 1½ kilowatts (1,500 watts) of the main stations, and relayed the London, Glasgow or Cardiff programmes, except in the afternoons and on one evening a week.

A ninth main station started at Belfast on September 14th, and was officially opened by the Governor of Northern Ireland on October 24th.



Topical

H.M. THE KING ARRIVING AT LIVERPOOL CATHEDRAL FOR THE CEREMONY OF DEDICATION

Another of the great events of the early days

On a purely experimental basis, a high-power, 25 kilowatt, station was started at Chelmsford on July 21st, soon famous as 5XX, from which London programmes were broadcast.

For approximately the first half of 1924 the programme development was a continuation of that of 1923. The actual hours of transmission per day per station averaged 6½. Programmes of importance include two broadcasts by His Majesty the King, the first on the occasion of the opening of the British Empire Exhibition, Wembley, on April 23rd, and the second at Liverpool on July 19th, at the consecration of the Cathedral, a series of Symphony concerts arranged at the Central Hall, Westminster, starting in February, the first service relayed from St. Martin-in-the-Fields on April 13th, and a succession of Shakespeare's plays (at the Cardiff station). A type of programme which began to be developed, and for want of a better name was called a "Feature Programme," was one which can only be described as an unseen but heard moving picture. With descriptive narrative, dialogues and episodes, with sound effects and music, the

Barratts

PREPARING FOR THE FIRST BROADCAST OF THE NIGHTINGALE

An event that captured the imagination of the country listener was taken through historic events and strange lands with a realism that was quite extraordinary. The Empire Day Programme was of this type, for listeners were not only taken round the Empire, but heard it built up. The nightingale also made its debut, and for the first time its song was carried from its natural surroundings in Surrey to the lands north of the Trent, and appealed enormously to everybody's imagination.

In the late summer and autumn, the tendency to specialisation, inevitable in any concern with so wide a field, began to have its effect.

Firstly, in August an Education Department was formed to co-ordinate the talks and lectures already being arranged at all stations both in the afternoons and evenings, and to arrange special transmissions for elementary and secondary schools. For some time past series of talks had been included by such authorities as Sir William Bragg and Sir Oliver Lodge, and on April 4th the first special school transmission, as an experiment, had been given by Sir Walford Davies.

The formation of the department had been foreshadowed as early as February 1924, when an Advisory Committee consisting of a number of experts from the various quarters of the educational world was formed in London. Similar committees were subsequently formed by the other stations, so that expression was given to opinions held in all parts of the country, and local requirements met.

The Dramatic Department was started about the same time, and was literally heralded with the thunder of guns. The new Dramatic Director, who was no stranger to the Company, having for some time been in charge at Aberdeen, was seized with a desire to make the report of a gun sound convincingly real when heard through the microphone. To the dismay of the staff, he filled in much of his time, with an accomplice, firing a shot-gun over the banisters into the well of the staircase. The microphone was, we were told, stubborn, and the resultant noise suggestive of flat champagne. In addition to this *feu de joie*, however, considerable research work was carried out in connection with the microphone technique, the finding of suitable types of plays, and sound effects. A nucleus of experienced players was collected, result-

THE ROOSTERS CONCERT PARTY—FAMOUS IN THE EARLY DAYS FOR THEIR ARMY REMINISCENCES

ing in the formation early in the next year of the London Radio Repertory Players.

Negotiations entered into during the summer with various great concert societies were brought to a successful conclusion in the autumn, and one of the strong sources of opposition thus withdrawn. The programmes included regularly the concerts of the Hallé Society, relayed from Manchester, of the Scottish Orchestral and Choral Union, from Glasgow, the City of Birmingham Symphony Orchestra, the Liverpool Philharmonic Society, and the Belfast Philharmonic Society, from the Ulster Hall. These concerts were an important addition to the broadcast programmes, and in those days of heavily damped studios and no artificial echo, the musical quality was often rather markedly better than that of the studio programmes.

Politics entered into the programmes for the second time in October, when the leaders of the three parties broadcast election speeches, the Prime Minister, Mr. Ramsay MacDonald from Glasgow on October 10th, Mr. Baldwin from the London Studio on October 16th, and the late Lord Asquith and Oxford, or Mr. Asquith as he then was, from

Paisley on October 17th. The results of the election were subsequently broadcast, until 1.15 a.m. on October 29th.

Other programmes of importance during this half-year were various speeches at public dinners, including that of the Prime Minister at the Lord Mayor's Banquet, the relay to 5XX by land-line of the opera "Le Prince Igor," from the Theatre de la Monaie, Brussels, and the reading of his play, "O'Flaherty V.C.," by George Bernard Shaw.

The new departments already referred to had to be housed apart, and rooms in the present north wing of the building at Savoy Hill were taken. Entry could only be effected by going out of the front door (now the West Entrance) and walking right round to the present East Entrance. Here, after braving the caretaker's dog, and getting rather a fright from the head of a bison which was inexplicably hung on the wall in a dark passage and gave an impression of a nightmare cowshed, one found the dramatists and educationists aloof in their secluded quarters. They were followed in a few months by various details from the other departments.

INTERNATIONAL SYMPHONY CONCERTS

In addition to the many concerts relayed from outside 1924-
sources, such as those of the Hallé Society, already referred 1925
to, and symphony concerts in the Company's studios, the B.B.C. arranged a series of International Symphony Concerts at the Royal Opera House, Covent Garden. The B.B.C. Symphony Orchestra at the first four of these concerts numbered eighty, consisting of the London Wireless Orchestra as a nucleus, augmented by players from other leading London orchestras. The conductors were Pierre Monteux, Ernest Ansermet, and Bruno Walter, on December 10th, January 15th and February 12th respectively. The fifth concert was a choral performance of the musical Miracle Play, "The Pilgrim's Progress," by Edgar Stillman Kelley, conducted by Joseph Lewis, the Musical Director of the Birmingham Station. Combined with the concerts arranged at the Central Hall, Westminster, in February and March, these concerts were the first which the B.B.C. undertook with the policy of giving, in addition to the works regularly included in concert programmes, performances of works which ordinarily

were not often heard, and which were beyond the compass of the studio.

MATERIAL CHANGES

1925 The most important event in 1925 was perhaps the opening at Daventry, on the Borough Hill, near the traditional site of the Dane Tree, of the High-Power Station 5XX, which replaced the existing station at Chelmsford. The official opening by the Postmaster-General, attended by the Board of Directors, various distinguished guests, including the Mayor of Daventry, and senior officials of the Company, took place on July 27th. Unique both as regards wave-length and power, 5XX filled many gaps between the existing stations, and reached out to the further parts of the British Isles, bringing into easy communication with London many of the most isolated areas. Daventry, it must be realised, has always been a transmitting station only, deriving its programmes from studios or outside sources under the control of other stations, its general destiny being managed in London, its local staff being responsible for the technical side of its programmes only. A small studio was actually provided on the Daventry premises, but it was never anticipated that it would be put to regular use.

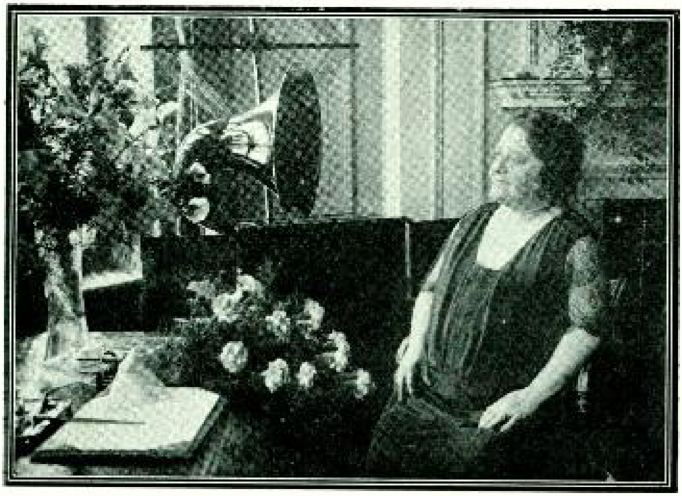
Another similar change was the erection of a new 2LO London transmitter in Oxford Street, in place of the old one at Marconi House, which, however, still remained in service order as a stand-by for emergency or experimental work. This new transmitter was double the power of any other main station transmitter, being 3 kilowatts, and the service area, in view of this and the increased efficiency in design and construction, was very considerably enlarged.

The question of accommodation for some time had been a cause for anxiety. Demand for space had long outgrown the supply. Studios which originally had been considered large would now barely contain an orchestra augmented for symphony work. Manchester's Dickinson Street offices and studios became almost intolerable. Reached by a luggage lift and in reality the top floor of a warehouse, the studio was so small that when an orchestra chorus and soloists were employed simultaneously, the door had almost to be closed forcibly upon the last entrant. The Newcastle premises also were equally inadequate. New premises were found, therefore, and occupied, with great relief to all concerned, at Manchester on December 12th, 1924, at Newcastle on December 23rd, 1925, and at Birmingham on January 20th, 1926. The Manchester premises, though much larger, were rather grim, being three floors below street level and facing the River Irwell, at this place at all events not an attractive stream. The Newcastle building was very pleasant, incidentally having been built in the eighteenth century as a maternity home, and the studio for a glorious month had the honour of being the largest in the country. It was outstripped by Birmingham, where the specially built studio, a blaze of blue and gold, would contain two, three, or even four, of the studios at most of the other stations. Cardiff had already moved in 1924 to better quarters in Park Place, and in December 1925 these same quarters were enlarged. Lastly,

Sport and General

A GROUP AT THE OPENING OF DAVENTRY STATION (5XX)

Sir William Bull, Capt. Eckersley, Lord Gainford, Sir W. Mitchell-Thomson (Postmaster General) and Mr. (now Sir John) Reith



TETRAZZINI IN HER LONDON HOTEL DURING HER SPECIAL VISIT TO ENGLAND FOR BROADCASTING

Savoy Hill, which had sent out colonies some time before, extended northward, and three new studios were added, two of medium size and a small one for talks. These and various new offices were in the north-west corner of the Savoy Hill building, which had been demolished in the war by an aerial torpedo, but in the early autumn of 1925 was rebuilt to suit the B.B.C.'s requirements. The new studios had an improved system of ventilation, which was subsequently fitted to the larger original studio; the sound-damping curtains were also made adjustable, being suspended on runners, and were lighter in weight and effect.

PROGRAMME DEVELOPMENTS

1925 A service of alternative programmes was instituted in the New Year (actually on Monday, December 28th, 1924), when 5XX (still at Chelmsford) transmitted programmes in contrast to those of all other stations on Tuesdays, Thursdays and Saturdays in each week. On Tuesdays and Thursdays the programme, though in contrast to that of London 2LO, was derived from a London studio, but on Saturdays was provided in rotation by the eight original main stations. Belfast was excluded owing to the effect of the submarine cable between Scotland and Ireland on programmes relayed in either direction.

The 5XX Weather Forecast at 10.30 a.m., and the Shipping Forecast after the News in the evenings, was started as a daily service on July 5th, and owing to the great range of the station, shipping all round the British coasts have continuously made good, and often vital, use of these forecasts. Gale warnings, given out at the first possible moment, and in reality supplements to the standard forecasts, have on several occasions been known definitely to have saved ships from disaster.

Experimental transmissions for amateur wireless engineers were started on March 2nd. These transmissions were weekly, and outside the normal programme hours. Entirely technical, they were undertaken by all the B.B.C. stations in turn, and among other diversions, consisted of periods of transmission at half power, three-quarter power, full power, over-modulation and so on.

During the autumn, the B.B.C. service of time signals was included in the Admiralty List by the Astronomer Royal, and the B.B.C., to guarantee the service, arranged for the superimposition of the Greenwich dot seconds on any programme which overran its time and trespassed on the time signals included in the list.

By the end of 1925, the programme hours for London and most other stations averaged over ten each week-day, and for Daventry, 5XX, over eleven.

The Radio Supplement, now known as *World-Radio*, appeared for the first time on July 17th. For a long time, at first a column and then a page had appeared in *The Radio Times* showing wave-lengths, call signs, and programmes, of Continental stations, but lack of space and the tendency of this feature to grow made it necessary to issue it separately.

At the risk of including rather a tiresome catalogue, mention must be made of other important programme events of the year 1925. Chief in importance is one further occasion on which H.M. the King broadcast at the opening of the

CHALIAPINE IN THE LONDON STUDIO

second year of the British Empire Exhibition at Wembley. A number of great artists made their first appearances before the microphone: John Barrymore on March 8th, Tetrazzini on March 10th in a concert provided by the *Evening Standard*, Paderewski on March 15th, Chaliapine on November 3rd, and Sir Harry Lauder on December 23rd. On May 15th Mr. Alan Cobham gave Miss Heather Thatcher a flying lesson in an aeroplane over London which was transmitted from the aeroplane, and received and re-radiated from the Company's stations. The Railway Centenary was celebrated with a special programme on June 25th, in which an actual broadcast of a train leaving King's Cross, and from the same train twenty-five minutes later, was included. A microphone for the latter was carried in the front of the locomotive's tender, and a special transmitter housed in a van at the front of the train. A descriptive transmission from a coalmine at Sheffield on June 27th included the actual relay from points underground of explanations and demonstrations of a coal-cutter, a shot-borer, an explosion of shot, a fall of coal, the filling of tubs, the noise of trains and the signalling apparatus of cages. While not actually the first transmission from the bottom of a coal-mine, for a concert had been relayed from a pit at Normanton in 1924, it was the first transmission of its kind combining genuine information with a novelty value. Another broadcast from the air on November 13th consisted partly of a concert from an aeroplane near Croydon, and partly of a practical demonstration of Direction Finding by the late Captain Hinchcliffe.

During the summer concerts were relayed from practically every seaside resort of importance in the country, the Outside Broadcast Engineers consequently being more than usually busy.

A Musical Advisory Committee was formed during the summer of 1925, and has met at regular intervals ever since.

BROADCASTS FROM THE THEATRES

With the exception of the Opera transmissions from the Old Vic, the International Opera Syndicate's Seasons at the Royal Opera House, Covent Garden, the B.N.O.C. seasons in London and in the Provinces, and the various Ballet seasons at Covent Garden, relays of performances from theatres, for reasons already explained, had been very few and far between. During the two years from June 1st, 1923, to May 31st, 1925, such relays had amounted to not more than a dozen and a half, of which eight only had been of the genus "Musical Comedy" or "Revue." In the early summer of 1925, however, negotiations were successfully concluded with the Theatrical Managers' Association, and an agreement come to whereby the B.B.C. could relay once in every fortnight an excerpt from a theatre lasting for half an hour. The B.B.C.'s earliest contentions were soon vindicated, for not only were these excerpts, judiciously chosen and prepared for the microphone with the greatest care by everyone concerned, successful as parts of the broadcast programmes, but, as box office returns showed, were invaluable as attractions to the theatres themselves.

THE LAST YEAR OF THE COMPANY

1926 The importance of broadcasting as a national service was emphasised to an extraordinary degree by the General Strike

MINERS AND RAILWAYMEN WAITING FOR THE B.B.C.'S NEWS BULLETINS in May 1926. When most other forms of communication were almost at a standstill, and newspapers in the ordinary sense non-existent, the B.B.C. carried on, in addition to its normal activities, an all-day service of news and general information which not only served to clear the fog of complete isolation which threatened to cloak the movements of the nation, such as they were, but proved invaluable in steadying nerves which otherwise might have communicated panic. The Bulletins issued throughout those days, at 10 a.m., 1 p.m., 4 p.m., 7 p.m. and 9.30 p.m., contained news from the usual agencies, notices from various Government Departments, and railway information of every kind. The copyright usually reserved by the News Agencies was for the period of emergency waived, and consequently the broadcast bulletins were re-diffused to the nation by every means possible. Every street in every city, town or village had a sheet of paper displayed with the latest broadcast news, and the B.B.C. was in addition bombarded with appeals for information and assistance without ceasing. At such a time it was of the greatest importance that the nation as a whole could be spoken to in intimacy by the Prime Minister and the Home Secretary, and, in the period of settlement which followed, by the Rt. Hon. J. H. Thomas, M.P.

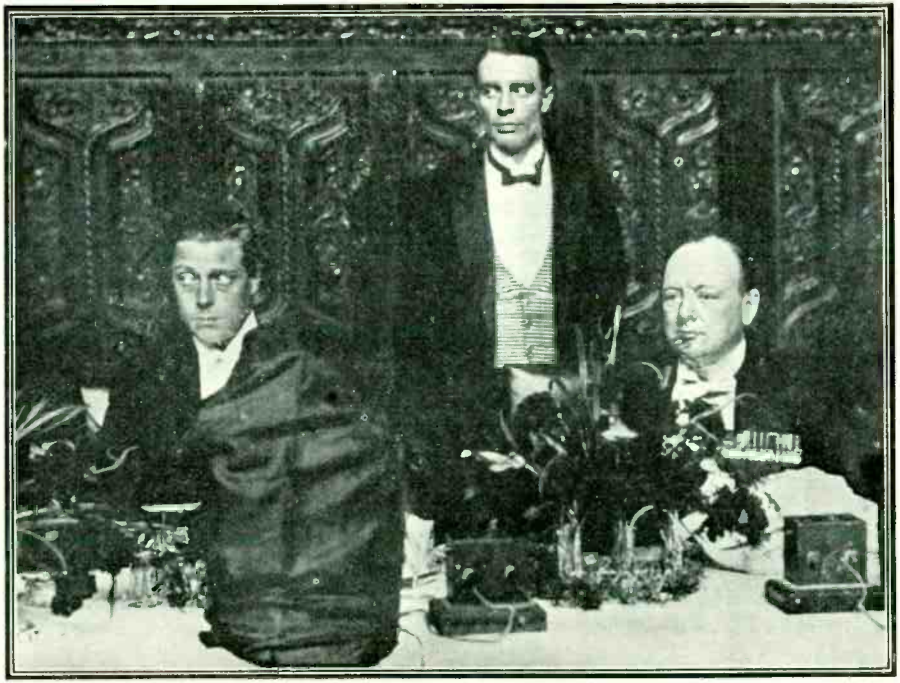
What has been described as the greatest musical achievement of the B.B.C. was the presentation at the Royal Opera House, Covent Garden, on March 30th, 1926, of a concert performance of the opera "Kitesh" by Rimsky-Korsakov, conducted by Albert Coates, which was the first, and so far the only, performance of the work in this country. Three series of public concerts were arranged during 1926. The Spring series of Chamber Concerts at the Chenil Galleries, Chelsea; and, in the succeeding autumn and winter, the International Series of Chamber Concerts at the Grotian Hall, and the 1926–1927 series of National Symphony Concerts at the Royal Albert Hall. The National Orchestra, as the B.B.C. Symphony Orchestra was called, was of unusual size, numbering 150 players, of whom 100 were strings. Conductors at the concerts in the period under review were Sir Hamilton Harty, Mr. Albert Coates, Herr Richard Strauss, Sir Edward Elgar and Herr Gustav Brecher.

An important innovation from the musical point of view was the introduction from 7.25 to 7.40, in place of the hitherto rather nondescript interlude between the talks, of a series of progressive musical recitals. Starting on January 4th, these recitals ran in groups of one or two weeks, each being devoted to the works of one composer by an individual artist.

On Thursday, October 7th, Evensong was relayed from Westminster Abbey. Not only was this the first time that a service had been broadcast from the Abbey, but it was the first time a service had been included in the London week-day programmes on a regular basis of any kind, for they were broadcast every Thursday afternoon at 3.0 p.m.

In a year of considerable achievement it is difficult to pick on any one programme as having been outstanding. Mention must be made, however, of the opening performance on September 20th of their London season by the D'Oyley Cart Opera Company of the "Mikado." Not only was this an almost perfect transmission, but it signalised the partial removal of the ban on the broadcasting of Gilbert and Sullivan music. Another triumph for the Outside Broadcast Department was the welcome on October 1st at Westminster to Alan Cobham on his return from his flight to Australia. Lastly, the performance on November 21st of James Elroy Flecker's play "Hassan," with incidental music by Percy Fletcher, brought wireless dramatic technique to a pitch previously unknown.

Programmes of an unusual nature, to give another catalogue, were the broadcast from the Gaumont Studios of the production of the film "Whirlpool," a second broadcast of a train leaving King's Cross Station (in connection with an Irish emigrant scene in the St. Patrick's Day Programme), the broadcasting of the Changing of the Guard at Buckingham Palace; a programme of "odd noises" which listeners were asked to identify; a talk from the bottom of the Thames near the L.C.C. building by a diver, who found little else in the river but beer-bottles, a fitting tribute to the national taste; a programme entitled "The Wheel of Time, Yesterday, To-day and To-morrow" (which, besides being intrinsically interesting, was chiefly peculiar for a reading of his own poems by Osbert Sitwell in a manner irresistibly suggestive of a machine-gun barrage); and lastly, "The Ceremony of



Barratts

THE MICROPHONE IN THE HOUSE OF LORDS

A broadcast of speeches by the Prince of Wales and Mr. Winston Churchill at the banquet to the International Parliamentary Commercial Conference the Keys" from the Tower of London. In passing, mention must be made of a series of "My Programmes" by prominent men, an attempt on the part of the B.B.C. to find out what types of programmes were popular, and to discover new ideas.

The London Radio Dance Band was formed in February, and in addition to providing dance music at times of day when it was not available from outside sources, it took part in the vaudeville programmes.

SUNDAY PROGRAMMES

1923–1926 The earliest Sunday programmes started round about eight o'clock in the evening, being usually concerts of a serious nature with an address in the middle. About March 1923, however, the address began to get separated from the concert, and a definite service arranged so that by the end of the year the Sunday programmes took on the general shape in which we find them to-day, which was an afternoon concert from 3.0–5.0, a service and address from 8.30–9.0, and a programme of music from 9.0–10.30, with a news bulletin at 10.0. From January 6th, 1924, until May 10th, 1925, there was a Children's Hour at 5.30, arranged by each main station in turn. On October 25th, 1925, the News Bulletin followed the service and preceded the concert, being read at 9.0 p.m.

On May 18th, 1923, the Central Religious Advisory Committee met in London for the first time, and was followed shortly afterwards by similar Committees at all B.B.C. stations then in existence, and thereafter as they were opened. Broadcast services were from the first without denominational bias; the committees were representative of all shades of religious opinion, and were probably unique as being regular meetings, without doctrinal discussion, of the representatives of the Established and Nonconformist Churches. As far as possible no broadcasting took place during the hours of evening church services, the exceptions being when church services were themselves broadcast.

The evening programmes were usually of a definitely popular nature, such as music by De Groot and the Piccadilly Orchestra, or Albert Sandler and the orchestra from the

Grand Hotel, Eastbourne, but concluded on a religious note with a specially chosen item, which on September 26th, 1926, was given a definite status and called the "Epilogue."

Appeals formerly had been given on week-days at various times, but after January 24th, 1926, under the title "The Week's Good Cause," they followed the Sunday evening service, lasting five minutes.

BROADCASTING AND THE PRESS

Before it had been decided that broadcasting in Great 1922–
Britain should be under a single control, certain people in 1926
the newspaper world had contemplated entering the new field and operating stations in conjunction with their existing activities. When it was known that a single organisation was to be formed, the newspapers united to protect themselves against any damage which it might do them. The first result of this move was that an agreement was concluded with the P.M.G. that the yet unformed Company should only obtain its news for broadcasting through the agencies which worked for the newspapers, that such news should be broadcast as prepared by Messrs. Reuters, and further that the first of the two bulletins should not be broadcast earlier than 7 p.m. This arrangement was in force throughout the life of the Company.

The general attitude of the Press to broadcasting cannot be described as ever having been cordial, although it has fluctuated between definite hostility and mere watchfulness. Almost from the beginning, broadcasting intelligence has been freely included in the papers, together with the daily programmes; at the outset an attempt was made to exact payment for the space occupied by these, but the sales of the only journal which at the time was including them increased so markedly that the matter was dropped. From time to time large-scale attacks on the B.B.C. were developed, the usual *casus belli* being the character and standard of the programmes, and many letters of complaint, and, in justice be it said, some of appreciation, filled the correspondence column. A proportion of the criticism was usually constructive, and the B.B.C. and the listening public profited thereby.

At the end of 1924, and for some eighteen months subse-

THE MICROPHONE IN DOWNING STREET

A broadcast on behalf of the late British National Opera Company, which took place during Mr. J. R. Clynes' residence at 11 Downing Street

quently, the B.B.C. and the Press co-operated to a certain extent as permitted under the revised regulations issued by the P.M.G. after the Sykes Committee Report had been considered. Certain newspapers provided programmes to the B.B.C., who, in return for such free material, broadcast a courtesy acknowledgment. These "provided" programmes were regarded by the B.B.C. as a temporary measure while funds were rather short, and with an increase in revenue and an improvement in relations with the Press, it was decided that only entertainments organised by them in the ordinary way should be considered, and handled as normal Outside Broadcasts.

FINANCE

It has already been said that the authorised Share Capital of the Company was £100,000, of which shares to the value of

£71,536 were issued. The Directors, early realising that the service must ultimately pass out of trade control, resolved on a policy that would enable the undertaking to be transferred to a Public Body unencumbered by capital liabilities when the Company's licence expired. This policy was carried out successfully. At 31st December, 1926, permanent assets had been acquired at a cost of £334,788 wholly out of revenue, and liquid assets had been reserved sufficient to pay all liabilities in full, including issued Share Capital, on the Company going into voluntary liquidation. As a result, the undertaking was handed over to the Corporation at no cost whatever to the State.

It is difficult to realise the magnitude of this achievement, but it may be an aid in appreciating it to know that the total net revenue of the Company throughout its existence was only £1,979,000, of which the Capital Reserve thus accumulated represents approximately 17%.

THE CRAWFORD COMMITTEE

In conclusion, it is appropriate to mention the Committee, 1925–
which was set up in the summer of 1925 under the Chairman- 1926
ship of the Earl of Crawford and Balcarres to consider the future of British broadcasting with reference to the expiry of the Company's licence on December 31st, 1926. It has been described how, born of the wireless trade, the B.B.C. had, still under a Board of Directors representative of the trade, become a public utility concern, financially independent of it and in policy unfettered by it. The interests of both were largely served by the same ends, for an increase in listeners meant both an increased revenue to the trade by the sale of sets, and to the B.B.C. through the issue of licences. The Crawford Committee submitted its report early in 1926, and while warmly commending it for its policy and its achievement, recommended the winding up of the Company and the constitution in its place of a public authority, thus ensuring a continuity of the policy of public service and impartiality initiated by the Company.

THE B.B.C.'S POST-BAG IN THE EARLY DAYS

THE END

While no change or pause was apparent to the listening public, the British Broadcasting Company, Ltd. came to an end after a strenuous and successful life at midnight on New Year's Eve 1926.

In its four years the Company had started from the very beginning, had been subjected to the most merciless criticism, had been faced with much determined opposition, and had submitted twice to vivisection at the hands of Government Committees, and emerged scathless.

Its achievements are marked by no memorials. It can only be said that the Company retained and increased the good-will of its listeners until at the end of its time the number of licences had steadily risen to just under two and a quarter millions.

THE RANGE OF BROADCASTING

A LIST SELECTED FROM THE PROGRAMMES BROADCAST BY THE OLD B.B.C.

NOVEMBER 15th, 1922—DECEMBER 31st, 1926.

NOVEMBER 1922.

15. First Programmes broadcast from the London, Birmingham and Manchester Stations.
25. First Orchestral Programme.

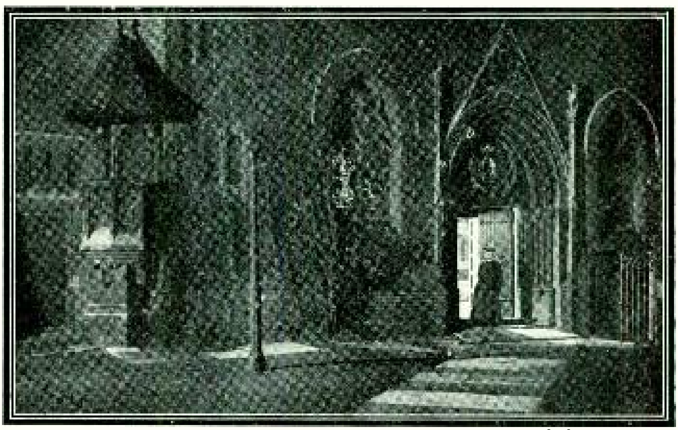
DECEMBER 1922.

11. First Vocal Quartet Programme.
23. First Children's Hour.
First General News Bulletins.
First Talk.
First Appearance before Microphone of a celebrated actor or actress from a current London Production. (Miss José Collins singing "The Mirror Song" from "The Last Waltz" at Daly's Theatre.)
24. The Newcastle Station opens.
First Religious Addresses (the Rev. J. A. Mayo, M.A., Rector of Whitechapel).

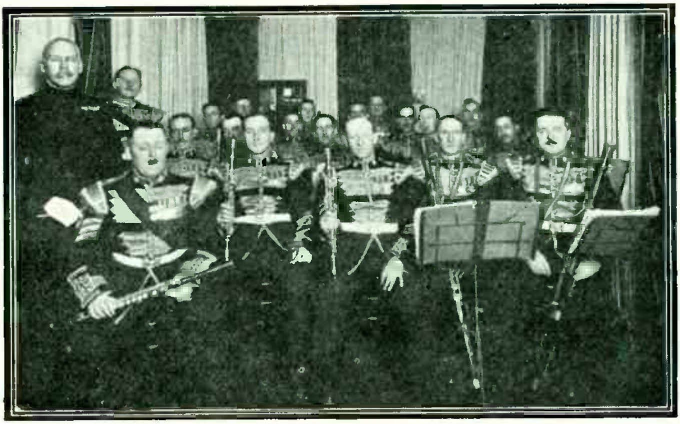
JANUARY 1923.

8. First Outside Broadcast.*
First Opera Transmission.*
First B.N.O.C. Performance.*
First broadcast from Royal Opera House, Covent Garden.*

*"The Magic Flute" (Mozart).



ST. MARY'S, WHITECHAPEL, AND THE REV. J. A. MAYO WHO BROADCAST THE FIRST RELIGIOUS ADDRESS



THE CROWDED STUDIO CONDITIONS IN THE OLD DAYS

The Irish Guards Band in the Dickinson Street studio at Manchester

14. First Chamber Music Concert.
23. First Military Band Concert (Band of H.M. Irish Guards).
25. First O.B. After-Dinner Speeches.*
First O.B. Concert.*
29. First Radio Society Talk by the President, Admiral of the Fleet Sir Henry Jackson.
30. First Variety Programme (the Veterans of Variety).

FEBRUARY 1923.

2. Cardiff Station opens.
9. First talk on Music, by Mr. Percy Scholes.
12. First Theatre O.B. Pantomime "Cinderella" relayed from the London Hippodrome.
16. First Dramatic Transmission. Quarrel Scene, "Julius Caesar" (Shakespeare).
First Technical Talk, by Prof. J. A. Fleming.
17. First Broadcast Appeal: the Winter Distress League, by Ian Hay.
20. First General Wireless Talk, by Sir Oliver Lodge.
22. First Zoo Talk by L.G.M. of the *Daily Mail*.
First Boy Scouts' Talk.
First Wireless Debate: "That Communism would be a Danger to the Good of the People." Proposed by Sir Ernest Benn, opposed by Mr. J. T. Walton Newbold, M.P.

MARCH 1923.

2. First Morning and Afternoon Programmes.
3. Glasgow Station opens.
9. First reading of a Short Story, by Mr. Gilbert Frankau.
26. First O.B. of incidental music to a

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*Speeches and Concert at "Burns Night" Dinner at Princes Restaurant. Mr. G. K. Chesterton proposes "The Immortal Memory."

film ("Robin Hood" at the London Pavilion).
First Dance Music Programme.
First Weather Forecast.
30. First O.B. from a Church ("St. Matthew Passion" from St. Michael's, Cornhill).

APRIL 1923.

13. First Studio Broadcast by Savoy Havana Band.
20. First Sports Talk: "The Football Cup-tie."
21. First Summer Time Warning Talk: "Alter Your Clocks."
26. First Appearance in Studio of Theatrical Company. "The Co-optimists."

MAY 1923.

1. Opening of Savoy Hill Studios.
First of 10.0 P.M. Evening Talks, inaugurated by Lord Birkenhead.
2. First of Afternoon Talks for Women, inaugurated by H.R.H. Princess Alice, Duchess of Athlone.
24. First O.B. Dance Band. The Carlton Hotel Dance Band.
28. First Long Play: "Twelfth Night" (Shakespeare).

JUNE 1923.

6. First Eye-witness Narrative of Sporting Event: "My Impressions of the Derby," by Mr. Edgar Wallace.
16. First Regular (weekly) Musical Criticism, by Mr. Percy Scholes.
First Symphony Concert, conducted by Percy Pitt.

JULY 1923.

1. First Sunday Afternoon Concert.
11. First Regular (weekly) Film Criticism, by Mr. G. A. Atkinson.

THE LATE GENERAL BOOTH BROADCASTING FROM TRAFALGAR SQUARE

13. First Wireless Man Hunt.
15. First O.B. Organ Recital, from Æolian Hall.
16. First Request Programme.
27. First Regular (weekly) Dramatic Criticism by Mr. Archibald Haddon.

SEPTEMBER 1923.

3. First Regular (weekly) Literary Criticism, by Mr. John Strachey.
12. First O.B. of Speeches at the British Association Meeting.
18. First O.B. of Ballet Music, Pavlova Season, from Covent Garden.

OCTOBER 1923.

2. First Broadcast by Duke of Connaught and Dominion Premiers.
3. First O.B. of Savoy Hotel Dance Bands.
6. First Dramatised Performance of a novel, "Rob Roy" (Sir Walter Scott). (Glasgow.)
10. Aberdeen Station opens.
11. First complete Studio Opera, "Il Trovatore" (Verdi). (Birmingham.)
14. First Oratorio, "The Hymn of Praise" (Mendelssohn). (Newcastle.)
17. Bournemouth Station opens.
18. First Concert Party: the Roosters.
25. First O.B. Opera relayed from "Old Vic." Garden Scene from "Faust" (Gounod).

NOVEMBER 1923.

1. First O.B. from Westminster Cathedral (Organ Recital).
9. First O.B. Speeches from the Lord Mayor's Banquet. The Prime Minister at the Guildhall.
8. First Programme Broadcast in Welsh. (Cardiff.)

Barratts

THE FIRST BROADCAST BY ARCHBISHOP LORD DAVIDSON, THEN ARCHBISHOP OF CANTERBURY

11. First Broadcast Armistice Ceremony.
14. First B.B.C. Birthday Programme. Concert by staff.
16. Sheffield Station opens.

DECEMBER 1923.

6. First Broadcast of Election Results (until 1 a.m. Dec. 7th).
23. First Broadcast of "The Messiah" (Handel).
26. First Broadcast Pantomime. (Birmingham.)
30. First Landline relay of Continental Station. Programme from Radiola Station, Paris.
31. First Broadcast by His Grace the Archbishop of Canterbury.

JANUARY 1924.

25. First O.B. Burns Memorial Celebrations, from Poosie Nancy's Inn, Mauchline, Scotland. (Glasgow.)
28. First Comic Opera, "The Dogs of Devon."
29. First Broadcast Mock Trial, arranged by Ernest Thesiger.
31. First Talk of series "From My Window" by Philemon.
First Adventure by A. J. Alan, "Jermyn Street."

FEBRUARY 1924.

12. First French Talk, by M. Stèphan.
22. First O.B. B.B.C. Symphony Concert, of a Series of Six at the Central Hall, Westminster.

MARCH 1924.

6. First Poetry Reading, by John Drinkwater.
16. First O.B. Service from Llandaff Cathedral. (Cardiff.)
28. Plymouth Station opens.

APRIL 1924.

4. First Special Transmission for Schools, by Sir Walford Davies.

PLACING THE MICROPHONE ON THE ROOF OF BOW CHURCH

Bow Bells were broadcast on the morning of Christmas 1925 as well as on other occasions

AT CARDIFF STATION'S SUNSHINE CARNIVAL AT WESTON-SUPER-MARE

13. First O.B. Service from St. Martin-in-the-Fields, and address by the Rev. H. R. L. Sheppard.
16. First Royal Horticultural Society Bulletin.
19. First Appearance before Microphone of Film Stars: Mary Pickford and Douglas Fairbanks.
23. First Broadcast by H.M. the King and H.R.H. the Prince of Wales. Opening of British Empire Exhibition, Wembley.
27. First O.B. Concert by De Groot and the Piccadilly Orchestra.

MAY 1924.

1. Edinburgh Station opens.
13. Speeches at the Reception of T.M. King and Queen of Roumania at the Guildhall, London.
15. First Greek Play, Sophocles' "Antigone." (Glasgow.)
19. First Broadcast of the Song of the Nightingale, from a wood in Surrey.
27. Speeches at the Reception of H.M. King of Italy at the Guildhall, London.
29. First O.B of Church of Scotland General Assembly. Speech by the Lord High Commissioner. (Edinburgh.)

JUNE 1924.

11. Liverpool Station opens.
30. First Broadcast of Malines Carillon, relayed from Belgium by landline.

JULY 1924.

1. First Broadcast After-Dinner Speech, by H.R.H. the Prince of Wales, at the Dominion Day Dinner, Hotel Cecil.
8. Leeds Station opens.
19. Speech by H.M. the King at the St. George's Hall, on the occasion of the Consecration of Liverpool Cathedral.

First Broadcast by His Grace the Archbishop of York at the Consecration of Liverpool Cathedral.
21. First Programme from Chelmsford 5XX High Power Station.
27. First Appearance of the original (2LO) Wireless Military Band.

AUGUST 1924.

5. First O.B. Welsh National Eisteddfod: Crowning the Bard, by H.R.H. the Prince of Wales. (Cardiff.)
7. "To-day's Chess Move." First of series August 7th to September 2nd.
15. Hull Station opens.

SEPTEMBER 1924.

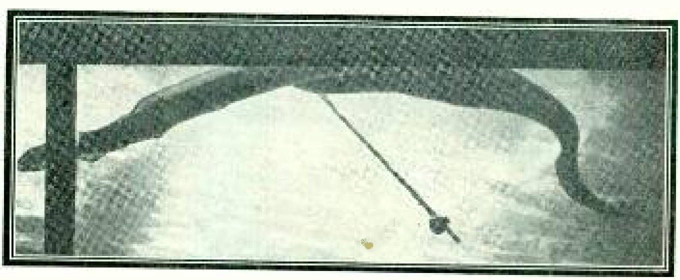
13. First Radio Garden Party, arranged by the Cardiff Station at the Sophia Gardens.
14. Unofficial opening of the Belfast Station.
16. Nottingham Station opens.
29. First Broadcast of Barrel Organ, in Feature Programme "Sportsmen All."

OCTOBER 1924.

3. First O.B. from the Zoological Gardens, London.
First Technical Talk by Ministry of Agriculture, inaugurated by Rt. Hon. Noel Buxton, M.P.
5. First Broadcast by the Chief Rabbi.
7. First O.B. Concert by City of Birmingham Symphony Orchestra, conducted by Adrian Boult. (Birmingham.)
13. First Election Speech. The Prime Minister, the Rt. Hon. J. Ramsay MacDonald, M.P. (Glasgow.)
16. First O.B. Concert by the Hallé Orchestra, conducted by Hamilton Harty. (Manchester.)
17. First O.B. Concert by Belfast Philharmonic Society, conducted by E. Godfrey Brown. (Belfast.)
21. Stoke Station opens.
24. Official opening of the Belfast Station by the Governor of Northern Ireland, His Grace the Duke of Abercorn. Concert at the Ulster Hall. (Belfast.)
27. First Broadcast Talk containing instructions to Voters.
29. Election Results Broadcast.

NOVEMBER 1924.

10. First Running Commentary on the Lord Mayor's Show.
Prime Minister's speech at the Lord Mayor's Banquet.
18. First O.B. Concert by the Scottish Orchestra (Glasgow), conducted by Felix Weingartner.



AN UNDER-WATER BROADCAST FROM THE ZOO

A conger eel swims past the hydrophone

A FLASHLIGHT PHOTO OF THE MICROPHONE IN A COAL-MINE

Note the glow of the miner's lamp at the speaker's feet

20. George Bernard Shaw reads his play, "O'Flaherty, V.C."
26. First Wireless Relay of American Station, KDKA.
27. First Wireless Relay of Continental Programme, Brussels station.
28. First Concert relayed from a Pit bottom—1500 feet deep—at the Whitewood Collieries, Normanton. (Leeds.)

DECEMBER 1924.

10. First of 1924–1925 Season B.B.C. International Symphony Concerts, at the Royal Opera House, Covent Garden.
12. Swansea Station opens.
15. Broadcast of the opera "Le Prince Igor" (5XX only), relayed from the Théâtre de la Monnaie, Brussels.
24. First Broadcast from "Somewhere in London" of Carols and Waits.

JANUARY 1925.

15. First O.B. of Cabaret: The Midnight Follies at the Hôtel Metropole.

FEBRUARY 1925.

1. First O.B. Concert by Newcastle Philharmonic Society. (Newcastle.)
20. First Weekly list of Market Prices for Farmers.

MARCH 1925.

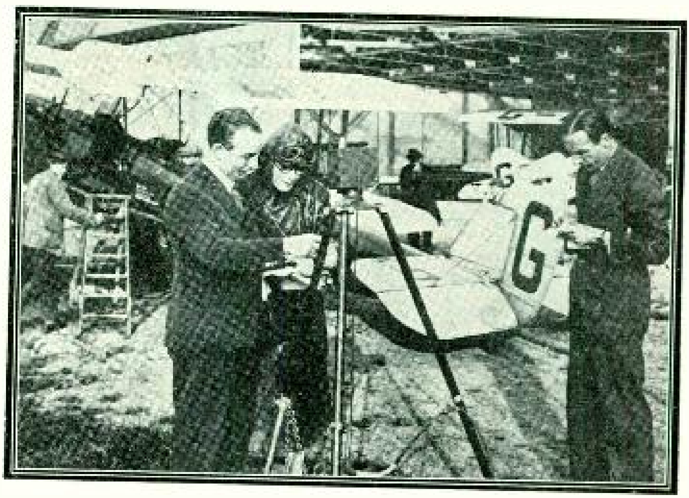
2. First Experimental Transmission for Amateur Wireless Engineers.
4. First O.B. Concert by the Bristol Symphony Orchestra (Cardiff), conducted by Eugene Goossens.
10. First Concert provided by a newspaper, the *Evening Standard*.
First O.B. Concert by the Liverpool Philharmonic Society (Liverpool), conducted by Granville Bantock.
11. First Special Radio Revue, "The 7.30 Revue." (Manchester.)
15. Pianoforte Recital by Paderewski.

APRIL 1925.

18. First Broadcast Crossword Puzzle (Musical Programme). (Bournemouth.)
22. First O.B. Concert from a ship, Cunard Line s.s. "Samaria" in Dock at Liverpool.
23. First O.B. of Bells from Buckfast Abbey. (Plymouth.)

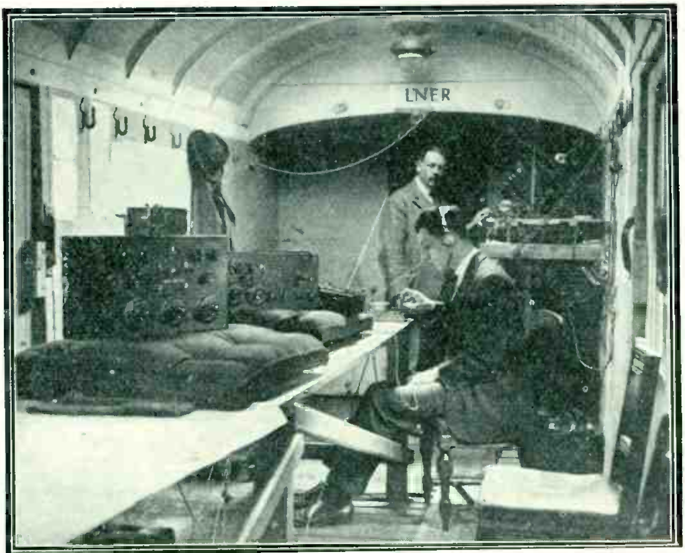
MAY 1925.

2. First Broadcast by H.R.H. the Duke of York at Royal Academy Banquet.
3. First Broadcast from York Minster. "Military Sunday." (Leeds.)
9. First O.B. Community Singing Concert from Royal Albert Hall, London.
14. First Broadcast Acrostic (Musical Programme). (Glasgow.)
15. First Broadcast from an aeroplane. Mr. Alan Cobham teaches Miss Heather Thatcher to fly.
19. First Speeches from the General Assembly of U.F. Church of Scotland.
22. First Broadcast Auction: the Earl of Carnarvon's Art Treasures sold at Christie's.



A BROADCAST FROM AN AEROPLANE

Sir Alan Cobham and Miss Heather Thatcher at the microphone before going up for a lesson in flying



Photopress

A BROADCAST FROM A TRAIN, "THE FLYING SCOTSMAN"

JUNE 1925.

1. First O.B. of Dunmow Flitch Trial, at Ilford. Judge, G. K. Chesterton.
3. First O.B. from one of H.M. Ships. Programme from H.M.S. "President" in the Thames.
5. First O.B. Service from Canterbury Cathedral. Orlando Gibbons Commemoration Service.
First O.B. of Royal Tournament, Olympia.
16. First O.B. of Aldershot Command Searchlight Tattoo.
27. First Descriptive Transmission from a Coal Mine at work. (Sheffield.)
29. First Broadcast by H.R.H. Prince Henry.
30. First O.B. from Railway Station: Scotch Express leaving King's Cross.
First Broadcast from a railway train, Scotch Express at 70 m.p.h.

JULY 1925.

21. First Broadcast by H.R.H. Princess Mary Viscountess Lascelles opening Mary Sumner House.
27. Daventry 5XX Station opens.
28. First O.B. from Grand Hotel, Eastbourne, by Albert Sandler.

AUGUST 1925.

3. First seaside O.B. Concert Party on the Wellington Pier, Great Yarmouth.

SEPTEMBER 1925.

7. First O.B. from League of Nations Assembly, Geneva. Presidential Address by M. Painlévé.
9. First O.B. Three Choirs' Festival, at Gloucester.

"POY" BROADCASTING A DRAWING LESSON FROM A STUDIO AT OLYMPIA

THE CHORUS OF "RADIO RADIANCE," ONE OF THE FIRST REVUES

The chorus actually danced in the studio on a special platform, the sound of their feet being broadcast. In later revues the sound was imitated

17. First Descriptive O.B. from Newspaper Machine Rooms, Carmelite House.

OCTOBER 1925.

1. First O.B. of opening of Nottingham Goose Fair. (Nottingham.)
4. First O.B. Service from Worcester Cathedral (Birmingham).
16. First Special weekly Broadcast to Continent. (5XX.)

NOVEMBER 1925.

5. Recital by Feodor Chaliapine.
9. First Broadcast by George Graves.
10. First Radio Military Tattoo (in Studio.)
12. First Broadcast Experiment in telepathy.
22. First O.B. Service from Truro Cathedral.
23. Opening of the Oxford Studio.
29. First O.B. from New College Chapel, Oxford.

DECEMBER 1925.

5. First "Gather-round." An Informal Programme with Donald Calthrop as compère.
6. First O.B. from Durham Cathedral. Brahms "Requiem."
7. First "My Day's Work" Talk, by a Tube Train Driver.
First Mystery Play Competition, £100 Reward. "The Mayfair Mystery."
15. "Radio Revels," arranged by all B.B.C. stations.
21. First O.B. of School Concert. End of term at Marlborough.
23. First Broadcast by Sir Harry Lauder.
27. First O.B. Carol Service from Belfast Cathedral.

AN INTERLUDE IN THE LONDON "RADIO REVEL" AT OLYMPIA

Classical dancing by students in the Faculty of Arts

30. First Drawing Lesson by W. Heath Robinson.

JANUARY 1926.

2. All England Festival of Folk Song and Dance, O.B. from Imperial Institute.
7. First Broadcast test for Shorthand Writers.

FEBRUARY 1926.

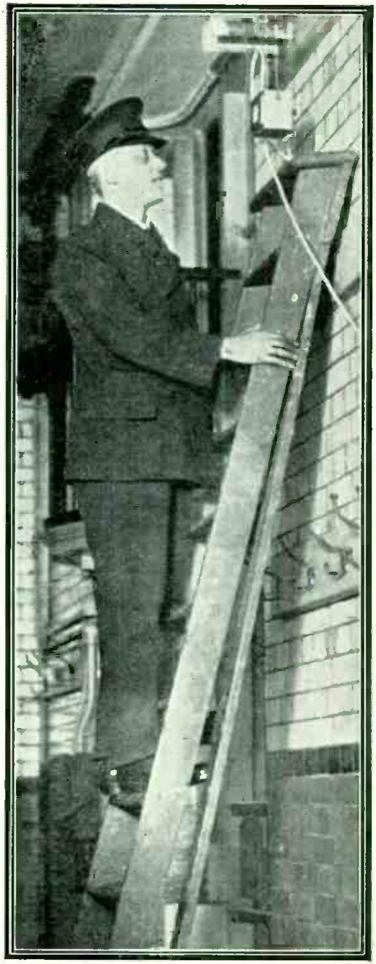
7. First O.B. by Cathedral Choir from Christ Church, Oxford.
8. First game of Musical Consequences.
16. First Broadcast by the London Radio Dance Band.
17. First Wireless Charade. Four Episodes and Solution.
22. First Broadcast of a rehearsal from a theatre: "R.S.V.P." at the Vaudeville.

MARCH 1926.

6. First descriptive Broadcast from a film studio. Production of "Whirlpool" at the Gaumont Studios.
11. First Broadcast of the launch of a ship: H.M.S. "Cornwall" at Devonport Dockyard. (Plymouth.)
17. First O.B. Carillon from Amagh Roman Catholic Cathedral. (Belfast.)
29. First O.B. of Boxing Match. Sounds of the fight, Johnny Curley *v.* Harry Corbett at the National Sporting Club.
30. First Performance in Britain of the Opera "Kitesh" (Rimsky-Korsakof), arranged by B.B.C. at the Royal Opera House, Covent Garden.

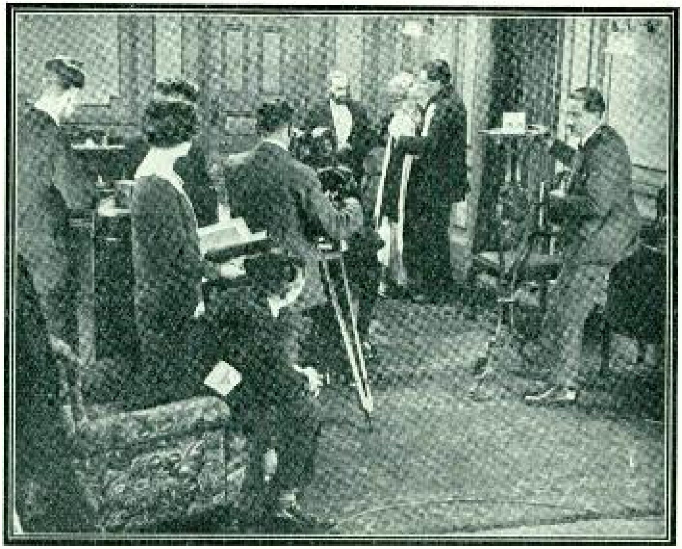
APRIL 1926.

4. First O.B. Service from Norwich Cathedral.
First O.B. Music from Southwark Cathedral.
5. First Broadcast of Changing the Guard at Buckingham Palace.
First Broadcast Dancing Lesson.



A BROADCAST FROM A FIRE STATION

Fixing the microphone near the alarm bell



A DESCRIPTIVE BROADCAST FROM THE GAUMONT STUDIOS

Fay Compton in the film "Whirlpool"

11. First O.B. Service from Chester Cathedral.
26. First O.B. of the B.B.C. Spring Series of Chamber Concerts at the Chenil Galleries.
30. First Broadcast of sounds of the sea for a Programme, from the shore at Plymouth.
31. First Programme relayed from Dublin, Irish Free State, Broadcasting Station.

MAY 1926.

2. First Broadcast of Series of "Shakespeare's Heroines."
10. First O.B. of Opera, International Opera Season, at Royal Opera House, Covent Garden: "The Marriage of Figaro" (Mozart).
23. First O.B. Service from Carlisle Cathedral. (Newcastle.)
26. First broadcast from the House of Lords. Speeches at the banquet of the International Parliamentary Commercial Conference.

JUNE 1926.

20. First O.B. Service from Lincoln Cathedral.
24. Speech by Mrs. Hubert Barclay, Central President, at the 50th Anniversary of the Mothers' Union.

JULY 1926.

5. First Broadcast from under the Thames, by a diver.
20. First Musical Debate. Classical *v.* Jazz. Sir Landon Ronald *v.* Jack Hylton.

A BROADCAST FROM THE BOTTOM OF THE THAMES

The diver ready to go down

SEPTEMBER 1926.

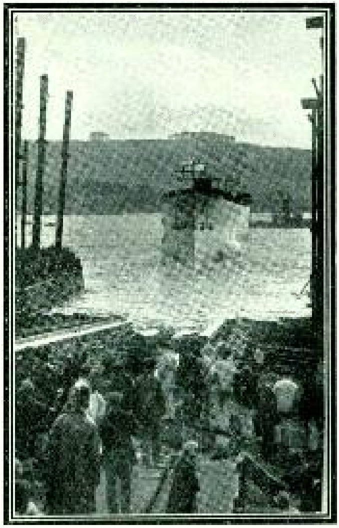
20. First O.B. of a Gilbert and Sullivan Opera, "The Mikado," Act I, at Princes Theatre.
30. First O.B. of Series of B.B.C. National Symphony Concerts at the Royal Albert Hall.

OCTOBER 1926.

1. Welcome to Alan Cobham on return from his flight from Australia, at Westminster.
5. First O.B. of the Series of B.B.C. International Chamber Concerts, at the Grotrian Hall.
12. First "My Programme," by a Man in the Street.
18. Dedication of the Organ, Liverpool Cathedral.
30. Wessex Programme, arranged in conjunction with Thomas Hardy, O.M.

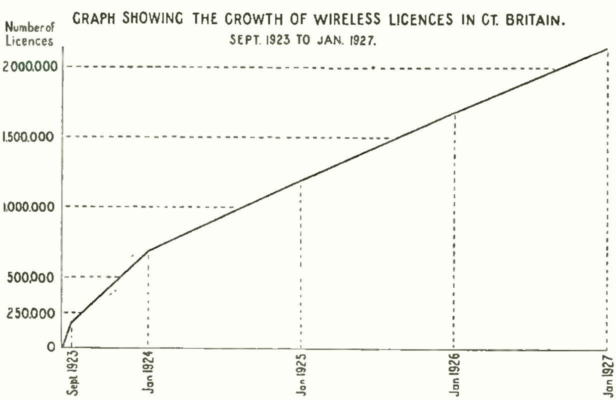
DECEMBER 1926.

9. First Broadcast of the Ceremony of "The Keys" at the Tower of London.
22. First Broadcast of the Nativity Play "Bethlehem," from St. Hilary's, Marazion. (Plymouth.)



A BROADCAST OF THE LAUNCHING OF A SHIP

H.M.S. "Cornwall" afloat at Devonport



GENERAL SECTION

THE ARCHITECT'S SKETCH OF THE PROPOSED NEW HEADQUARTERS FOR THE B.B.C. IN PORTLAND PLACE, A STONE'S THROW FROM QUEEN'S HALL

IS THERE NATURAL "WIRELESS"?

By Professor J. Arthur Thomson, M.A., LL.D.

MANY have asked the question—certainly not a foolish one—whether there may be in Nature, apart from man's interference, any analogues of "wireless." For broadcasting purposes man generates, by artificial methods, electro-magnetic radiations of enormous wave-lengths which pass through space, or, as some say, form great ether-waves. But these electro-magnetic radiations are of the same general nature as the light-waves and the heat-waves that reach us from the sun; they all travel at the same velocity—186,300 miles per second; they differ in their wave-lengths. So the question comes to be: Are there electro-magnetic waves naturally produced to which living creatures, including, of course, man, are sensitive? and the first and very obvious part of the answer is that many living creatures besides ourselves are sensitive to the ordinary light-rays and heat-rays from the sun. Some expert students of ants maintain that certain of these high-strung little creatures are visually sensitive even to starlight. But the question opens out when we notice the modern confirmation of what Lord Avebury proved long ago, that ants can *see* ultra-violet rays, which are invisible to us, though they exert a tonic influence on our health. Similarly there is no doubt that bees and some other insects are sensitive to ultra-violet rays. Thus our first proposition is this, that where there is definite evidence of electro-magnetic waves, besides ordinary heat and light, being naturally present in the immediate environment of a living creature, there is no reason to deny the possibility of the living creature sensing these waves.

Another proposition may be safely ventured, that many living creatures are in certain directions far more sensitive than man. If we put into our mouth in front of our tongue a copper and a silver coin, there is a slight electric discharge whenever the two coins touch. We notice a slightly acid taste. To a weak discharge of this kind the Hindu student is twice as sensitive as a European, but a common weed called Biophytum is four times more sensitive than the Hindu!

Man can make an instrument so sensitive to slight changes in temperature that it records the fact that someone opened a shutter in the door of the room and thrust in his warm hand; but there are many cases among living creatures of similar sensitiveness to changes in electro-magnetic vibrations. Sir Jagadis Chandra Bose, who has done such brilliant work in demonstrating the sensitiveness of many ordinary plants, records that when he was studying one day the response that a plant made to slight changes in illumination, he observed a sudden change in reactivity for which he could find no laboratory cause. But on looking through the window, he noticed that a wisp of cloud was passing across the sun! A bat seems to sense an obstacle before it touches it, and in a dark room criss-crossed with taut wires it will fly to and fro without touching any, as the absence of audible vibration proves. Or, passing to mechanical stimuli, we know that an earthworm can detect the slight vibrations of the soil produced by the light footsteps of the thrush or blackbird. So our second point is that we must be careful not to rule out a hypothesis of animal sensitiveness to physical stimuli on the ground that these are too delicate to be perceived. Man has no conception of the spider's delicacy of touch, or of the honey-bee's delicacy of smell. Man's range of sensitiveness is probably greatest of all, but along any one line he may be surpassed.

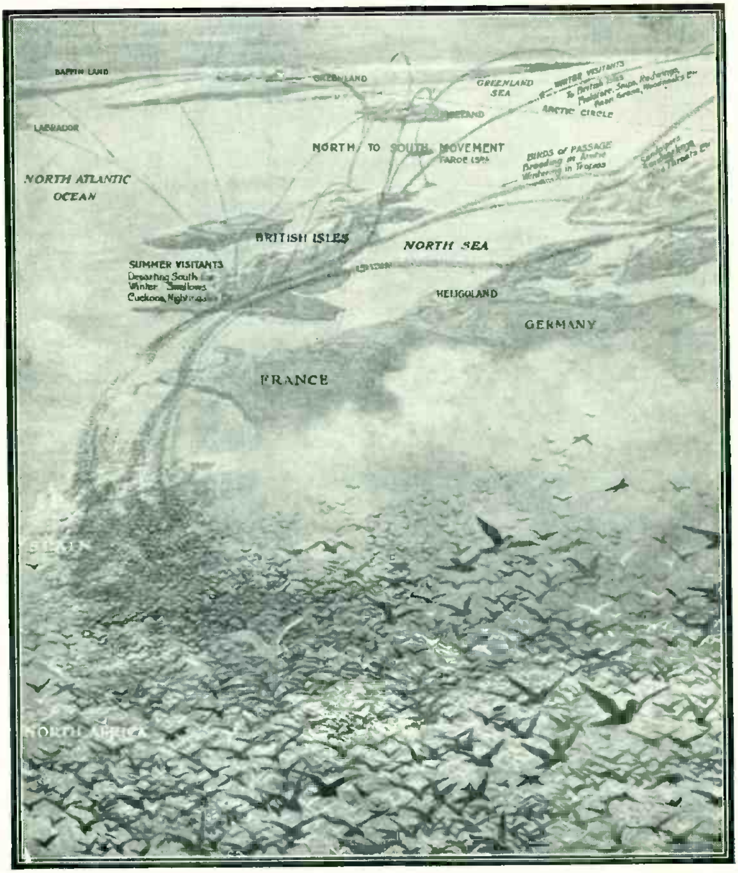
Our third proposition is that there are among living creatures various puzzling phenomena which may perhaps become less enigmatical if we admit the possibility of unusual sensitiveness to electro-magnetic radiations in space. Among these puzzling phenomena the most familiar is the way-finding exhibited by migratory birds. It has been proved that some species of terns or sea-swallows transported from their nests, in hooded cages on board ship, into regions outside their migrational range, are in some cases able to find their way home in a few hours or days, according to the distance. What clues or cues do they utilise in this distance-orientation? We may profitably separate this exhibition of orientation from a distance from the way-finding of ants and bees when they have secured their booty and turn their face homewards. For the trend of modern investigation is in favour of the conclusion that the power of way-finding at the insect level is the outcome of an individual learning of the topography of the district. The ants and bees master certain sensory cues. There are some puzzling residual phenomena; but at present it looks as if the insect's finding of its way was usually explicable in terms of enregistered experience of visual, tactile, and olfactory wayposts, and also in terms of kinæsthesia, or enregistration of muscular movements. We need not go further into this matter, but the theory of individual apprenticeship to cues does not throw much light on the fact that young swallows succeed in many cases in migrating from Britain to Africa, or on the fact that a young swallow, marked with an aluminium ring on its foot in an Aberdeenshire farmsteading, has been known to return from Africa to its birthplace the following year. Even when much is put to the credit of (*a*) social tradition—those birds leading well in 1930 who followed well in 1928 and 1929, (*b*) unrecorded tentative explorations in the air such as are suggested by the behaviour of carrier pigeons, and (*c*) the acute and extensive vision exhibited by birds, many naturalists are inclined to think that there must be sensory cues of a subtler sort, and one of the suggestions is that birds are sensitive to differences in terrestrial magnetism—a view that seems to have found some favour with Lord Kelvin. Every locality has its characteristic magnetic features ("declination" and "dip"), and the hypothesis is that migrating birds and carrier pigeons seek out the magnetic conditions that they are accustomed to in their home or homes. All we are here concerned with is that this possibility is not to be pooh-poohed as absurd. But there are obvious difficulties. Thus, (1) the "magnetic sense" has not been *proved* for any bird or for any other animal; (2) the homing of swallows from a great distance would, on the hypothesis suggested, imply sensitive appreciation of a succession of very complex magnetic diversities; and (3) "the capacity for perceiving magnetic directions would by itself be no more serviceable to a migrant than would be a compass to a human being not also possessed of a map or at least of a mental picture of the country to be traversed. The magnetic indications must not only be perceived but must also be brought into due relation with the essential geographical facts." (A. L. Thomson, "Problems of Bird Migration," 1926.)

While the magnetic sense of birds remains a mere hypothesis until it is proved experimentally that they are sensitive to changes in the magnetic conditions of their environment, there is no absurdity in the supposition; and here it should be noticed that many creatures have sensory structures whose precise function is uncertain, while others show a surprising sensitiveness to such influences as impending changes of weather, although we cannot precisely say how they are affected.

There is in some cases a remarkable sensitiveness to the phases of the moon, more, it seems, than can be readily accounted for by a correlation with the highest and lowest tides. The Atlantic Palolo worm at Tortugas spawns by breaking off the posterior part of its long narrow body, and it does this punctually within three days of the moon's last quarter between June 29 and July 28. The Pacific Palolo at Fiji and Samoa does the same at full moon in October or November. The Californian Smelts, called Grunions, wriggle out on the sandy beaches exactly at high tide on the second, third and fourth nights after the highest tides in Spring, usually in April. The little green Convoluta worms of the flat beach of Roscoff come up whenever the tide goes out, and sink into the sand again at the first splash of the returning flow; and they will continue doing this for a week at the appropriate time when transferred to the tideless aquarium of the laboratory. Of course the problem in this and in many other cases is complicated by the establishment of a bodily rhythm to which the environmental change is only the trigger-puller.

If the young Loggerhead Turtle, just hatched out of the egg, be placed in a deep tub, it moves in all directions tentatively. But if it is placed on the bare sand in which the eggs were laid, or on the tub turned upside down, it moves towards the sea. It is constitutionally wound up to do so, and Parker's careful experiments have proved that while it has a constitutional preference for blue colour and for going down a slope rather than up, its main inborn bias is to move towards the more open horizon, which usually means the sea.

It is unprofitable to consider telepathy *in this connection*, for to bring it in here would imply a mixing up of two sets of formulæ. We have been discussing the sensory discrimination



DRAWING ILLUSTRATIVE OF THE MIGRATION ROUTES OF BIRDS of electro-magnetic vibrations, such as those of "wireless," but telepathy means the immediate affection of one *mind* by another *mind*, and *not* by means of the sense-organs. Moreover, apart from electric fishes, no animal is known to give off radiations. It would be very profitable, however, to consider cases of human hyper-æsthesia, *i.e.* of exaggerated sensitiveness to sensory stimuli, which *might possibly be* electro-magnetic. Here should be considered, for instance, the alleged hyper-æsthesia of "dowsers" and metal-finders. But this cannot be shortly dealt with. Of even greater interest is the possible stimulation of living creatures by the small amount of gamma radiation present in Nature. Perhaps there is enough to serve as a trigger-puller to new departures or variations—the raw materials of possible evolution. So our final proposition is, that we must be careful not to close the door on the suggestion that living creatures may be influenced by electro-magnetic radiations in Nature, besides those of ordinary light-waves and heat-waves.

Berridge

THE ELECTRIC CAT-FISH

This fish is said to be capable of giving a shock of between 100 *and* 150 *volts*

ELECTRICITY AND THE BODY

By PROFESSOR A. V. HILL, F.R.S.

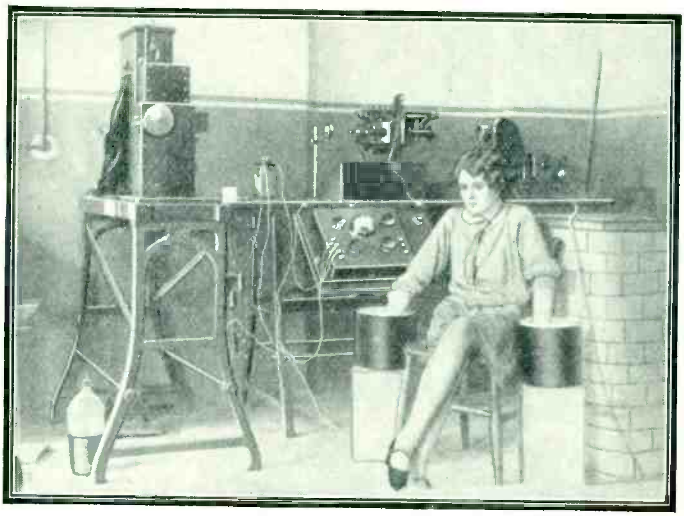
PHYSIOLOGISTS have long been interested in the effects of electrical "stimuli" on the tissues of the living body; indeed, the so-called galvanic current is said to have been discovered, by Galvani, as the result of observing the twitch of a frog's leg evoked by bringing it in contact with two different metals. When a constant current (of not too great intensity) is passed between electrodes through a living nerve or muscle, it "excites" the tissue, *i.e.* produces a response, nerve message, or muscular contraction, (*a*) when it is "made" and (*b*) when it is "broken": at "make," excitation occurs at the cathode; at "break," at the anode. If the constant current be very strong it may cause chemical changes and electrolysis in the salt-solution of which living tissues are largely composed; and such changes may produce secondary excitation during the passage of the current, or even damage. The primary effect, however, of a direct current is excitation at the cathode at "make," at the anode at "break," and nothing the rest of the time.

The most usual type of current employed in the laboratory for stimulation is an "induction shock," a single sharp burst of current produced in the secondary of an induction coil by make or break of the current in the primary. Each shock evokes a single message in a nerve, a single response in a sensitive end-organ (*e.g.* a "touch" or "pain" spot in the skin), a single twitch in a muscle. If a series of shocks be given in rapid succession, each produces its response; a stream of messages runs in the nerve, a continual sensation arises from the end-organ, a contraction is maintained by the muscle. The frequency must not be too high, *i.e.* more than about 1,000 per second, or the tissue may fail to follow the stimuli.

An alternating current acts like a series of shocks; a current of 50 cycles stimulates 50 times a second at *each* pole, since each is the cathode 50 times a second. An alternating current, therefore, produces a much more severe shock than a direct current.

The effect of an electric current depends upon two main factors: (*a*) its "density" at or near the point stimulated—for a given total current a small localised electrode is more effective than a large diffuse one; and (*b*) the sensitivity of the part of the body affected—a nerve-ending, a nerve, or the "motor-point" of a muscle (the point where the nerve joins it) are all more readily stimulated than a muscle. In this connection it should be noted that, with any but very weak currents, stimulation occurs not only at the electrodes, but at any point where a current, sufficiently dense, enters or leaves an excitable living cell.

The effect of a given voltage depends largely upon the resistance encountered, especially in the skin: if the battery be one of high resistance, or if the skin be dry, the shock experienced even from quite high tensions may be small: if, however, the battery be of low resistance, or if the skin be damp (especially with acid, alkali, or salt solution), a considerable shock may result from relatively low tensions. If



TESTING THE RESISTANCE OF THE BODY WITH THE HANDS IN SALT SOLUTIONS

From "Living Machinery" by courtesy of G. Bell & Sons the hands be fully immersed in salt solution, and allowed to become thoroughly wet, the apparent resistance between them to a direct current will be of the order of 1,500 ohms: to an alternating current, owing to the relative absence of polarisation, it will be less. If smaller contacts be made, or if the skin be not saturated with moisture, the apparent resistance may be much higher. If there be any breaks in the skin, *e.g.* scratches or cuts, even a few volts led in between the jars of salt water in which the hands are immersed will produce a current of such density through the injured point that quite unpleasant sensations may result.

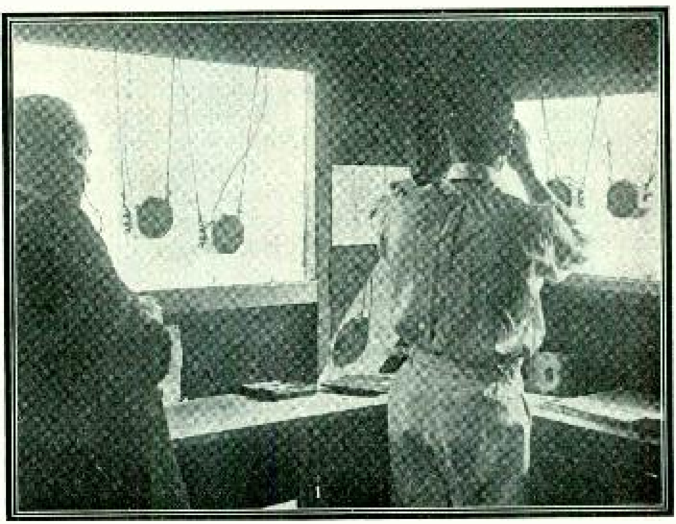
The danger of severe electric shocks, especially from alternating current, lies chiefly in the effect they may have upon the heart. Normally the wave of contraction of the heart spreads evenly over it in a co-ordinated way, ensuring a powerful pumping action on the blood. It is possible, however, to start off artificially in the heart muscle an inco-ordinate activity consisting of "circus" waves chasing around in various directions and producing no proper mechanical effect. This state may be set up by applying an alternating current to the heart, and once started, it tends to persist: if it does, the body (and the heart itself) will no longer be supplied with blood and oxygen, and unconsciousness and death will rapidly follow. Such is a common cause of death by electric shock or electrocution. An alternating current of 100 volts or less, passing between damp contacts in the skin, may have fatal effects in this way, if the current lines pass through or near the heart. If, however, the skin be hard and dry, or if the contacts do not lead the current near the heart, such a voltage may have little or no effect. Stronger currents, however, even if they do not injure the heart, may kill in another way, by producing irreparable damage in the central nervous system.

The "resistance" encountered in the skin to the passage of a direct current is considerably affected by—of all things!—the emotions. Get a friend to place his hands in bowls of salt solution and to keep quite still. Make contact with the solution by metal plates soldered to wires which connect the subject to an ordinary Wheatstone's Bridge. Measure his resistance, employing 2 or 4 volts and a mirror—or a sensitive pointer—galvanometer. It will be, say, 1,800 ohms. Say Bo!

to him suddenly in a loud voice, or announce that you are going to recite a list of names of young ladies, or threaten to stick a pin into him, or to cut off his head—and after a lag of about 3 seconds the galvanometer will deflect rapidly, indicating a fall of resistance of 100, 200, or more ohms. The resistance will rise again slowly if you leave him in peace, but it will fall again on repeating the stimulus. I can *feel* my resistance falling (or so I imagine) when my alarum-clock goes off at 7 a.m., or when I am suddenly called upon to "say a few words." The effect is due, probably, to some kind of polarisation in the skin, which is controlled or affected by the involuntary nervous system. It is quite outside one's own control. The experiment almost invariably "comes off": I have seen it performed on a variety of people, from a laboratory boy to a Queen.

An alternating current, even of high tension, but of very high (*e.g.* wireless) frequency, will not excite at all, apart from its heating effect at the point where it enters the body. A current of intermediate frequency will excite if it be strong enough: but it must be much stronger than a current of low frequency. This is not due, as is commonly said, to the current running only in the surface of the conducting body, for, as a matter of fact, the surface of the body is its most sensitive part, being covered with highly excitable end-organs each connected to a fine nerve fibre. It is due to the fact that a current produces its excitatory effect by concentrating dissolved ions, *i.e.* charged molecules, at membranes or interfaces, or in some similar way, and if the current alternates frequently enough, the result of one half of each cycle is exactly neutralised by that of the other half, in which the current runs in the opposite direction. Unless, therefore, a single half-cycle can stimulate, a succession of complete cycles will have no effect at all: a current has to be very strong indeed if it is to charge a condenser to a high potential, through a resistance of thousands of ohms, in a millionth of a second.

The body itself produces electricity. Every nerve-message, every muscle-twitch, every heart-beat, is accompanied by a wave of electric change travelling rapidly along the affected fibres. These electric changes can be recorded and studied, and so a great deal has been learned about the nature of the events which occur in such organs. The capillary electrometer and the Einthoven string-galvanometer have long been used for these purposes. The modern developments, however, of wireless, and particularly of amplifiers, have made it possible (as can be seen in Professor Adrian's book, "The Basis of Sensation") to study these rapid and minute electric changes with relative ease: while Matthews' oscillograph (the invention of a physiologist; and therefore at present unknown to physicists!), which is really a glorified loud-speaker, can record, practically without distortion, a single "action current" in a single nerve fibre (diameter 0.007 mm.) embedded in a nerve. Such things, and many others, there are, by which physiologists have profited through the labours of wireless engineers. It is fitting, therefore, for one of them to end an article in the B.B.C. Year-Book with a tribute of thanks to wireless for what it has done, and is likely to do, in the study of the strange events occurring in the living body.



Sport and General

THE SCHNEIDER TROPHY BROADCAST

The commentators in the B.B.C. hut looking out on to the Solent

A TRIP TO CANADA

THE pioneer work done by the B.B.C. for the past five years in the use of wireless for education has lately aroused keen interest and friendly emulation abroad. In December last, Savoy Hill was visited by a number of delegates from the principal European broadcasting stations who seemed to be especially desirous of studying educational developments, and early this year the Canadian Royal Commission on Broadcasting came over for the same purpose.

In the meantime, and quite independently, the B.B.C.'s Education Director, Mr. J. C. Stobart, was invited to be one of the speakers at the Fourth Triennial Conference of the Canadian National Council of Education to be held at Victoria and Vancouver, B.C., early in April.

This invitation was cordially accepted, and Mr. Stobart undertook the long journey as the B.B.C.'s official representative. The tour, which was jointly organised by the Canadian National Council and the Canadian Pacific Railway, occupied over two months and extended for some 15,000 miles of sea and land. Everywhere in Canada there was manifest a lively interest in the British system, which differs from that in vogue on the North American continent in several particulars. In Canada at present there is no unified control, broadcasting stations are numerous and are competitive, fees are accepted for use of the "air," and the direction of the stations' activities is generally in the hands of companies whose main activities are centred elsewhere—railways, newspapers, grain companies, etc.

Among the controllers of 60 or 70 Canadian broadcasting stations there is one Provincial Government (Manitoba), and one University (Edmonton, Alberta). In spite of their number, the Canadian stations are usually outclassed in respect of power and resources by the transmitters of the U.S.A. to the southward, and the Canadian listener, who is usually provided with a set that would be considered exceptionally powerful over here, often prefers to listen to the stronger programmes that come to him free of charge from across the border. Unity of control such as obtains in Britain is rendered difficult of attainment in Canada by the immense width of that country—which covers seven degress of longitude, or 3,000 miles. The time factor is another great difficulty: 8 p.m. in Toronto is about 5 p.m. in Vancouver, and about 10 p.m. at Halifax. But the Royal Commission under the chairmanship of Sir John Aird may be trusted to find a solution of these and other problems. That Canadian listeners are not altogether satisfied with present conditions was shown by the keen attention with which they listened to Mr. Stobart's account of the British system, with its advantages of unified control in the spirit of public service, its single licence fee and absence of advertisement, its educational and religious policy, and its impartial political information and non-sensational news.

The general topic of the Vancouver Conference was "Education and Leisure." The Indian poet, Rabindranath Tagore, spoke on the philosophy of leisure, a powerful plea directed against the strenuous materialism of the West. Sir Aubrey Symonds, Permanent Secretary to the Board of Education, gave addresses on the film in education and the playing-fields movement. Mr. H. M. Richards, Chief Inspector to the Board, discussed the right use of hobbies and folk song and dance; and Dr. Winifred Cullis spoke on health in the schools. Sir Charles Grant Robertson's subject was "Leisure and the Drama."

Representatives of Australia, New Zealand, France, Italy, Germany, Japan and Czecho-Slovakia described characteristic post-war movements in their countries.

Two public sessions and one private discussion were devoted to "Radio." Mr. Stobart gave two addresses in the Vancouver Theatre, which was filled with an audience of more than 1,500 people each time. The morning topic was "Radio in Education," and in the evening it was "Radio and Leisure," the former being devoted to detailed description of how the B.B.C. organises its work in Schools and Adult Education, while the latter was a more general account of B.B.C. programme policy. The chairman at the morning session was the Rt. Hon. Arthur Meighen, P.C., formerly Dominion Prime Minister, and in the evening, the Hon. Joshua Hinchliffe, British Columbia's Minister for Education. Both spoke with eloquent praise of the British system, and not without envy. As a formal result of these two meetings, the Conference in private session next morning passed the following resolution unanimously:—

> "that in the interests of Canadian life and culture it is imperative to proceed at once to organise radio broadcasting on a basis of public service with Dominion and Provincial co-operation."

In addition to the Vancouver Conference, Mr. Stobart was invited to speak at many other Canadian cities on the way out and home, including Moncton, N.B., Montreal, Hamilton, Toronto, Winnipeg, Regina, Edmonton, Calgary and Ottawa. He gave in all twenty-four public addresses and ten broadcasts from Canadian stations. A visit to Niagara Falls and a special trip to Prince Rupert by way of the Inside Passage from Vancouver, and a seaplane flight over Vancouver City were among the diversions of the journey.

MR. STOBART AND SIR C. GRANT ROBERTSON ON BOARD THE C.P.R. LINER S.S. "MONTROSE"

While in Canada, Mr. Stobart made it his business to inquire into national resources for the construction of suitable Dominion programmes, and from the Ottawa National Museum he was able to bring back details of the national folk music, both Eastern and Western, which has lately been made available through the labours of Mr. Marius Barbeau and others.

The tour was made especially enjoyable by the traditional hospitality of Canadians, public and private.

DISCUSSIONS AND DEBATES

THERE are few branches of programme work which offer such a wide field for experiment as the broadcasting of discussions, conversations, and debates, and few in which such demands are made on the speakers. It is thanks only to their sympathetic interest and their readiness to be victims in these experiments that the B.B.C. has been able to learn something of the technique required and of the almost infinite possibilities of the future.

The evolution has been not unlike that of the broadcast play—starting with traditional methods and gradually feeling its way towards its own individual form. Debates arranged by outside agencies were occasionally offered for broadcasting, and some of these were successfully relayed. The drawbacks here were that the portion selected for broadcasting was usually only part of a longer discussion, and listeners therefore heard an incomplete argument, while the quality of transmission was seldom as clear as a transmission from a studio. Series of debates were next tried, specially arranged for broadcasting, first in an outside hall, later in a large studio at Savoy Hill. It was then found that though timing arrangements were easier, the atmosphere and circumstances were far from congenial for most speakers. The audience was apt to be oppressed by the muffled feeling of the studio, with its paraphernalia and red lights. The speakers had a real ordeal in sitting waiting, even for a minute or two, in front of this subdued and silent audience, for the red flicker to give them the sign to begin: and the presence of a visible audience made them feel a kind of uncertainty about their real objective. Were they out to convince the rows in front of them, or the invisible millions without? It was then realised that the method most likely to meet all these difficulties was to arrange an argument or conversation between two, or possibly more, speakers, with no visible audience, to which listeners would really be eavesdroppers. By using a studio of medium size, decorated and furnished as far as possible like an ordinary sitting-room: by putting the speakers in armchairs by the fireside, with a supply of cigarettes and refreshments, it was possible to secure an atmosphere of friendly informality, in which something approaching ordinary conversation between them was possible: while by giving the speakers a subject to argue about with each other, the need for a visible audience disappeared. Instead of the bewilderment of a double audience, or the chill of an unresponsive microphone, it was possible to arrive at something much nearer actuality.

On the other hand, the completely informal impromptu conversation is liable to be too diffuse to be altogether successful. Real every-day conversation is not quite sufficiently crisp, nor of sufficient uniform interest, to hold an invisible audience for long. A degree of artificiality is essential—something more distilled, more carefully planned, than ordinary good talk is required, and this means careful preparation and usually some rehearsal, whether the speakers actually use notes or MSS. or not.

The possibility of fixing a microphone in a private house and relaying the ordinary conversation of a group of good talkers familiar with each other, with their subject, and with their surroundings has been contemplated: but apart from the fact that the microphone would act as an effective damper on the speakers, it has been realised that the results would be too natural, too full of pauses, hesitations, interruptions, people speaking at once, and so on.

The chief line of advance seems likely to be a development of the present studio arguments or conversations, so as to include conversations between more than two speakers, and so as to find the right mean between the prepared MS. and the completely impromptu argument.

If there is one thing more than another, however, that these experiments have taught, it is that there is no cut-and-dried method which can be applied to all discussions. Every speaker, and indeed every subject, presents a different problem of psychology. An arrangement which will suit one broadcaster will be an impossible ordeal for another. A conversation which is only going to take fifteen or twenty minutes almost invariably needs to be written out and rehearsed in order to get the necessary amount of crispness and concentration, and a high level of material. This means that your speakers must have something of the dramatist as well as something of the actor in them, able to write good dialogue on the one hand and to act it naturally on the other. Longer discussions are usually better when they are undertaken either quite impromptu, or with the aid of a few notes: but that by no means precludes careful planning in advance, nor a mapping out by the speakers of the ground to be covered.

The method used for the discussion on the De-rating Bill was an attempt to find the best way of presenting a series of expositions of a complicated question. A certain degree of formality seemed to be necessary, and a certain period free from interruption, to enable listeners to get a clear and connected idea of each speaker's explanation or criticism. There is reason to think that for the object in view, *i.e.* a clear and simple explanation, there was something to be said for the method.

All this will show that the successful choice, arrangement, production, and performance of a broadcast discussion is no easy matter. A speaker needs to have a good broadcasting voice and delivery, an appreciation of his audience, an ability to choose his words and arrange his thoughts well: and these requirements must be looked for among those with some real claim to speak on a particular subject, who are able to give the time needed for preliminary voice tests, rehearsals, and so on. If the subject is a hotly controversial one—indeed in any discussion—it is important to try and find opponents who can not only speak with equal authority but with equal effectiveness.

It is sometimes suggested that the B.B.C. would be wise to give up the search for speakers combining all these virtues, and merely arrange for announcers, or others with good microphone voices, to read or act a dialogue prepared by the experts. But this is not only a counsel of despair: it would be a surrender of the whole case for broadcasting. Through the microphone listeners can come into direct contact with men and women who have made some special contribution in the sphere of discovery, science, literature, adventure, gallantry, wit, or humour, and it is the conveying of personality that is one of its chief functions. Experience has shown that people with the right gifts exist and are willing to help, and while there is undoubtedly much still to be learnt, there is already something to show.

LORD SANKEY, THE LORD CHANCELLOR, WHO WAS THE FIRST PRESIDENT OF THE CENTRAL COUNCIL FOR BROADCAST ADULT EDUCATION

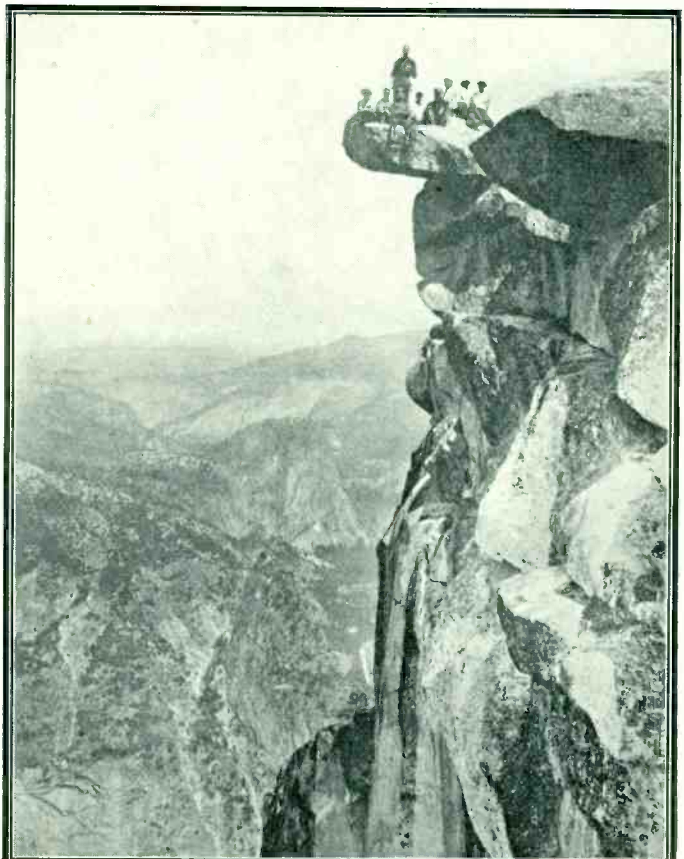
THE EDUCATIONAL COUNCILS

LAST year's Handbook foreshadowed the establishment of national councils for education on the lines laid down by Sir W. H. Hadow's Committee in the report *New Ventures in Broadcasting*, published in 1927. The actual constitution of the new Councils has been worked out patiently in detail by two Interim Committees, one for Adult Education and the other for Schools. Both Councils are now in full working order. While the B.B.C. has not, as indeed it cannot, divested itself of its final responsibility for everything broadcast, it has handed over to these Councils the planning and organising of courses in both departments, and it is already beginning to profit by the great educational experience of these two important bodies.

ADULT EDUCATION

The Central Council for Broadcast Adult Education was appointed on a dual basis. It includes 24 members chosen by specific organisations as their representatives, and in addition the B.B.C. has nominated 18 members as representatives of various interests associated either with broadcasting or with some branch of education. Among the organisations represented in the former category are the Board of Education, the Extra-Mural Consultative Committee of the Universities, the Tutorial Classes Joint Advisory Committee, the Association of Education Committees, the County Councils Association, the Municipal Corporations, the L.C.C., and, among voluntary societies engaged in the work of adult education, the British Institute of Adult Education, the Workers' Educational Association, the Co-operative Union, the Trades Union Congress, the National Confederation of Employers' Organisations, the National Federation of Women's Institutes, the Y.M.C.A., the National Adult School Union, the Rural Community Councils, the Tutors' Association, the National Union of Teachers, the Joint Committee of the Four Secondary Associations, the Three Technical and Art Associations, and the Library Association.

All these Associations gave the most cordial response to



E.N.A.

GLACIER POINT IN THE YOSEMITE VALLEY, CALIFORNIA

A typical illustration from a B.B.C. "Aids to Study" Pamphlet the Corporation's invitation, and appointed their most important officials to this work.

Among the nominated members are Sir Walford Davies (music), Sir Oliver Lodge, Professor Julian Huxley and Professor Cramp (science); Literature is represented by Colonel John Buchan; international affairs by Professor Noel Baker; the Carnegie Trust by Lieut.-Colonel J. M. Mitchell; religious education by Dr. Basil Yeaxlee; drama by Mr. Geoffrey Whitworth of the British Drama League; agriculture by Sir John Russell, Director of the Rothamsted Experimental Station; the interests of adolescents by Dame Katharine Furse; psychology and broadcasting technique by Dr. Cyril Burt; health, hygiene, diet, etc. by Professor Winifred Cullis; women's interests by Dame Meriel Talbot; and with these are associated five former members of the Interim Committee, Miss E. S. Haldane, C.H., Dr. J. Franklin Sibly, Mr. G. D. H. Cole, Professor Searls, and the Hon. Oliver Stanley.

The first Chairman was Lord Justice Sankey, who was unfortunately compelled to resign on becoming Lord Chancellor in the Labour Government. The full Council has already held three meetings. Current business is, however, transacted by a strong Executive Committee under the Chairmanship of Mr. G. H. Gater, and small sub-committees are in charge of matters relating to:

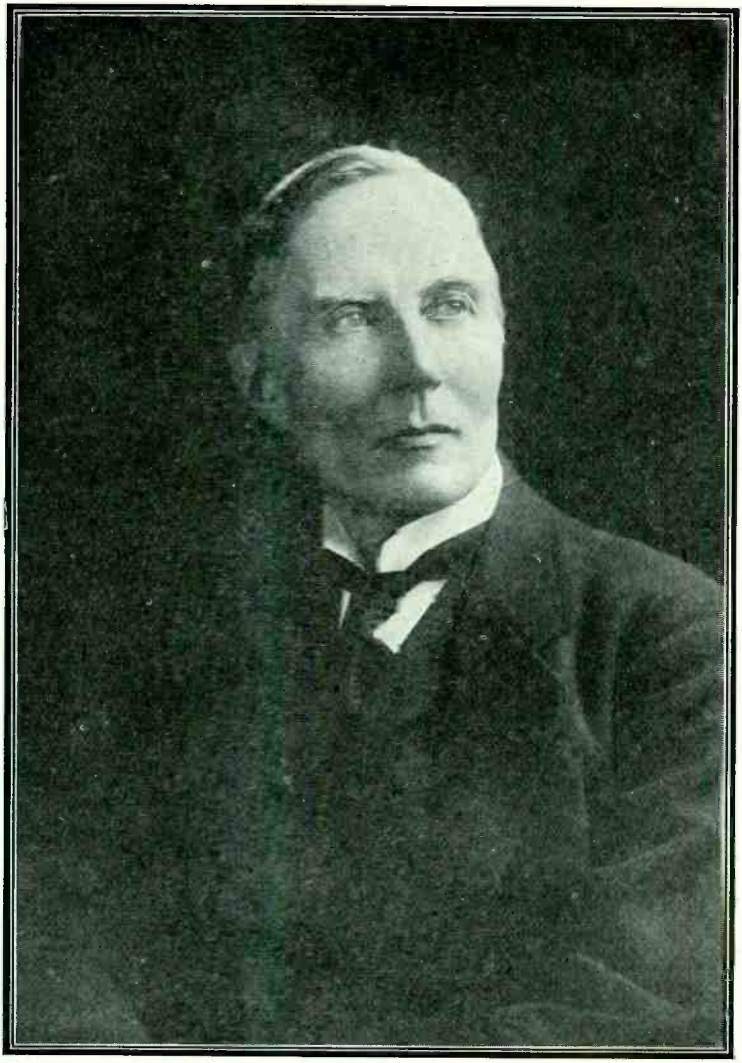
(i) Finance and General Purposes.
(ii) Programmes and Publications.

Pending the accession of other sources of revenue as foreshadowed in the Hadow Report, the B.B.C. has assigned to the Council an annual credit to cover the cost of adult educational broadcasting on its present basis. The Council is not only devoting its attention to broadcasting, but also to the organisation of classes and groups at the listening end, and it is also planning lectures and demonstrations in the country in order to draw the attention of the public to the facilities provided. The Carnegie Trust has promised important grants to help in certain experiments which are being organised in typical areas. An intensive experiment, for instance, in Kent, will be launched in the autumn, and the West Midlands Area Council with a grant of £500 from the Carnegie Trustees is laying plans for extensive experiments in that area. One new development for which the Council is entitled to credit is a short training course for group leaders held at the University College, Hull, with the assistance of Professor Searls.

Area Councils are being set up wherever the demand for Adult Education by wireless has focussed itself sufficiently to require a subordinate local organisation, and schemes for such Councils have already been approved, by the Executive Committee of the Central Council, for Yorkshire; the North-West Region, to include Lancashire, Westmorland and Cheshire; and the West Midlands. A local Committee in Plymouth has also been approved to support interest already shown in the possibilities of broadcast adult education in that district. The importance of this contribution to educational facilities is being increasingly recognised by public bodies such as the Home Office, the Army, and the Royal Air Force.

SCHOOL BROADCASTING

The Central Council for School Broadcasting came into existence a little later, but it is now in full working order. It is constructed on similar principles, namely, a representative element and a nominated element. The Board of Education and the Associations representing the Local Education Authorities have chosen their representatives as in the case of the Adult Council. The National Union of Teachers has four representatives; the Joint Committee of the Four Secondary Associations, two. Other bodies represented are the Independent Schools Association, the Association of Preparatory Schools, the Training College Associations, the Joint Committee of the Three Technical and Art Associations, the Scottish Education Department, the Association of Scottish Education Authorities, the Educational Institute of Scotland, and the Ministry of Education for Northern Ireland. Among the nominated members are several of those mentioned above, with the addition of Sir Benjamin Gott, Sir Ernest Gray, Miss W. Mercier, Professor T. Percy Nunn, Principal of the London Day Training College, Professor Oliver Prior of Cambridge, Mr. Frank Roscoe, of the Teachers' Registration Council, Mr. R. E. Sopwith, Pro-



THE RT. HON. H. A. L. FISHER

President of the Central Council for School Broadcasting fessor J. Arthur Thomson, Mr. W. W. Vaughan, Headmaster of Rugby School, and Mrs. Wintringham, the former M.P.

The Chairman is the Rt. Hon. H. A. L. Fisher, Warden of New College, Oxford, and formerly President of the Board of Education.

The Board of Education has as its representative Miss A. G. Philip, Chief Woman Inspector of Schools, and Mr. G. T. Hankin, H.M.I. Mr. G. H. Gater is again the representative of the L.C.C. Mr. Frank Roscoe is the Vice-Chairman and the Chairman of the Executive Committee. The full Council has already held two meetings, and its Executive Committee has been steadily at work during the spring of 1929. A special sub-committee has been formed to deal with the establishment of a Sub-Council for Scotland, and another to consider the general outlay on pamphlets issued in connection with school broadcasts. There are also special sub-committees to deal with: Geography, History, Modern Languages, English Literature, Music, Special Secondary School courses, and an experimental course.

Among the earliest resolutions of the new Council were the following: that there should be no other local Councils except the Scottish Sub-Council, that local broadcast lessons to schools should be discontinued, since the majority of schools receiving broadcast lessons now used the Daventry Station (this decision not applying to Scotland); and that the practice of correcting written work in connection with school broadcasts should be discontinued.

The Corporation is already feeling the value of the authoritative support as well as the wide educational experience of such a body; and again it has to be recorded that no single invitation to join the Council was declined.

THE NATIONAL LECTURES

THE original conception of the scheme for National Lectures was to strengthen B.B.C. programmes on the intellectual side by providing at regular intervals lectures by the very highest authorities on subjects such as science, music, literature, medicine, exploration, art, etc., such lectures to last for more than double the usual twenty minutes' space, and to be given from all stations at a prominent time in the programmes.

It was thought that this would not only be intrinsically acceptable to listeners as enabling them to hear two or three times a year the views of great masters in the intellectual field expressed in greater detail than is customary in the ordinary short talks, and given with proportionately greater authority and time for preparation, but that it would also be a valuable gesture by the Corporation as a mark of its recognition of the importance of learning in national life. It was intended that the National Lectures should be of such a standard as to bring within the reach of every British household pronouncements of a quality not inferior to the Romanes and Reid lectures at Oxford and Cambridge respectively.

While the B.B.C. was reluctant to add to the number of its Advisory Committees, it was thought best to invite a number of the most distinguished authorities in the academic, scientific, and literary, world to enrol themselves as a panel of informal advisers, in order to give the B.B.C. the benefit of their experience in the choice of subjects and lecturers. The B.B.C. was highly gratified by the acceptance of its invitation by all the distinguished men to whom it was addressed. The full panel comprises the Earl of Balfour, Sir William H. Bragg, the Earl of Crawford and Balcarres, the Marquess of Crewe, Mr. H. A. L. Fisher, Sir Israel Gollancz, Sir William Hardy, Sir J. H. Jeans, Sir Frederick G. Kenyon, Sir Donald MacAlister, Sir Henry Newbolt, Sir Ernest Rutherford, Sir J. J. Thomson, Professor T. F. Tout, and the Marquess of Zetland.

Two lectures in the series have already been given. The first lecture (on Poetry) was appropriately given by the Laureate, Mr. Robert Bridges, O.M. The talk was given on February 28th, 1929, from Magdalen College, Oxford, by kind permission of the President, Professor Gordon, and as it was subsequently reprinted in *The Listener*, it was available for perusal by great numbers of the public. The lecture, which lasted about three-quarters of an hour, dealt with the essential nature of poetry in the form of an imaginary dialogue with a typical poet. It ended with a noble plea for beauty in education, and an explicit recognition of the educational importance of broadcasting.

The second lecture was broadcast by Dr. Arthur S. Eddington, Plumian Professor of Astronomy in the University of Cambridge, on the subject of *Matter in Interstellar Space*. He dealt chiefly with the cosmic cloud, "a cloud of extremely rarefied gas which occupies the space between the stars," its temperature, density and probable composition.

> "In imagination we see the atoms swarming like gnats in what was once thought to be an utter void. And, as we contemplate it, there comes the thought that this cloud is the unused remnant of that primæval chaos from which by the shaping of time the stars, the sun, the earth, living forms, and all our material surroundings of to-day, have emerged."

The reception of these two lectures has been most gratifying. There is ample evidence that the listener is not afraid of enjoying strong meat. As *The Times* remarks: "They have introduced an unsophisticated audience to the excitements of knowledge. Remarkable as the first two lectures have been, the membership of the Advisory Board and the great range of subjects in which first-rate original research is being done in this country are a guarantee that the scheme can be continued on its original high level."

INTELLIGENT LISTENING

By Filson Young

ONE of the reasons why broadcasting is not universally cultivated by people who are most able to avail themselves of its services is that we do not sufficiently use discrimination in our listening.

It is quite a common experience to find people who, having no receiving apparatus in the house, therefore have a very vague idea of what the broadcasting service really is. Quite often one hears such people say, "I don't think I really want the wireless: there is such a lot of stuff broadcast that one does not want to hear." Absurd as it seems on close examination, this is quite a common attitude. It is equivalent to saying, "I don't like reading because there is such a mass of printed matter which I don't want to read": or, "I don't like travelling because there are a great many ugly towns and places in the world": or, "I would rather be without a sense of smell because one sometimes comes across a disagreeable odour."

These analogies represent only a very slight exaggeration of the absurdity of the prejudice against broadcasting to which I have referred. At the best it implies that broadcasting is a thing from which, if you have a receiver in your house, you cannot escape, that you are obliged to have nothing or all of it. The water and electricity supplies with which your house is furnished are at your disposal, but they do not function continuously: you have no stream of water, or current of heat or light, unless you turn it on. Surely it is only common sense to treat the broadcast service, when you have it installed in your house, in at least as careful and selective a way! There is no more stupid use (or misuse) of the broadcasting service than to say, "Let's turn on the wireless," in the hope of being entertained, without ascertaining first whether the programme is one which you would wish to hear. It is, I am afraid, largely because the service is so cheap that this unintelligent habit is acquired. If you had to pay for it item by item, or if a meter were installed and you paid for the service in proportion to the time you listened to it, you would find that a very much more selective use would be made of the programmes; in other words, you would look at the programmes beforehand and decide what you wanted to hear.

It is the very common failure to exercise intelligently this privilege of selection that has kept so many intelligent people from giving broadcasting a regular and appointed place in their hours of leisure. To such people I would say—"Install a wireless set and order *The Radio Times*, but make it a practice to mark off in the week's programmes the items to which you wish to listen: note the days and times on a memorandum which can be put in some conspicuous place: and leave your wireless set severely alone at all other times. In this way you will be surprised to find what a real enrichment it may become to your life of leisure. People will use it differently, according to their temperaments: some will be guided entirely by what they see announced in the week's programmes: others will decide to make a regular habit, say, of listening to one symphony concert, one Variety programme, one evening of light music, one pianoforte recital, and perhaps a Bach Cantata each week. Others, with a different inclination, will pick out certain talks, lectures, debates or items of entertainment that they think should be interesting. If you do this beforehand and you find that the items you have selected are disappointing to you, you will then, I think, have a legitimate cause of complaint against the programmes. But I think it would surprise most people to find how well they would come out in the test of a critical commentary based only on this intelligent use of broadcasting.

It is high time that people realised that they have no excuse whatever for being bored by broadcasting: there is no need for them to listen: and I should be very much surprised if there is one household in a thousand in England that would not, if they chose their programme items beforehand, find at least two hours every week which they regard as delightful and valuable entertainment. Do you know any other source from which you could always be certain of such a couple of hours every week? I doubt it very much.

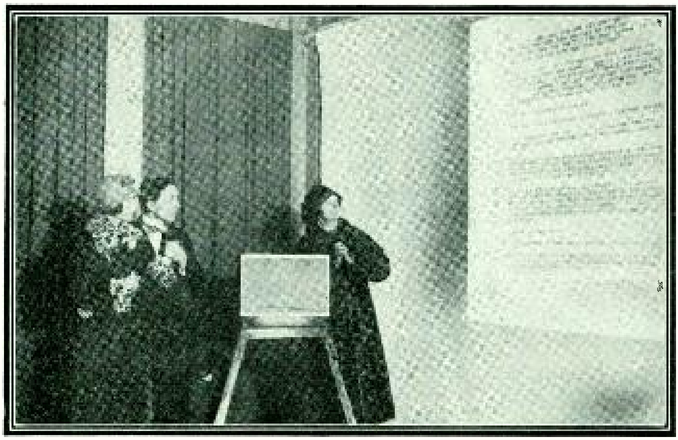
And for those two hours, unobtainable in any other way, you would be paying at the rate of one penny per hour.

BROADCAST DRAMA

IT is the immediate aim of those responsible for broadcast drama at Savoy Hill to establish there a sufficiently large library of microphone plays to make an end of the rather hand-to-mouth method of filling the dramatic part of the programmes, which till recently was made inevitable by the scarcity of suitable material. Something like a hundred plays are submitted to the Productions Department every month. The reasons why only about two per cent. are accepted are: firstly, that the financial reward for a broadcast play must be small compared with that attainable by the author of a play that is successful on the ordinary stage, where receipts can be derived from an indefinite number of performances; and secondly, that it is bound to be difficult to write a successful play for the microphone without some special knowledge of its peculiar requirements. With this obstacle in view, and in the hope of encouraging the submission of suitable plays, a series of articles recently appeared in *The Radio Times* entitled "Radio Plays and How to Write Them."

There are at present three main sources of supply for the microphone: stage plays, adaptations of novels, and specially-written plays. The microphone play is rapidly developing an art-form of its own—a form so different from the art of the theatre that, with certain big exceptions, among which are Shakespeare's plays, the stage is coming to be regarded less and less as a source of supply. The microphone dissolves the limitations of space and time imposed by the three-sided box of the stage, and opens out boundless fields of action in which to set a plot. Novels offer excellent material which, when specially adapted, this new technique can use: good stories, rapid change of scene and time, revelation of actual thought and memory in the minds of the characters. And, of course, the original play, when the possibilities of this expansive treatment are understood, can supply still more suitable material; but the writers who understand it are still too few.

Writing in a special drama number of *The Radio Times*, Mr. Compton Mackenzie said that the one permanently indispensable necessity in broadcast drama is sincerity. The test of the ear alone, by which a broadcast play is inevitably judged, is a severe one. Whatever is insincere or pretentious



Barratts

AN EARLY EXPERIMENT WITH WORDS PROJECTED ON A SCREEN

To enable the actors to ook up as they speak and to obviate the handling of books

jars upon the ear much more disastrously than if spoken from the stage, where it can be carried off by the varied simultaneous appeals of movement, colour, lighting, scenery, and personal beauty. But it is difficult to estimate one's own work from this point of view; and in case this seems a counsel of perfection, there are also certain very practical considerations for the attention of the would-be dramatist.

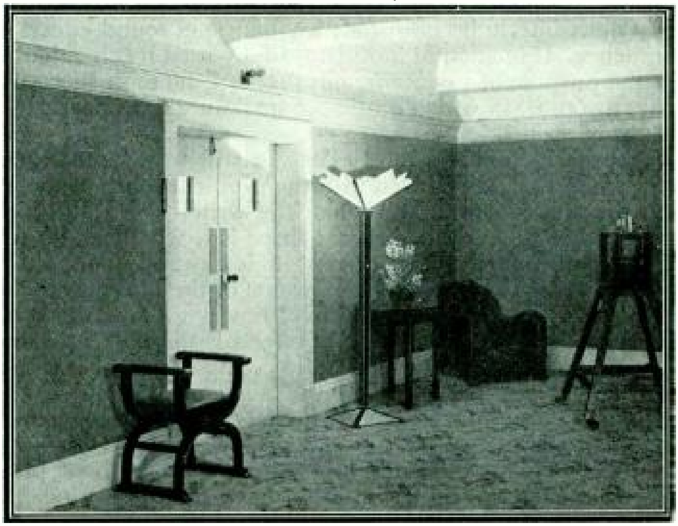
The choice of subject for a wireless play is almost as limitless as that of any other work of art; but not quite. The very universality of the listening audience implies limitations of subject. Granted that on occasions a play may justifiably be directed to a special section of listeners, broadcast drama is only fulfilling its public service when the majority of its plays appeal to the majority of its listeners. So far it has been found that this general appeal is only made by plays which tell a vivid, eventful story, or in which the characters are so genuinely conceived that they communicate human feeling through the delicate medium of the microphone. People are most naturally interested either in the human experiences that are common to all of us, or in those uncommon experiences of adventure and romance in which we all, when we have time, like to imagine ourselves taking part. It was by the exploitation of these two instinctive interests that the cinema came to stay, and it is by developing, though with different methods, along those same lines of interest that broadcast drama will become in the best sense popular.

Listening is still a comparatively new experience; and partly because it is so new, and partly because it employs only one sense-organ, it is a strain to listen for a long time. A good wireless play, therefore, needs to be much shorter than the average stage play, and to be broken up as much as possible. The best length is found to be between an hour and a half and two hours. Unlimited by sight and the necessity for changes of scenery, it can be divided into as many "scenes" as the story requires, and for the sake of variety the "scenes" should be as short and frequent as possible. A play that runs for two hours can quite successfully be divided into thirty scenes. But the changes of scene must be made quite obvious in some way: by the fading of one into another; by very short interludes of music; by the use of sound effects or by silence. If incidental music is skilfully used it is invaluable for the purpose of variation; but perhaps the most successful plays are those in which music occurs naturally as part of the course of events.

The production of sound effects is still to a large extent experimental, and research into the problems both of theory and practice is continual. When the writer of a radio play first realises that at his disposal there is a whole studio full of mechanism for creating effects, he is naturally tempted to indicate their use wherever the events of the plot permit. It seems as if experience will prove, however, that the most sparing and least realistic use of effects is the best, and that they are most striking when used to create atmosphere rather than actual sounds, which, if the dialogue is genuine and alive, will be supplied more adequately by the listener's own imagination.

In the course of the development of the broadcast play, two main methods of presentation have emerged. One, the method in which the play is introduced by a narrator who links the various big divisions or "acts" of the play by narrative, explanatory or descriptive. This is probably the best form to use in the adaptation of microphone plays from novels. The other, by means of which the play proceeds simply from scene to scene, linked only by the fading of dialogue, musical interludes and so on, seems to be the most natural method for the writer of original plays. In choosing between these two forms, however, the obvious aim to keep in mind is lucidity. There is no other rule for the writer of a broadcast play which is half so important as this.

Those who are taking a serious interest in broadcast drama have no doubt that it has come to take a permanent place alongside the theatre and the cinema, but they are very well aware that there is still plenty of scope for investigation and experiment in its problems. That this is so is a sign of its vitality. But such experimentation can no longer be used as an excuse for imperfect work. Broadcast drama has found its feet as a recognised art-form. It must now depend on practical performance to justify that recognition.



THE DRAMATIC STUDIO OF THE NORTH REGIONAL STATION IN THE NEW BUILDINGS AT MANCHESTER

VARIETY AND THE STAGE

THE past year has seen a marked change in the B.B.C.'s relations with Variety managements, inasmuch as broadcasts from music-halls are now a regular feature of the programme. A great share of the credit for this belongs to Mr. George Black, a Director of the General Theatre Corporation, who at once grasped the possibilities of broadcasting, and by his ready co-operation contributed in no small measure to the successful development of the present system.

Up to October of 1928 there had been sporadic relays of "turns" from charity performances at music-halls. October 22nd, however, saw the first of the regular broadcasts from the Palladium, which still continue at fortnightly intervals. Subsequently, Sir Oswald Stoll's co-operation resulted in the first relay from the Alhambra, which took place on February 12, 1929, followed by the Coliseum on February 25th. At the present moment, therefore, listeners can count on one broadcast from a music-hall a week, which, dovetailed as it is into the studio variety programme, forms a pleasant change, and a contrast in "atmosphere."

After considerable experiment, it was decided that "playing on" by the B.B.C. Dance Orchestra was the most effective method of presenting the "turn." At a minute or two before zero, therefore, the studio dance band strikes up. Exactly at the appointed moment the Control Room engineer superimposes the music-hall stage sounds upon the dance band, the latter being "faded" down as the former is brought up in volume. As a result, the listener feels himself transported, as by a magic carpet, from studio to packed auditorium, with a stimulating effect on more lively imaginations. The relay ends in the same way. For some seconds, therefore, before and after the "turn," dance music and the music from the theatre orchestra are blended together in a not unpleasing welter of sound which at least one listener has mistaken for the prelude to a concert of modern Chamber Music!

Among the "turns" most successfully broadcast were Jackie Coogan, Odali Careno, Jack Hylton's stage act, Randolph Sutton and Muriel George and Ernest Butcher (Palladium), Fred Duprez, Marie Burke, Charles Hayes and the operetta "Cupid and the Cutlets" (Coliseum), and Flotsam and Jetsam, Winnie Melville and Derek Oldham (Alhambra). Roars of laughter overwhelmed the microphone during part of Will Hay's act at the Palladium, or this "turn" would have ranked high.

Viewed empirically there seems no reason why these activities should not continue successfully, both from the point of view of the management, the artist, and the B.B.C., so long as material is available.

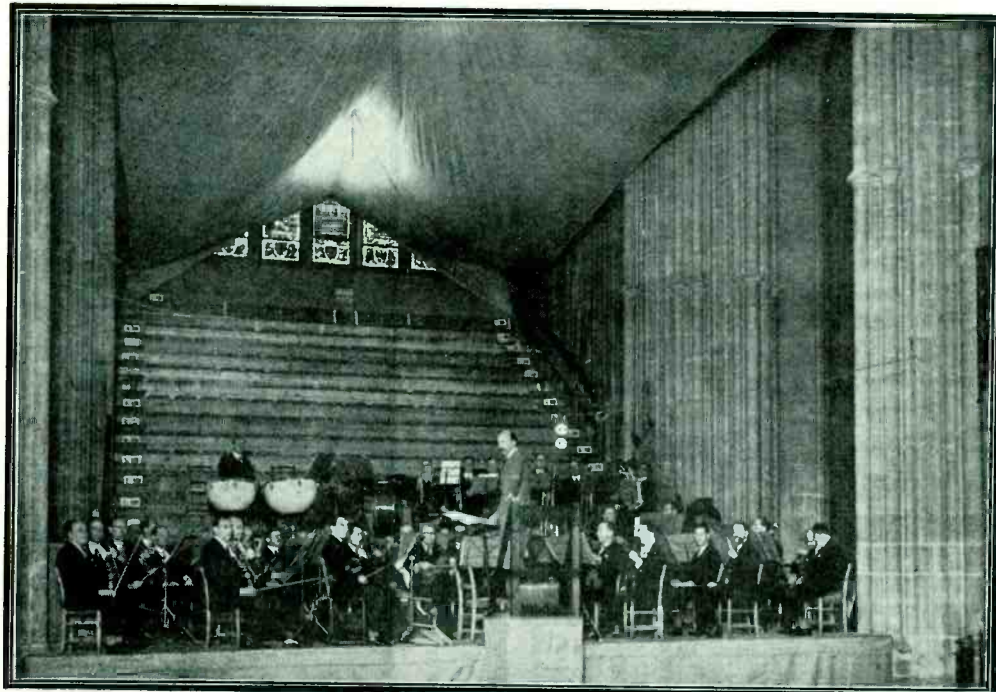
IN THE WINGS OF THE COLISEUM

The record of the past year's broadcasts from theatres is not a long one, but excerpts from the West End successes, "Virginia" and "So this is Love" (from the Palace and Winter Garden respectively), were very well received, as was a pantomime, "Cinderella," from the Theatre Royal, Manchester. To these must be added the recent and popular broadcasts from "Mr. Cinders" (Adelphi), "So This is Love" (Gaiety), and "Hold Everything" (Palace). Last but not least, part of the first performance of the revived Co-Optimists, including the final speeches from the stage, was broadcast from the Vaudeville Theatre on July 8th. This was the first occasion of a "first night" performance being broadcast. It is becoming more and more difficult to find musical comedies from which portions can be selected for broadcasting. Most of the difficulties are technical, but programme obstacles of timing and continuity are always present. As an example of the former, it may be mentioned that not a little of the colour and life of the chorus "Roll Away Clouds," from "Virginia," was lost simply owing to the necessity for fading down the microphone current to prevent "blasting," the whole chorus being massed "down stage" on top of the microphone.

One cheerful impromptu connected with the theatre must have special mention. This was the rehearsal of "Merry Merry" relayed (to give away a secret) from the stage of the Palace Theatre, immediately the audience had left the theatre after the evening performance of "Virginia." The atmosphere of cheeriness, and the singing and dancing were particularly well transmitted, though unfortunately at the late hour comparatively few listeners were able to hear it.

Bon-Accord

THE MICROPHONE AT THE BRAEMAR GATHERING



THE B.B.C. SYMPHONY ORCHESTRA IN CANTERBURY CATHEDRAL

NATIONAL MUSIC

A GREAT deal is written in these days about our "national" school of composers, and with justice, for we have a number of keen, sincere, gifted musicians who, being essentially English in sentiment and outlook, and expressing *themselves* in their art, are creating music which is essentially "English." The B.B.C. quite rightly encourages these young men by making as many opportunities as can conveniently be arranged for their best work to obtain a hearing. Some of the more experimental of their works are played over in their presence by the Wireless Orchestra during special sessions arranged for this purpose. This achieves a twofold object: it sometimes serves to discover new music of potential value to wireless programmes, and it always teaches the composer himself a good deal. He can compare the sound of his music with his intentions when he wrote it, and thereby increase his own experience, knowledge, and technique, and consequently his means of self-expression. Thus, even behind the scenes, broadcasting is helping the development of a truly national school of music.

THE NATIONAL CHORUS

Three years ago the B.B.C. gave at the Royal Albert Hall a series of symphonic concerts on a big scale. There was a large orchestra, and for certain works that needed it a chorus of 250 singers was organised with the co-operation of various leading choral societies. The intention was that these should be in every way first-class concerts, at popular prices for those who could go to the hall, and broadcast throughout the length and breadth of these islands for those millions who could not. They were in every sense concerts for the people: and they were therefore called National Concerts, and the orchestra was correspondingly named the National Symphony Orchestra, and the Chorus the National Chorus.

Then, with the coming of the Queen's Hall Concerts, the general term was dropped, but persisted in reference to the "National" Chorus, which, because it had to be organised afresh each time, varied in personnel from concert to concert.

Because of this, and the fact that it had in prospect some even more exacting performances, the B.B.C. decided to place the Chorus on a permanent footing. With the knowledge and co-operation of the Choral Societies, and responding to the public invitation extended through the microphone and in the Press, just under 1,500 experienced amateur choral singers presented themselves for audition at Savoy Hill, and from them the newly-constructed National Chorus was built. It soon showed how careful selection, permanency of personnel, and regular rehearsals could improve the work of a chorus; and there is little doubt that it has gone a long way towards realising the B.B.C.'s intention of forming an amateur body of singers that would become the finest Chorus in the country. The big choral works projected for its second season—Beethoven's "Choral" Symphony, Handel's "Solomon," Bantock's "Omar Khayyám," and the immense and difficult Eighth Symphony of Mahler—should show how continued work together, and direction by a keen and gifted trainer, have enabled it to fulfil its early promise, and justify its ambitious title "The National Chorus."

A NATIONAL ORCHESTRA

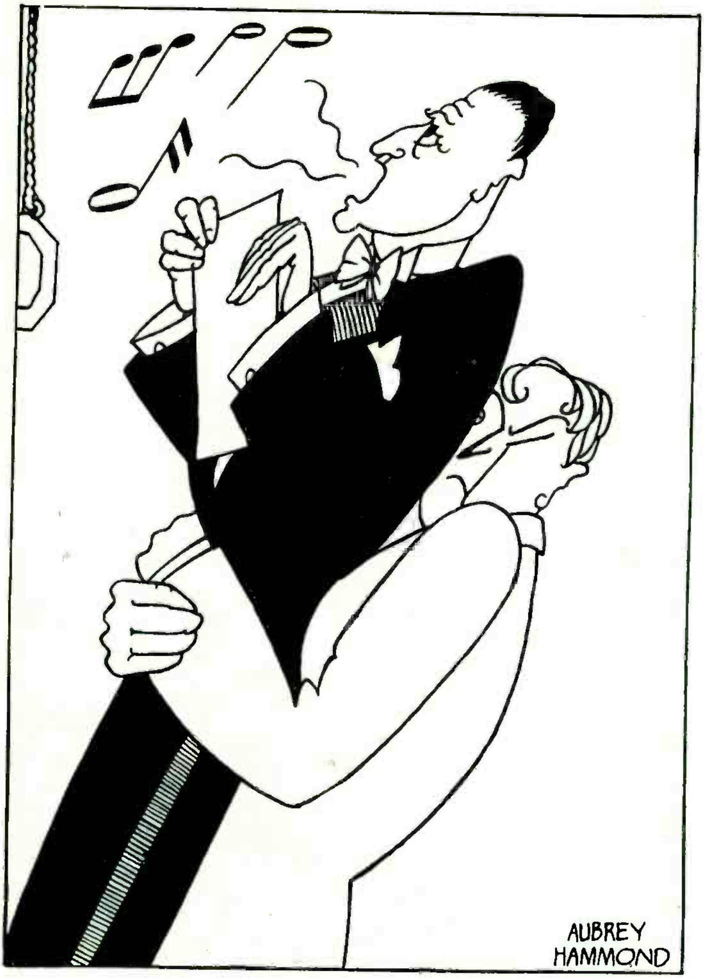
In the last few months the B.B.C. has been developing what is in many respects a still more ambitious scheme: more ambitious in that it involves professional, not amateur, musicians, and strikes at the root of what has for many years been a factor militating against good orchestral performances. London has had many orchestras, and no one would wish to belittle the fine traditions of, for instance, the Royal Philharmonic and London Symphony Orchestras. At the same time, no one would deny that London's orchestral performances have always left much to be desired for the simple reason that there has never been an orchestra either free from the deputy system, and thus sure of an unchanging personnel throughout the season, or working always under one capable, understanding conductor, who, taking each "department" in turn, welds them finally into the homogeneous whole that one recognises in such perfect ensembles as certain continental and American orchestras.

To put this ideal into practice means the breaking down of many of the traditions of orchestral players who have never been accustomed to the idea of "putting all their eggs in one basket," but have depended rather upon engagements here, there and everywhere, with perhaps a permanent theatre engagement to boot. The B.B.C. is inviting some of the leading players of the country to form the nucleus of its orchestra; they will receive good salaries and are expected to devote the whole of their energies to constant rehearsals and the many performances of the orchestra. They are further encouraged to associate themselves with the venture by the guarantee of three years' engagement, with the possibility of further renewal at the end of it. Sir Thomas Beecham is the principal in the artistic direction of the scheme, and he personally will direct most of the rehearsals and many of the performances.

The B.B.C. hopes that this orchestra and the National Chorus will prove worthy partners in a scheme for providing the nation with the best music in the best possible way.

THE B.B.C. MUSIC LIBRARY

A very important factor behind the scenes



A DAY IN THE LIFE OF AN ANNOUNCER
III. SINGERS MUST BE TACTFULLY HANDLED

INTERNATIONAL COPYRIGHT

CONSCIENTIOUS broadcasting concerns throughout the world have had to give serious consideration to the international aspect of authors' rights, and some of the extremely difficult problems raised by this new medium have still to be solved.

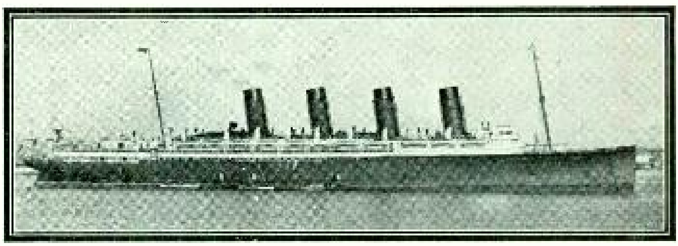
Prior to 1886 the protection of an author's copyright in a country other than his own was governed by separate international treaties framed to give the author protection to the same extent as that accorded him in his own country. The result of this, however, was a very complicated state of affairs due to the differences in the treaties with various countries. In addition there was the fact that between certain countries such treaties did not exist, with the consequence that an author's work could be freely pirated. The lack of any reciprocal copyright agreement between Great Britain and America was a particular handicap to the British author at that time, and Charles Dickens' abortive visit to the United States with a view to preventing the pirating of his own works and those of his contemporaries is a matter of literary history. The Americans had so little to give in return that the absence of an agreement was all to their advantage. In 1886, however, several great Powers met in conference, and this meeting, known as the Berne Convention, was the beginning of the International Union for the protection of the rights of authors over their literary and artistic works, to which most of the great countries have become signatories. It is a matter of disappointment to all interested in this subject that America remains outside the Convention, but reciprocal arrangements for copyright protection have now been made between that country and other Powers, including Great Britain, so that the anomalies of Dickens' day have ceased to exist. Another important outsider is Russia, which never adhered to the Convention, but a national of that country can obtain protection throughout the countries in the Convention by simultaneous publication in Russia and one of the countries of the Union. There is, however, no reciprocity, *i.e.* a British author's work is not protected in Russia.

It is the object of the International Copyright Union to provide that an author of any country of the Union shall enjoy the same protection for the use and production of his work in a country other than his own as he enjoys in that to which he belongs. As, however, the protection at present accorded is governed by the law of the country in which it is claimed, there is much to be done by the Union in the way of obtaining uniformity of copyright legislation amongst its members. It is doubtful whether complete uniformity is possible owing to fundamental differences of law, but in spite of this the Union serves its purpose very adequately.

The author's control over his work for broadcasting purposes was brought into the Convention at the Rome Conference in May 1928—the first meeting of the Union since before the War. By that date broadcasting had been established on a large scale for six years or so, and much experience had been gained as to the needs of authors and broadcasters respectively. As to the general principle that broadcasting should involve the payment of fees to the authors or holders of copyrights, there was no dispute. But the exact definition of the extent of the authors' right was a matter of acute controversy; many held that broadcasting possesses a public, non-commercial character which should entitle broadcasters, in the public interest, to make use of work even against the author's objections—always subject, of course, to a fee to be decided by agreement or arbitration Eventually, therefore, the Rome Conference adopted the course of establishing the authors' right, but making its *exercise* subject to domestic regulation in each country.

This question, which deeply concerned the jurists at Rome, is only one of the many new problems which broadcasting has brought to the fore. Another group of such problems is that of "rediffusion," *i.e.* the use of a receiving-station and loud-speaker in halls, cafés, etc. for the entertainment of the general public as distinct from the licensed listener. Yet another is that of international line relay. In general the rule has been adopted—rather under a common-sense interpretation of justice than under the compulsion of the courts—that the relaying of a work broadcast in another country amounts to the same as performing it at one's own station. But in a recent case the point was raised whether the broadcasting in England of a work audible to French listeners with long-range sets constituted an infringement of the author's rights in France, in which country no permission to broadcast had been obtained. In the particular case, the point was ruled out on a point of procedure, but the example will serve to show the intricacy of the subject, and the difficulty of adapting laws based on older conceptions of matter and property to this new sort of intercourse, in which every kind of intellectual and artistic product of the human mind has to be conveyed through an immaterial medium to an indefinitely dispersed audience.

THE "MAURETANIA" SAYS GOOD-NIGHT



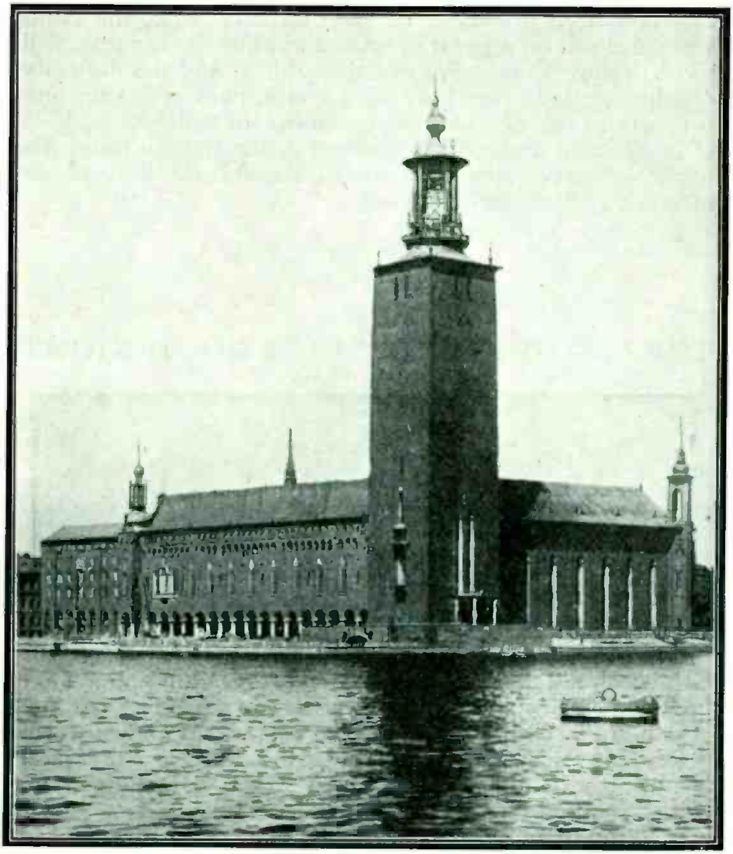
On August 23rd listeners heard the siren of the "Mauretania" which had arrived at Southampton after breaking her own record for the Atlantic crossing.

Captain S. G. S. McNeil, her commander, in a few words before the microphone, described the ship as "the most beautiful craft afloat," and said she was a monument to British shipbuilding and engineering.

"On the trip to Cherbourg," he added, "it almost looked as if the old ship were trying to convince us of what we already knew, that her heart was sounder than ever."

Then Captain McNeil said: "Mauretania, blow your whistle. Say good-night, like a good girl."

And across Southampton Water came three long wailing blasts.



E.N.A.

THE NEW TOWN HALL, STOCKHOLM

A typical illustration from the pages of "The Listener," the B.B.C.'s new weekly

B.B.C. PUBLICATIONS

ALL the B.B.C.'s publications find their origin in the broadcast programmes, to which each and every one is accessory in some way or other. The majority are derived from the British programmes, but a small group, made up of World-Radio and its subsidiary publications, meets the requirements of listeners to foreign programmes and fosters the international aspects of broadcasting.

There may possibly be listeners who are unaware of the existence of some of the B.B.C.'s publications and of the advantages to be derived from them as cheap, authoritative, and artistic, aids to listening. For their benefit something is said in the following pages of *The Radio Times*, *The Listener*, *World-Radio*, and the B.B.C. books and pamphlets.

Particular attention is drawn to *The Listener*, a new weekly published in the year covered retrospectively by this book, as being something unique in contemporary journalism in this country: unique in that there is no other serious weekly review covering so wide a field so thoroughly and so authoritatively. *The Listener* prints a full selection of the broadcast talks, and reflects their great variety of subject and interest.

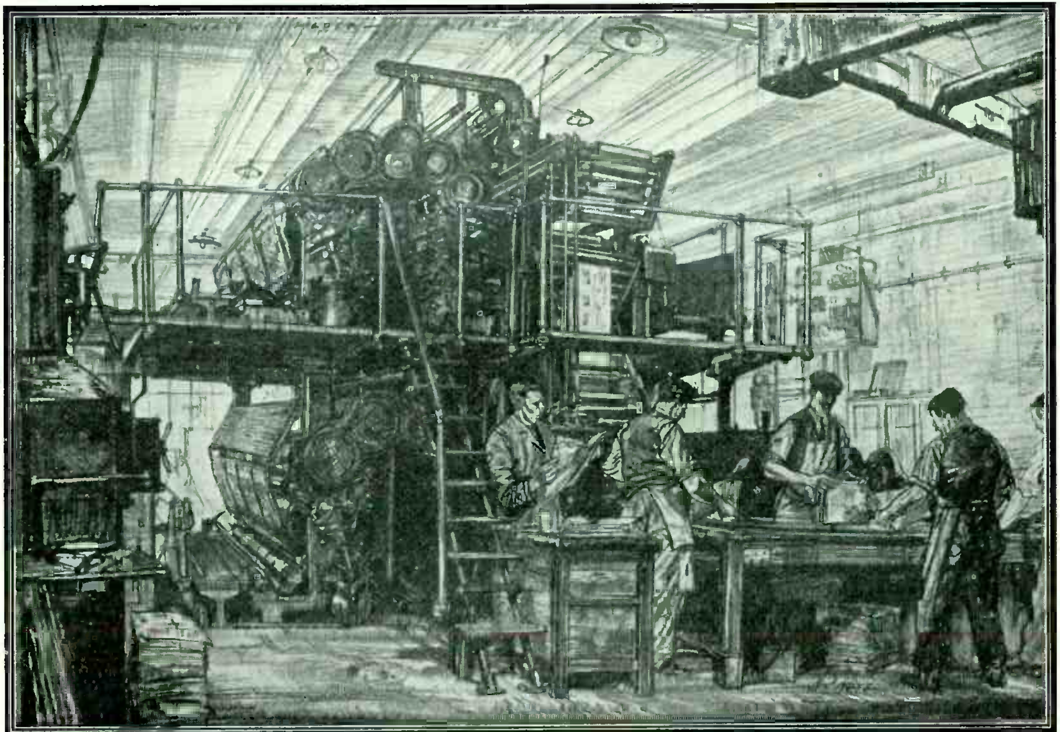
All B.B.C. publications can, if need be, be obtained direct from the B.B.C. Bookshop, Savoy Hill, London, W.C. 2: but most of them can be more conveniently bought from any bookstall, newsagent, or bookseller. Certain of the B.B.C. pamphlets can be purchased under a Subscription Scheme, particulars of which will be found in the advertisement columns of *The Radio Times* and other publications. Details of certain free technical pamphlets will be found on p. 460.

A SHORT summary of the B.B.C. programmes for any given day is published in most daily newspapers. This is often regarded as sufficient by the listener who regards wireless as a toy, or a noise, and is content to switch on his set for a few minutes haphazardly at any time of the day or night, without feeling the need for anything more than a general answer to the question "What's on?", or a rough verification of the fact that what he thought was an orchestra was really a military band.

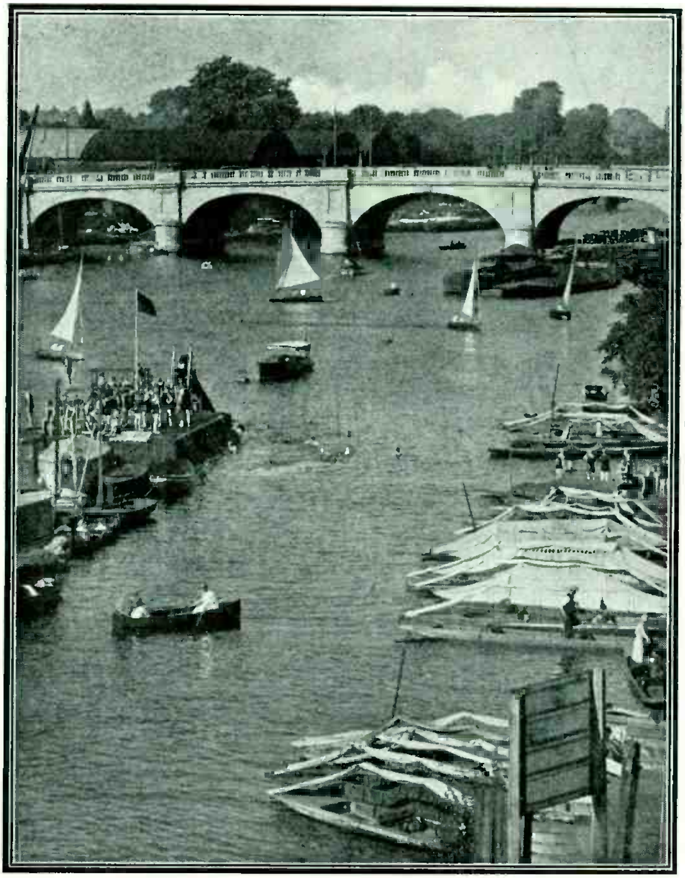
The Radio Times, on the other hand, prints the detailed official weekly programme of the B.B.C., and is published on Fridays with programmes for the week starting on Sunday. It is intended to provide a complete accompaniment to the programmes, in the form of notes, articles, and illustrations, as well as a magazine acceptable to everyone interested in broadcasting. Although some listeners may use it mostly for casual reference to the programmes, its main purpose is to enable its readers to plan their listening a week ahead and to provide for them everything necessary for the enjoyment and understanding of the programmes. Without its help, listening is blundering in the dark; with it, it becomes a sensible and congenial occupation.

In the past year *The Radio Times* has developed its policy of publishing special numbers in addition to the customary enlarged Christmas number. These have taken the form of holiday issues (Summer, Easter, Whitsun) and special programme numbers such as Vaudeville, Radio Drama, Sporting, Opera, and Military Music. A new feature in the Christmas number of 1928 was the eight-page supplement in sepia photogravure, the success of which has justified its repetition in 1929. In September 1928 the design of the ordinary weekly front cover of *The Radio Times* was modernised.

Perhaps the most striking feature of the past year has been the great increase in the number of letters sent to *The Radio Times*. These now average two or three hundred a week and deal with almost every aspect of the programmes. These letters are quite distinct from the programme opinions which listeners have sent to the B.B.C. from the very earliest days.



A DRAWING BY ROWLAND HILDER. THE GREAT ROTARY PRESS ON WHICH "THE RADIO TIMES" IS PRINTED



Edgar Ward

KINGSTON BRIDGE

Another typical illustration from "The Listiner"

The Listener

THERE is no other paper in Great Britain quite like *The Listener.* In journalistic character and standard it takes its place beside the old-established sixpenny weekly review such as *The Spectator* and *The Saturday Review*, but it differs from them in four ways, viz. in being non-political, in covering a wider field, in being fully illustrated in half-tone, and in being sold for twopence. The price is dictated by the B.B.C.'s cardinal principle of making everything it provides available for the poorest listener who wants it: the illustrations are the necessary complement of the loud speaker; the avoidance of party politics is one of the inherent conditions of broadcasting; and its wider field is that of the whole range of the spoken word in the broadcast programmes. Hence *The Listener* is not a political weekly; to call it a literary weekly is to understate its scope; and it does not aspire to be a "popular weekly" with the usual connotation of sensations, scandals, and "mammoth" competitions.

It was for these reasons that there was no substance in the fears of the publishing and newspaper interests, which opposed the publication of *The Listener* in January 1929. *The Listener* fills a definite place as a digest of the broadcast talks, and meets a long-felt need which no previously existing paper tried to satisfy. Further, it is helping to enlarge the public interested in knowledge and in books, a process entirely beneficial to the Press and publishing trade, besides carrying the hall-mark of the public interest.

One of the main objects of *The Listener* is to promote the effectiveness of the B.B.C.'s work in adult education, by linking up the interests of the occasional listener with those of the serious, regular student. Both will find here a dignified, simple and reliable guide to current problems and movements of thought and taste.

The reader should realise that he will find in *The Listener* each week nearly everything of permanent value in the spoken word of the broadcasts of the previous week: many of the important talks are reprinted in full, and extracts are made from the others. He will also find notes, articles, and illustrations to accompany the talks of the forthcoming week, the paper being published in mid-week (on Wednesday) to facilitate retrospective reference to one week and prospective reference to the next. Special mention should be made of the illustrations, a strong feature of the paper, perhaps unparalleled in contemporary journalism.

In the autumn of 1929 *The Listener* issued the first of a series of illustrated supplements designed to meet the practical needs of readers who wish to study some particular subject or period. The first supplement provided an introduction to the appreciation of art, and the second a complete study of puritanism. A Christmas supplement will deal with "The Supernatural in Literature." The supplements are intended to be complete, workman-like, and authoritative, with really full, but selective, bibliographies, and suggestions as to practical steps to be adopted for experience and experiment.

"THE LISTENER" IN THE SHADOW OF THE MATTERHORN

W O R L D - R A D I O

EARLY in 1930, or possibly sooner, *World-Radio* will appear on the bookstalls with its front cover printed in black and red, thus giving a distinctive note to a journal which has established itself as the most important world-programme paper. The past year has mainly been notable for the steady development of the technical side of the paper in the direction of making increasingly available for the reader the fruits of the B.B.C.'s knowledge and experience in all matters connected with broadcasting. The articles carry the technical authority of the B.B.C. and deal with every possible question, from the simplest difficulties of the non-technical reader to abstruse problems of transmission and distant reception.

For readers of this book who have not seen *World-Radio*, it should be explained that it publishes each week some sixty columns of foreign programmes arranged under the days of the week. In addition it publishes lists of stations in order of their wave-length (a dictionary for identifying unknown stations), selected lists of the most important foreign broadcasts, and much other matter designed to help the listener to distant stations. Every owner, therefore, of a valve set capable of receiving foreign stations should find *World-Radio* indispensable, especially as it offers an unrivalled free identification service to readers who are puzzled by unknown stations, and puts its technical experience at the service of any reader requiring help or advice.

Two *World-Radio* publications should be mentioned. Its *Broadcasting Map of Europe* has been prepared under the supervision of the Hydrographer to the Royal Navy (Rear-Admiral H. P. Douglas, C.M.G.) and employs a projection which gives absolute accuracy in distance and direction from the British Isles. The map is printed in colours and mounted on linen. The *Station Identification Panels* provide, in tabular form, full particulars of all important stations under the headings of frequency, wave-lengths, power, distance from London, and opening signal, with the station's method of closing down and any other characteristic details, as well as information as to what other station's programme it is in the habit of relaying. The book of panels is frequently revised.

THE B.B.C. PAMPHLETS

EVERY listener should become acquainted with the pamphlets published in connection with the broadcasting programmes. These pamphlets reach a high standard artistically and typographically, deal authoritatively with a variety of subjects, and conform in price to the B.B.C.'s ideal of cheapness as a means to the widest service.

The School Pamphlets, which are arranged in the manner best suited to the needs of schools, are perhaps, owing to their form, of limited general interest, although the subjects dealt with—travel, science, music, history—have the widest appeal, and many older listeners would find pleasure in going to school again, at home, with the help of a pamphlet and wireless set. The Aids to Study Pamphlets, on the other hand, do not sacrifice their general interest on the altar of broadcasting, and they may, but not with the greatest advantage, be read merely as pamphlets entirely divorced from the programmes. These pamphlets deal with subjects such as heredity, chemistry, mechanics, electricity, biology, history, philosophy, astronomy, and the country-side, are well illustrated, and contain bibliographies and advice as to study, in addition to the short sections summarising the broadcast talks in connection with which they are issued. Any possessor of a wireless set who happens to be suffering from a temporary lack of interest in life is invited to try the tonic effect of studying some entirely new subject with the help of a series of broadcast talks, an Aids to Study Pamphlet, and a copy of *The Listener* (see p. 253). Study will be found a great stimulant and an architect of character and happiness.

Attention should be drawn to the opera librettos, issued once a month before the broadcast and providing in printed form the words which no opera company in the world can make clear and audible throughout a performance.

Finally the B.B.C. Technical Pamphlets exist to remind listeners of their dependence on the proper functioning of their sets, and to help them towards the ideal of perfect reception.

TECHNICAL SECTION

THE ETHER

TRANSMISSION

STUDIO AND RELAY

RECEPTION

INTERNATIONAL

GENERAL

CAPTAIN P. P. ECKERSLEY

Chief Engineer to B.B.C. since 1923, who resigned his appointment in September 1929

THE ETHER

SPACE AND ETHER

By Professor A. S. Eddington, F.R.S.

As far as, and beyond, the remotest stars, space is filled with ether. It permeates the interstices of solid matter. It is everywhere. Ether bears the radio waves from the transmitting station to the listener. The same kind of waves as radio waves, but many octaves higher in frequency, work a television receiver with which we happen to be naturally equipped, viz. the eye; these waves (which are generally named "light") travel to us through the ether from near and far, and he who looks up at the stars in the night sky receives with his eye waves which have travelled through the ether for hundreds of years—so remote are their stations of origin. Besides waves, the ether can transmit a kind of strain, such as the force that is bad for our watches near the dynamos of a generating station, or the tension that precedes the crack of lightning.

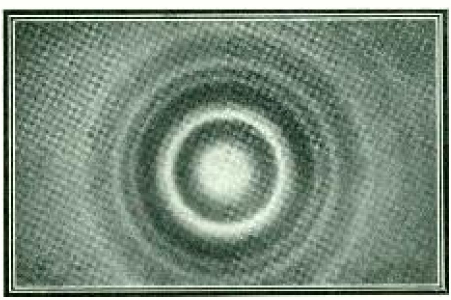
How much does ether weigh? Is it lighter than hydrogen or denser than platinum? Is it fluid like water or rigid like steel? How fast is our earth moving through it? In which direction do the particles of ether oscillate when a wave passes over them? These are some of the questions one naturally asks; and at the end of a century's study, physics can give no answer to any of them. We are, however, convinced that the unanswerableness of these questions is not to be reckoned as ignorance, but as knowledge. What we have found out is that ether is not the kind of thing to which such questions would apply. Ether is not a kind of matter. Questions like these might be asked about matter, but they cannot, for example, be asked about Time; and we must reckon ether as one of the things they are inappropriate to. Ether has no weight; that does not mean that it is lighter than hydrogen, but that the notion of weight of ether has the same kind of inherent absurdity as the notion of weight of Time. It is some advance in our knowledge of ether that we should be able to enumerate a string of qualities and characteristics that it has *not* got. Of positive characteristics it is less easy to speak, though there always remains the property with which we started, viz. that it is capable of undergoing some kind of wave-oscillation. One nineteenth-century physicist in answer to the question "What is the ether?", replied, "The nominative of the verb to undulate."

Ether is not a kind of matter; it is non-material. (That, of course, does not mean that it is in any way associated with ghosts.) It is more fundamental than matter—a simple basis out of which matter emerges as a complex structure. There was once a theory that material atoms are vortex rings in the ether. The theory is quite untenable, but it illustrates very well the kind of relation we expect to find between ether and matter. You can describe the nature of smoke-rings to anyone familiar with smoke, but it would be difficult if not impossible to describe the nature of smoke to anyone who was only familiar with vorticity. Similarly, we have to explain matter in terms of ether; we cannot explain what ether is like in terms of matter or the other familiar things of experience.

Since ether is not material it has not any of the usual characteristics of matter—density, rigidity, etc.; but it has quite definite properties of its own. The mathematician describes the state of the ether by symbols, and he describes its characteristic properties by mathematical laws which the symbols obey. When one of the symbols takes rapidly fluctuating values (positive and negative), that means that a wave is passing over the corresponding spot in the ether; the period of the fluctuation indicates whether it is a radio wave, or a light wave, or an X-ray. The same symbol taking a steady value will indicate a magnetic or an electric strain in the region. And so the symbols serve to connect up phenomena which at first sight appear totally different. It is all very mysterious—using symbols without having the least conception what they really stand for; but that is the way we are able to extend science into regions beyond reach of any of our familiar conceptions. I need scarcely remind the listener to broadcasting that these methods have abundantly justified themselves by their practical results.

There is no space without ether and no ether which does not occupy space. A few distinguished physicists maintain that modern theories no longer require an ether—that the ether is abolished. I think all that they mean is that, since we never have to do with space and ether separately, we can make one word serve for both together; the word they choose is "space." I do not want to drift into a verbal discussion as to whether the word "space" will stand the strain they are putting on it. If they employ the term "space" they need to add a long statement explaining all that they intend it to imply; just as I, who use the word "ether," am trying in this article to explain what it implies. At all events they agree with us in employing an army of mathematical symbols to describe what is going on at any point where the ether is (or, according to them, isn't). "Wheresoever the carcase is, there will the eagles be gathered together," and where the symbols of the mathematical physicist flock, there presumably is some prey for them to settle on—which the plain man at least will prefer to call by a name suggestive of something more than passive emptiness.

The change in our conception of the world wrought by the ether theory may be illustrated by an incident not infrequent in astronomical observatories. A visitor is handed a photograph of some interesting celestial object. He looks at it attentively, but is puzzled; he cannot get the hang of the thing. At last the astronomer sees what is the matter. "I ought to have explained. This picture is a negative. The dark marks are the things to follow, the bright part is to be regarded as mere background." The visitor adopts the hint, mentally turns the picture inside out as it were, and now it all makes sense. Something like a turning inside out of our familiar picture of the world around us is what the ether theory really stands for. The early electrical theories focussed attention on an electric fluid flowing in a wire, treating the space outside the wire as mere background. Faraday taught us that, if we would understand the phenomena of current electricity, the supposed background—the field outside the wire—was the place to attend to, the place where things were going on. At one time the change of view was carried to an extreme; the wire became mere background—a groove that guided the activity that was observed in the ether around it. That would scarcely be true to-day. But Faraday's view of an activity outside the wire has never been modified. To the theoretical physicist wireless telegraphy is much less sensational than telegraphy with wires. That electrical energy can be transmitted without constraint through the ether is not surprising; the odd thing is that we should be able to compel it to follow the guiding line of a telegraph wire. If you can make this reversal of the picture, turning space from a negative to a positive, so that it is no longer a mere background against which the motion and extension of matter is perceived, but is as much a performer in the world-drama as matter is—then you have the gist of the ether theory, whether you care to use the word "ether" or not. I think the plain man will hardly attain this picture if he conceives nothing but empty space outside matter. Some essence or quality capable of modification and activity must be added to the ordinary conception of space, and it is this addition which we try to convey when we say that all space is filled with ether.



WAVES OF MATTER

The pattern formed by electrons which have gone through a very thin film of gold, and are behaving as if they were ether waves

RAYS AND WAVES

By Sir William Bragg, K.B.E., F.R.S.

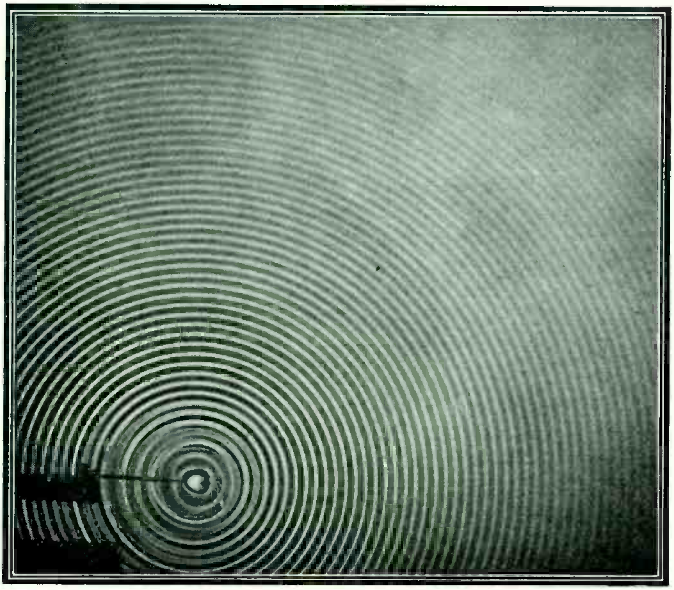
THE very title of this article, a title chosen by the Editor, is significant of the existence of an extraordinary problem, one of the most important and most interesting problems in physical science. No one can yet give the complete solution, and yet no scientific question has been more studied in the past, or, in its various forms, is attracting more attention now.

Why should there be any connection between rays and waves? We do not associate them very readily. Our most vivid impression of rays is found in the streaming of light from a source, in the shafts of sunlight when revealed by scattering as they cross a misty sky or a dusty room. We represent them by straight lines "radiating" from a point source. If we use the term ray or radius in any other of the senses which it is made to cover, the principal idea is still the divergence of geometrical forms from a point, as in the petals of a flower, or the elements of a design, or the conventional drawing of a star.

The sun's rays are of such primary importance to the world and its inhabitants that their source has been worshipped as a god. When man began to inquire into the mutual relations of the phenomena about him, one of his first efforts was to solve the nature of light. It is easy to see why many great thinkers, and Newton among them, have been led to conceive of light rays as streams of minute corpuscles proceeding from the luminous source. The transfer of energy along straight lines was then so readily explained. Moreover, the hypothesis could be made to cover other observed effects, and especially the two important attributes of intensity and quality. The first of these is measured by the quantity of energy crossing a given area in a given time; and may obviously depend on the number or mass or speed of the particles. It is to be observed, however, that there is but one velocity of light in space. The second attribute, that of quality, is far more difficult to define precisely. Within certain limits our eyes and brains detect variations of this quality and register them as differences of colour. Outside those limits our senses fail: when we hold our hands to receive the warmth of the sun's rays or of a fire, we can make a rough estimate of intensity, but quality escapes us. Yet heat rays are known to differ among themselves and from visible rays only as one kind of visible ray differs from another, say red from blue.

On the corpuscular theory of light this variation in quality might be supposed to lie in differences among the corpuscles.

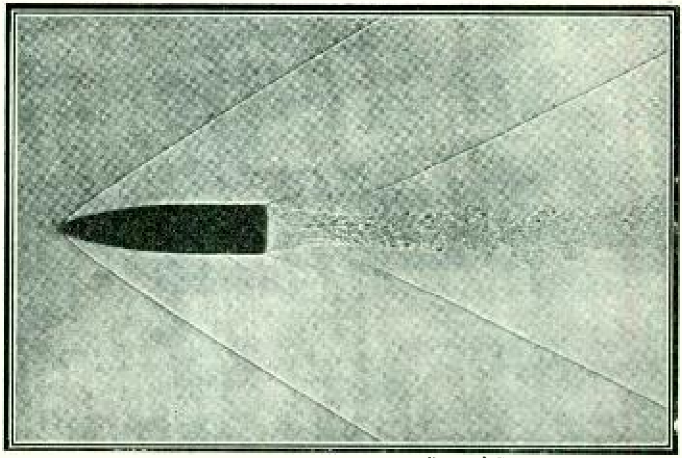
Now, what are waves? Our imagination at once shows us the movement of waves over the surface of the sea. There is here also a propagation of energy. The wave motion takes up the energy of the wind and brings it to a shore where it shifts sand and rocks: first air, then water, then earth. Moreover, we can find something in wave motion to correspond to the emission of rays from a central source. We say that when a stone falls into the water, ripples "radiate" from the point of



Dr. A. H. Davis, National Physical Laboratory

WAVES IN WATER

Ripple photograph showing "radiation" closely analogous to that of wireless waves



Research Dept., Woolwich Arsenal

AIR WAVES

An instantaneous photograph of the flight of a shell

striking. There is some resemblance here to the transfer of energy by corpuscular radiation.

In other respects rays and waves seem to differ entirely. When waves move over the surface of the sea, they do not take the water with them; they use it, so to speak, and pass on. The energy travels forward at a steady rate, but the water does not, nor do any objects that float upon its surface. These only rise and fall, and sway backwards and forwards. Wave motion is a strange thing to imagine. Why, one may ask, does the form travel forwards at all? Mathematical investigation of course supplies an answer at once; but it is not easy to satisfy one's mind by other means. If the sea were suddenly frozen so that all its waves stood still, and if then it were suddenly thawed, would the motion continue as before? No: the water would simply flop up and down, there would be no reason why the waves should move in one direction rather than in the other. To restore the old conditions the water on one side of each wave crest must be given back its upward momentum and that on the other its downward momentum.

Thus a difference is made between the two sides of the wave: to the water on one side the crest advances, from that on the other it recedes, and again there is a direction of propagation.

The sea waves, like light, have the two attributes of intensity and quality. A slight sea, a moderate sea, a rough sea; these expressions imply different degrees in the rate of transference of energy over the surface, the higher the wave, the greater the rate, other things being the same. But also waves may be long or short, ocean swells or ripples: here is an obvious difference in quality.

They were not unreasonable, therefore, who tried to describe light as a wave motion in an all-pervading ether, which medium had to be invented for the purpose. There was no difficulty in the conception of a wave motion in space, though the familiar wave motion of the sea was in two dimensions: there could be no thought, of course, of making a mental picture of it. Their chief difficulty was to explain the straight line propagation to which shadows are due, the property which actually suggested the corpuscular theory. The difficulty was finally surmounted when it was observed that a shadow is never perfectly sharp. When waves flow past an obstacle the shadow is blurred and hazy unless the distance from crest to crest is small compared to the size of the obstacle. It is possible for a boat to shelter behind an island but not behind a single post sticking out of the water. In order, therefore, to explain light as a wave motion in the ether it is only necessary to suppose that the wave length is very small indeed compared to the dimensions of objects usually viewed by the naked eye. This conception is supported by the observed fact that a microscope fails to give us true pictures of objects below a certain size, and does so just in the manner we should expect if the failure were due to an approximation of the size of the object to the length of the wave of light.

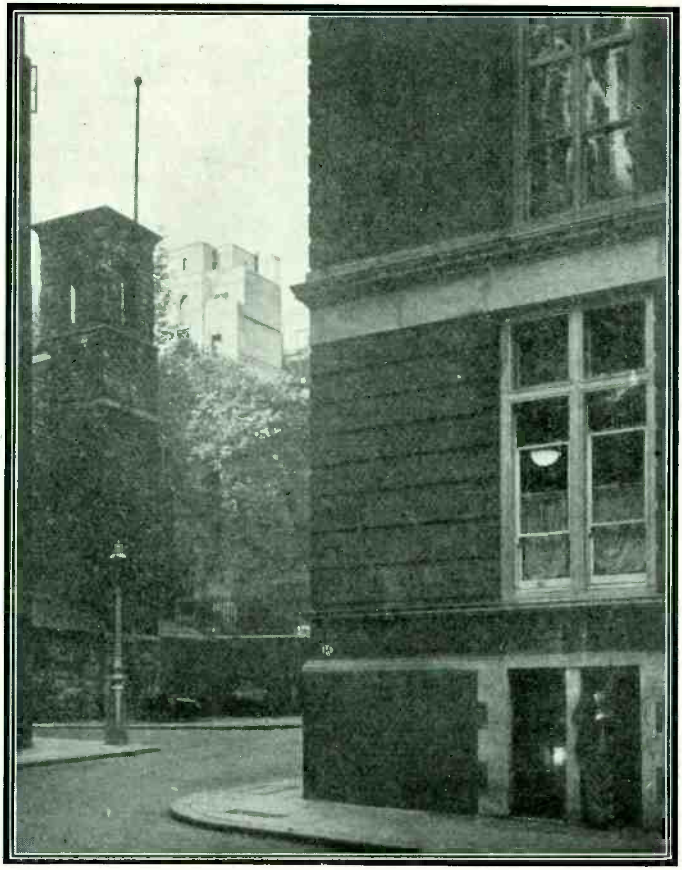
Thus streams of corpuscles and waves in an ether have both been used as a means of picturing the propagation of light. And we must extend this word light to include far more than the eye can see. Wave lengths that are visible are a little less than a ten-thousandth of a centimetre from crest to crest. Ultra-violet rays, X-rays, gamma rays, are shorter; waves used in wireless are far longer, as we observe in the broadcasting columns of our daily papers.

Why then do we not in these days confine ourselves to one mode of expression? Why do we add complications by using sometimes one and sometimes the others?

Not long ago the wave had become the one useful mode of expression. All the great optical discoveries of the nineteenth century were expressed in terms of it: indeed no other course was possible. Nor is it possible now to use any other means of describing innumerable and frequent phenomena. For instance, Appleton and his fellow-workers tell us how a wireless signal may arrive at a given spot on the earth's surface by two different paths.* One of these runs close to the surface from source to receiver. The other path is in two portions, one half consisting of an upward motion in the air, the other of a downward movement subsequent to reflection by the Heaviside layer in the upper atmosphere. If the two paths differ by an exact number of wave-lengths, they join again crest to crest and the signal is strong. But if there is a half wave-length over, each crest of one fits into a hollow of the other and there is no result. It is impossible to describe this effect conveniently in terms of corpuscular rays.

Recently, the corpuscular theory has reasserted itself; for there are some phenomena which the wave theory is hard put to it to explain. These occur most obviously in places where streams of high-speed electrons impinge on a target as in the X-ray bulb, and where the X-rays in their turn produce flying electrons. The electron streams are clearly corpuscular rays: the X-rays are known to be waves like those of light. But there is no doubt that the X-rays themselves behave in some ways like corpuscles in flight: and when we find ourselves obliged to recognise that in some way the corpuscular theory and the wave theory are both true, and simultaneously true, we also recognise that we have still a great deal to learn. We do not yet know all that there is to know of rays and waves. The desire to solve the riddle has been an urging impulse of the development of physical science for centuries past, and still the interest grows.

* See next article.



AN UNUSUAL VIEW SHOWING THE CORNER OF THE B.B.C. OFFICES AT SAVOY HILL AND THE FAMOUS SAVOY CHAPEL

ATMOSPHERIC ELECTRICITY AND WIRELESS TRANSMISSION

By Professor E. V. Appleton, M.A., D.Sc., F.R.S.

ALTHOUGH everyone knows that a thunderstorm is a manifestation of the electrification of the atmosphere, few people are aware that the atmosphere, even in fine weather, is the source of quite marked electrical activity. If a person walks out of a building he immediately becomes electrically charged, partaking of the general surface charge of the earth. In normal fine weather this charge is negative, and therefore attracts downwards the positive electricity which is always present in the atmosphere. The result is a downward current of electricity from the atmosphere to the ground, which amounts to about a thousand amperes for the whole earth. Thus the atmosphere is to a small extent electrically conducting even in the regions near the earth. Evidence derived from the phenomena of wireless transmission and of terrestrial magnetism has shown, however, that in the upper regions of the atmosphere, say 60 miles or so above the ground, the atmosphere is a very good electrical conductor, its conductivity there being comparable with that of the earth. This ionised or conducting region, which is known as the Heaviside layer (for it was Dr. Oliver Heaviside who first postulated its existence), may be regarded as the positive pole of the big battery responsible for the downward flow of positive electricity through the atmosphere, the negatively charged earth acting as the negative pole. Controversies still exist as to the source of the energy of this huge battery, which has an electromotive force amounting to about a million volts, but the theory fairly generally accepted nowadays is that this energy is derived from thunderstorms, which are always in action at some point or other on the earth's surface.

For our present purpose, namely, the study of the influence of atmospheric electricity on wireless transmission, we need not concern ourselves with the current produced by this big battery, nor with the problem of its source of energy. It is the fact that both of its spherical poles, namely, the Heaviside layer and the ground, are electrically good conductors that concerns us here, for we have to think of our wireless waves as travelling economically in the space between these two shells rather than as spreading out wastefully into space from a point on an unsurrounded sphere.

Let us consider the favourable influence of the Heaviside layer first. If this conducting shell were absent it would be quite impossible to send signals, say, from one side of the earth to the other—as is done every day by Beam wireless. To realise this it is only necessary, as Sir Joseph Larmor pointed out some time ago, to imagine the scale of length reduced so that the earth shrinks to a sphere of 10 inches diameter and the wireless wave-length shrinks by the same relative amount to become the wave-length of visible light. Familiar experience tells us that if a small source of light were situated at a point on the surface of such a sphere there would be no appreciable illumination at the antipodes. We therefore conclude that wireless waves in the large-scale case cannot bend round the earth's curvature without the assistance of some other agency. Since, however, the Heaviside layer acts as a kind of reflector to wireless waves, the waves travel to and fro between it and the ground and so reach the most distant part of the earth. In so travelling the loss in the strength of the waves is in some cases so small that the signals are still appreciable after the waves have travelled as many as four times round the earth.

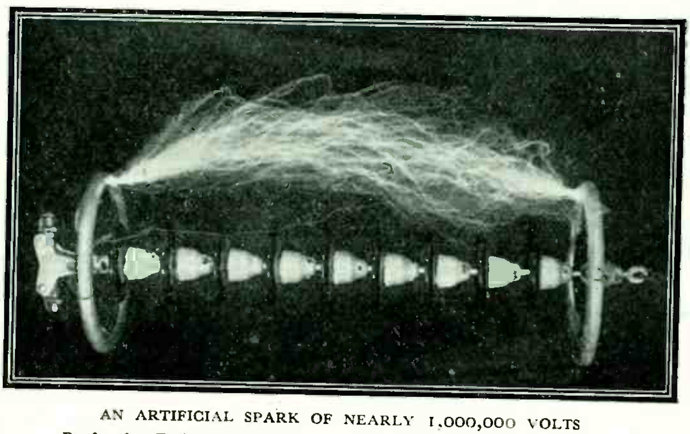
The way in which this atmospheric layer of reflecting electricity affects broadcasting is sometimes advantageous to the listener and sometimes not. During the day the reflecting power of the layer for broadcasting wave-lengths is low and signals are received mainly by way of the short straight path from the transmitter to receiver along the ground. But after sunset the layer reflects to a much greater extent, so that, in general, both direct waves and reflected waves arrive at the receiver. As the reflected waves from the layer are very variable, while the ground or direct waves are quite constant in intensity, the type of resultant signal depends on the particular position of the listener. At short distances the signal is mainly due to the ground waves, so that a constant and reliable service is possible, but at about 100 miles from the transmitter very marked variations are experienced as the variable reflected waves change from being in-step with the ground waves at one moment to being out-of-step a minute or so later. The result is generally a signal of variable intensity and, during the signal minima, bad quality. At distances greater than 100 miles the signal is almost wholly due to the reflected waves and is therefore somewhat variable in intensity.

Listeners who are situated a long way from the transmitting station, and who are able to receive only at night-time, often complain of the uncertain intensity and bad quality of their signals, but they should remember that the day-time signal is that to which the sensitivity of their receiver really entitles them. The stronger night-time signal they experience is merely a gift from the upper atmosphere, and they should not complain if it is a somewhat variable quantity.

Experiments on the very short waves have shown that the ground waves die out very rapidly, so that here reception at even moderate distances is accomplished only by waves that have been deflected by the upper atmosphere. But theory shows that the reflecting power of the Heaviside layer becomes smaller the shorter the wave-length. For example, we know that light waves which are very short pass uninfluenced through the layer. The question of the penetration of the layer by wireless waves, therefore, arises. This matter has recently received considerable attention in connection with the mysterious short-wave wireless echoes discovered by Engineer Hals and Professor Størmer in Norway. Listening to signals from the Dutch station PCJ they heard echoes as long as fifteen to thirty seconds after the original signal. To account for these signals Professor Størmer put forward the striking theory that we are here dealing with a case of the penetration of the Heaviside layer by the short 30-metre waves, and that the waves have further travelled out into space to be ultimately reflected by a stream of electrified corpuscles shot out by the sun. Many experiments are now in progress with the object of testing Professor Størmer's remarkable theory.

The question of the penetration of the Heaviside layer is intimately connected with another question, namely, that of the cause of the electrical conductivity in the upper atmosphere. There is little doubt that the free electricity which exists in the layer is due to solar radiation, and within recent years much evidence has been brought forward showing that there is a definite correlation between the reflecting power of the layer and the number of spots on the sun, which is a measure of solar activity. It is well known that there is a definite periodicity in the number of sunspots, the cycle lasting eleven years, and wireless reception appears to show evidence of a similar cycle. It is also believed that climatic changes on the earth, such as exceptional rainfall or drought, follow a similar cycle, so that we might say that, through the sun's agency, there is some connection between wireless and the weather, though there is, of course, no support for the suggestion that wireless transmission affects the weather.

The trend of modern wireless development is such that the radio-engineer is aiming at utilising the beneficent influences of the Heaviside layer to the fullest extent. If we attempt to weigh up the advantages and disadvantages of the influence of the ionised layer, we must regard the successes of long-distance transmission, which are brought about solely by the influence of the upper atmosphere, as more than setting off the fading which listeners unfortunately experience at times, so that on the whole the ionised layer must be considered as a real boon to mankind.



AN ARTIFICIAL SPARK OF NEARLY 1,000,000 VOLTS
Produced at Freiberg, Saxony, by the Hermsdorf-Schomborg Insulator Co.

LIGHTING AND ATMOSPHERICS

By R. L. Smith-Rose, D.Sc., Ph.D., A.M.I.E.E.

THE phenomenon of a thunderstorm accompanied by lightning is one of the most magnificent and at the same time the most awe-inspiring demonstrations of natural powers that human beings ever witness. Even to-day the occurrence of a really large and prolonged thunderstorm instils a certain amount of terror into the minds of men and women, particularly those of lesser education and intelligence. Part of this fear arises from the fact that many of the most spectacular thunderstorms occur at night, when the human resistance to abnormal mental impressions is at or near its lowest ebb. Considering that thunder and lightning have been studied since the earliest days of scientific discovery and experiment, it is perhaps a little surprising to find that an explanation of the actual events occurring during a storm, and of the train of circumstances leading up to it, formed subjects of acute discussion among some of the world's leading scientists at the British Association meeting held as recently as September 1928. Among the difficulties on the scientific side is that of ascertaining the actual facts; many lay observers, and even some of more scientific training, have recorded inaccurate or greatly exaggerated impressions of the events they witnessed.

Without attempting to trespass on controversial ground, it may be said that a thunderstorm arises from the separation of charges of electricity in or near clouds in the atmosphere. When the accumulation of charges becomes sufficiently great, the intensity of the electric stress causes an electrical discharge or spark to occur, during which the positive and negative charges rush together to neutralise each other. This discharge is made evident to our senses by its sound or thunderclap and by the light of the flash. On account of the enormous difference in the velocities of light and sound, the light from any discharge is seen an appreciable time before the sound is heard, this time difference being dependent upon the distance of the observer from the discharge. In the British Isles we are accustomed to look upon thunderstorms as of comparatively rare occurrence and practically limited to the summer months. As a result of statistics collected over a number of years from over 3,000 observing stations, it has been shown that on an average thunder is heard in these latitudes on from 8 to 10 days per year. In tropical regions, on the other hand, thunderstorms are experienced on from 33 to 60 days per year. The complete analysis of this world-study of thunderstorms actually observed shows that on an average there are in progress at any one moment about 1,800 thunderstorms in different parts of the world. Actually, of course, these storms are of more frequent occurrence in the summer than in the winter months. In association with these storms it is estimated that lightning flashes occur at an average rate of one hundred per second. When looked at on this basis one begins to understand the possibility of all the numerous atmospherics heard on a wireless receiver being attributable to lightning flashes as their origin.

As to the actual manner in which the electrical discharge takes place, it is found that lightning flashes as seen from the earth's surface are broadly divisible into two classes. The first of these is supposed to originate in a charge of positive electricity within the cloud, and it grows in a downward direction towards the ground, branching in its path, as indicated by the sketch in Fig. 1. The second type of flash is characterised by its starting from the ground and branching as it moves upwards towards the cloud (see Fig. 2). This type originates in a positive charge on the ground induced by the accumulated charge of opposite sign in the cloud above. Other flashes may occur within the cloud itself, but it is naturally rather difficult to obtain evidence of the existence of these, since they may be quite invisible from the earth's surface. Of the lightning flashes taking place between cloud and earth, observations show that the first or positive type is much more frequent than the second or negative type. In its passage to or from the earth the discharge naturally seeks the easiest path, and thus it tends to make use of any earthed metallic or other conducting objects for the lowest portion of its path. It is to be noted that in the first type referred to above, the discharge originates in the positive electricity in the cloud and grows by ionising the air beneath. As the air ionises, the electrons or negative particles are drawn upwards along the discharge path to

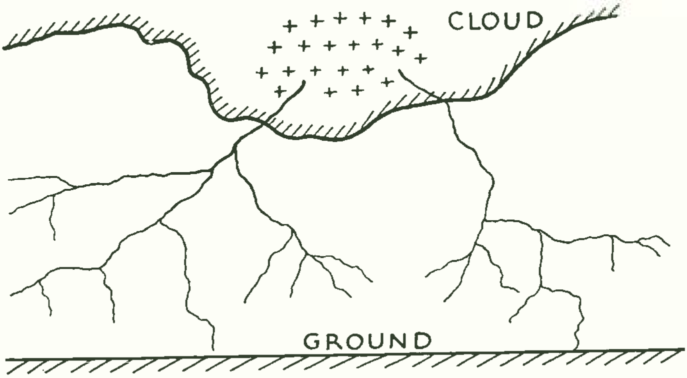


FIG. 1

neutralise the positive charge. When this positive charge is entirely neutralised the discharge ceases, and this may occur before all the branches have reached the ground. An examination of photographs of lightning flashes shows that this is a frequent occurrence.

The most direct way in which lightning flashes come into contact with the wireless listener or experimenter is through what are termed atmospherics, those intermittent grinding or clicking noises which are experienced on any sensitive wireless receiver. While in these latitudes these noises only become really serious in the summer-time, in tropical regions they are far worse and more frequent at all times of the year. A little consideration of the results of experimental measurements of the electrical quantities associated with lightning flashes will show how these atmospherics come about. It has been shown that the quantity of electricity discharged in a flash is of the order of 20 coulombs, representing a current of about 10,000 amperes flowing for about two-thousandths of a second, which is the average duration of a flash. Since the average length of a lightning flash is from one to three miles, the flash corresponds to a wireless transmitting aerial of this length carrying a current of 10,000 amperes. The resulting radiation may, therefore, be from 2,000 to 10,000 times as strong as that from the Daventry station. It is thus to be expected that the effects of the flash will be detectable as an atmospheric on all sensitive receivers within a radius of several thousand miles. When the average frequency of lightning flashes, as stated earlier, is remembered, it is small wonder that atmospherics may practically always be heard on a very sensitive receiver. Recent research carried out in this country under the auspices of the Radio Research Board has enabled visual records of atmospherics to be obtained. These records have supplied much useful information on lightning discharges. Amongst other things they have indicated that the maximum interference is experienced on the longer wave-lengths between 4,000 and 30,000 metres, which agrees with wave-lengths deduced from the usual lengths of lightning flashes. Small-scale experiments carried out with electrical discharges in laboratory apparatus tend to support the view, not generally accepted, that no disturbance is experienced prior to the commencement of the electrical discharge, and that therefore each atmospheric originates in a lightning flash somewhere, whether this be visible or not from the earth's surface.

In considering the results of damage by lightning, it is perhaps surprising to find from the records that in tropical regions the occurrence of material damage is much less frequent than in more temperate zones, although, as has already been pointed out, thunderstorms and lightning

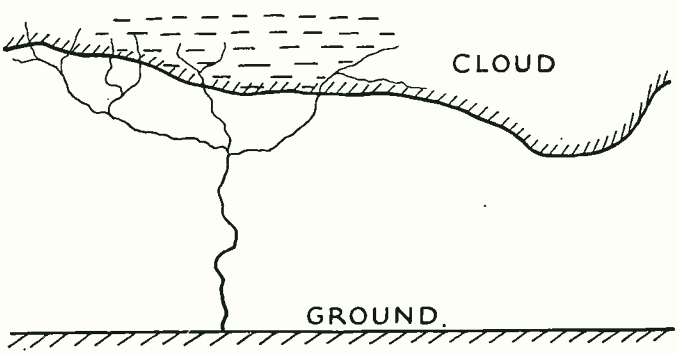


FIG. 2

flashes are much more frequent near the equator. The explanation of this is, that the average height of the clouds is greater in the tropics and it is much more common for the discharges to take place between neighbouring clouds or between different portions of the same cloud than down to the earth, a frequent spectacle being a series of progressive discharges along the under surface of a cloud. When, however, a flash does take place to earth, the effects of the discharge upon any obstacle in the path are frequently made evident by the damage done to trees, buildings, human beings or animals.

A considerable amount of research on the subject of protection from lightning has been carried out in America by the aid of a model lightning generator which gives voltages up to about one-hundredth of those of a natural lightning stroke. By reducing all dimensions to scale the effect of lightning strokes from a model cloud to overhead electrical transmission lines, and to model buildings, has been studied. As a result of such experiments it was shown that with lightning from a cloud immediately overhead no stroke passed to the ground within a radius of about four times the height of the rod above the surface; also that the effectiveness of the rod as a protecting device increased with its height. From such experimental data the chance of objects of different height being struck can also be estimated. For example, a six-foot man on flat ground directly under a storm centre with a cloud at a height of 1,000 feet would be hit fifteen times out of every hundred strokes, while a building 25 feet high would be hit every time. If the man lay flat on the ground his chance of being struck would be reduced to once every hundred strokes. When, however, the storm had moved about three hundred feet away the chance of either the standing man or the building being struck would be practically negligible. It will thus be appreciated that the risk of damage to life or buildings due to lightning is somewhat remote, but that in any case it can be materially reduced by the use of a lightning rod raised to as high a point as possible above the building or area to be protected, and connected at its lower end to a well-earthed metallic plate. The presence of the rod will not increase the chance of being struck, as there will usually be a gutter or water-pipe sufficiently conducting to determine the direction of a stroke in the neighbourhood. Where great precautions are necessary, such as the protection of oil wells or reservoirs of large area, it would seem essential to surround these by a ring of well-earthed metallic towers spaced apart at a distance not greater than four times their height. Even then, while it is possible that one of these towers might take the main stroke of a flash of the type shown in Fig. 1, it would be possible for one or more of the branches to miss the towers and do possible damage. The only really satisfactory method of obtaining complete protection is to shield the building or object inside a continuous metallic enclosure which is adequately earthed. Provided that there is no hole in this enclosure and that no conducting wires pass from outside to the inside without being connected to the metal work at the point of entry, then no spark can occur inside when a flash takes place to the outer metal work. This method of protection is naturally rather costly, but is adopted in this country for the protection of powder magazines, where, naturally, one single hit would have disastrous consequences. On the other hand, the protection by a ring of towers as mentioned above is adopted in America for the protection of oil wells, etc., with apparently very successful results.

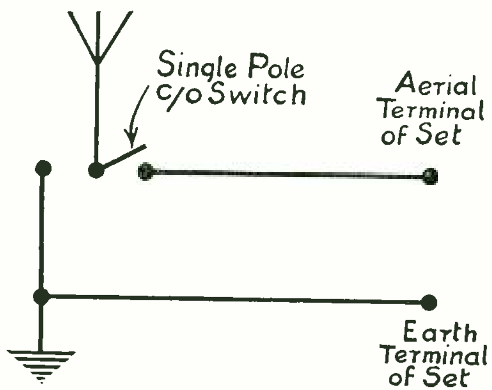
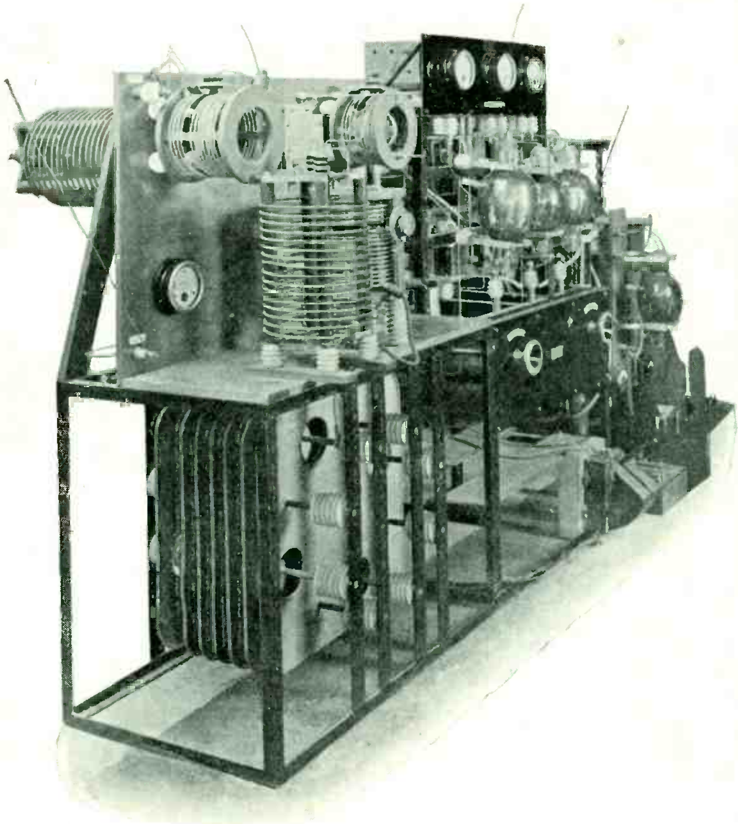


DIAGRAM OF AN EARTHING SWITCH

See para. 2 opposite

EARTH YOUR SET!

1. Don't forget that there are two and a half million sets in use and it is very seldom that a set is damaged by lightning. There is, therefore, only a very slight chance of your particular receiver being damaged.
2. If you wish to listen with an absolute minimum of risk of damage to your house or receiver, an earthing switch connected as is shown in the sketch on the opposite page should be mounted outside the house.
3. If this is inconvenient, the switch can be mounted inside the house as near the point of entry of the aerial as possible, but this is not as good as having it outside.
4. If you already have an earthing switch and are liable to forget to earth the aerial when the set is not in use, it is better to have a lightning arrester installed. A lightning arrester is an automatic earthing switch which will earth the aerial should it accumulate a heavy charge. It may not, however, be quite as effective a protection as an earthing switch. A lightning arrester should be inspected periodically, particularly after a thunderstorm.
5. Should your house already be fitted with a lightning conductor, don't disconnect it, as it will not have a bad effect upon your reception.
6. Don't continue listening when a thunderstorm is near, particularly if you are using headphones.
7. When earthing your aerial, be careful not to touch the metal portions of the switch.
8. If you are using an indoor aerial it is immaterial whether it is earthed or not during a thunderstorm; but it is advisable not to continue listening.
9. Should you be listening during a fall of snow, hailstorm, or thunder shower and experience clicking noises in your reception, it is better to switch off and earth the aerial.



THE EVOLUTION OF THE BROADCASTING TRANSMITTER

1. *The original experimental transmitter at Marconi House*

TRANSMISSION

THE SERVICE AREA OF BROADCASTING STATIONS

DURING past years research and experiment undertaken by the B.B.C. have established certain data which make it possible to predict the true service area of broadcasting stations. A full account of the theoretical considerations and experimental verifications of theory is given in a monograph published by the B.B.C. entitled "The Service Area of Broadcasting Stations."* It is thought that a short account of the theory might be of some interest and value to readers of the B.B.C. Year-Book. This article is accordingly made up of extracts from that monograph.

DEFINITION OF SERVICE AREA

It is considered that degree of service is a function of the clarity with which a programme can be heard. The degree of unwanted interruption to the programme is the degree of failure to give service. The majority of listeners in all countries find their continued interest in broadcasting due to what they hear, not the means by which they hear it. If what they hear is variable in strength, frequently distorted and accompanied by a background of extraneous noises, their enjoyment comes from causes for which the broadcasting engineer cannot hold himself responsible in any way. We are here concerned with broadcasting, not the art of fishing for microvolts in the eddies of the ether. The excellence of the transmitting

* Copies obtainable from the B.B.C., price 5*s*.

service at a given point must be expressed quantitatively as a ratio of wanted signal field strength to interference field strength. This is, of course, largely independent of the type of the receiver; the response characteristic of the transmitter and the receiver will, however, be influencing factors.

In previous publications* three types of service area have been defined as follows:—

(1) "A" service area, in which the field strength is greater than 10 millivolts per metre.
(2) "B" service area, in which the field strength is greater than 5 millivolts per metre.
(3) "C" service area, in which the field strength is greater than 2·5 millivolts per metre.

Extracts from the paper referred to read as follows:—

"A listener within an 'A' service area can be absolutely guaranteed a service whatever (within obvious limits) the sources of extraneous interference, but will require a reasonably selective receiver to hear relatively distant or weak stations.

"A listener within a 'B' service area can be guaranteed crystal reception with a good outdoor aerial, but will be at the mercy of the worst types of interference which occur in perhaps 5 per cent. of cases normally met with.

"A listener within a 'C' service area will be subject to interference from spark sets, electric trains, atmospherics, etc., but in time should be assured of (say) an 80 per cent. service, because it is hoped that some of the interference under the above categories will be eliminated at the source."

Notwithstanding the above definitions, the boundaries of the service area will always be determined where the (variable) strength of the space or indirect ray is frequently equal to or greater than the direct or ground ray. This point is dealt with later.

It is perhaps not irrelevant at this stage to point out that one does not seek, in including the majority of listeners within an "A" or a "B" service area, to make it impossible for

* P. P. Eckersley, "The Design and Distribution of Wireless Broadcasting Stations for a National Service," *Journal of the Institution of Electrical Engineers*, Vol. 66, No. 377, May 1928.

listeners of whatever nationality or district to listen to stations other than local. As an engineer responsible, however, for giving pure quality reception, it would seem that one's first concern is to give a service to populations inside the service area of the stations under one's control, *i.e.* to the "local," not the "distant," listener. Broadcasting has an undeniable international significance, but this is only based upon secure foundations when listeners of different nationalities find themselves inside the service area of the same station. Owing to the unfortunate unsuitability of the wave-lengths allocated to broadcasting by international Governmental agreement, service area is usually (with the notable exception of the long-wave stations) too limited to embrace any but one group of nationals. We must thus, for the present, look to the internationalisation of broadcasting in the linking of distant studio and local transmitter by wire, so that the "distant" programme is radiated by the "local" station.

This article is thus confined wholly to a study of true service conditions, and is, therefore, concerned only with the problem of the listener anxious to hear the "local" programme, whatever it may be, foreign, regional, or national.

THE ATTENUATION OF THE DIRECT OR GROUND RAY

Service area has been defined. The object now is to forecast the field strengths set up in the area around the transmitting antenna. An antenna radiates rays both parallel to and at an upward angle to the earth's surface. The rays parallel to the earth's surface—the so-called ground rays—must first be considered. A complete theory of radiation of ground waves has been set out by Sommerfeld.* The theory has been applied to broadcasting problems in other publications.†

A complete set of attenuation curves has been worked out according to the Sommerfeld theory. It is insisted that these curves are not purely theoretical; they have been verified experimentally.

* *Annalen der Physic*, 1909, Vol. 28, p. 665.

† R. H. Barfield, *Journal of the Institution of Electrical Engineers*, 1928, Vol. 66, p. 204.

A typical set of curves is given in Fig. 1.* The interest in these curves is that the Sommerfeld theory makes it a simple scientific calculation to find out the attenuation of waves over any sort of ground, by simply changing the labelling of the curves of Fig. 1. Thus if waves are transmitted over sea, where the conductivity is a hundred times greater than that of ordinary pastoral country, the curve for, say, 200 metres in Fig. 1 becomes the curve for 2000 metres, or, in another way of putting it, the attenuation of Daventry 5XX radiations on 1600 metres over land is the same as that of a 160-metre wave sent over the sea. This has an enormous practical importance.

In predicting the field strength of the ground ray, then, it is only necessary to know the conductivity of the earth when it is possible to apply the appropriate curve of Fig. 1 and find out the field strength at any reasonable distance. The curves of Fig. 1 are drawn for a radiation represented by the expression that "there is 1 k.w. radiated," but it will be seen hereafter that the design of the antenna makes a considerable difference to the strength of the ground ray, and it will be possible to give curves which take this factor into account. The power in the aerial must obviously influence the extent of service area.

CALCULATION OF THE VALUE OF THE INDIRECT RAY

So far, an expression for the attenuation of the ground ray has been arrived at.

An aerial radiates rays parallel to, as well as at an upward angle to, the earth's surface. We have so far showed how to calculate the value of the direct or ground ray. This section confines itself to a calculation of the indirect ray. The calculations are extremely general, and the results cannot be relied upon to more than the order of 2 or 3 to 1. As has been mentioned before, however, this is not a very serious matter.

The following is an extract from a paper read before the Institution of Electrical Engineers by P. P. Eckersley and Mr. Howe, of the B.B.C. staff, which shows how an indirect-ray value has been calculated and partially checked by experiment.

"The authors, in the absence of complete data as to the

* Detailed curves for different distances are given in the monograph on "The Service Area of Broadcasting Stations," mentioned on p. 281.

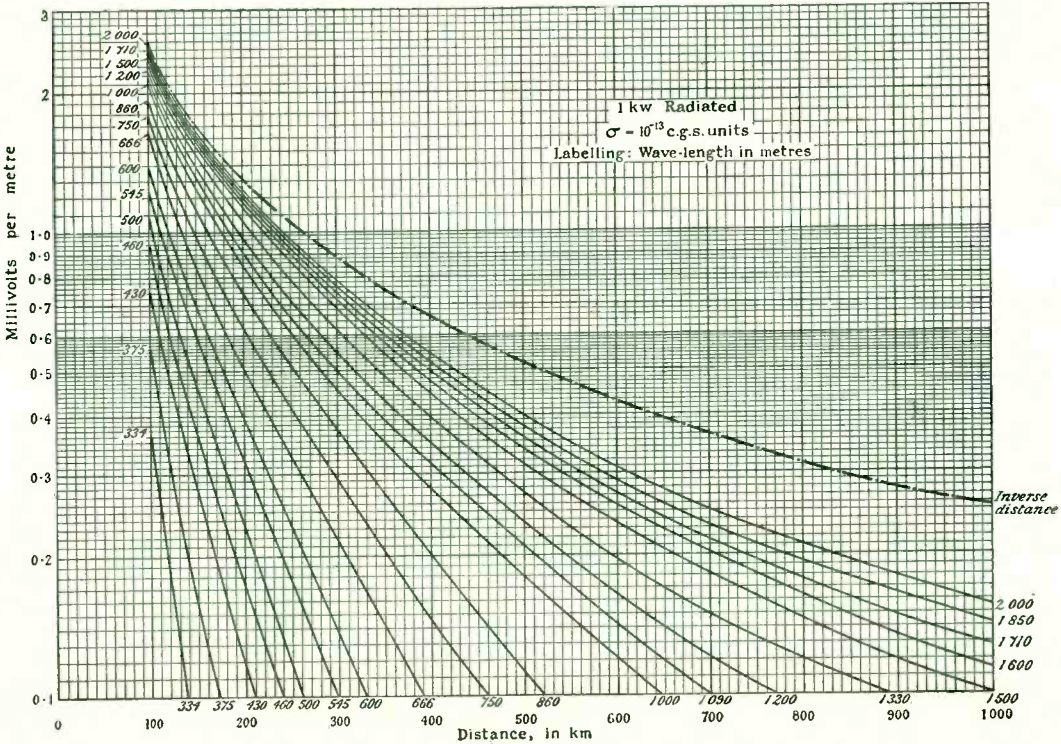

1 kw Radiated
σ = 10⁻¹³ c.g.s. units
Labelling: Wave-length in metres
Millivolts per metre
3
2
1·0
0·9
0·8
0·7
0·6
0·5
0·4
0·3
0·2
0·1
2 000
1 710
1 500
1 200
1 000
860
750
666
600
545
500
460
430
375
334
Inverse distance
2 000
1 850
1 710
1 600
1 500
1 330
1 200
1 090
1 000
860
750
666
600
545
500
460
430
375
334
0
100
200
300
400
500
600
700
800
900
1000
Distance, in km

FIG. I

measured absolute value of the indirect ray, have attempted to estimate it to a sufficient accuracy.

"Their method to estimate the field strength value of the indirect ray has been as follows:—

"They assume that the transmitting aerial (T) radiates rays typically A, B, C, D, etc. (Fig. 2 of this paper), D is the direct ray, while C, B, A, are angular radiations. Rays A, B, C travel in a straight line until they meet the Heaviside layer, where they are bent earthwards again and impinge on the earth at points P_1, P_2, P_3, distant x_1, x_2, x_3, etc., from the transmitting station, T. In order to estimate the value of the reflected ray at points P_1, P_2, P_3, etc., the authors have made the following assumptions:—

"(1) That the strength of upward radiation from a transmitter is determined by multiplying the full radiation in a horizontal direction by the cosine of the angle between the upward and horizontal radiations, *i.e.* the transmitting aerial has a semicircular vertical polar diagram.

"(2) That the minimum absorption coefficient of the Heaviside layer is 0·9. That is to say, if E_1 is the strength of any ray A, B, C (Fig. 2) before entering the layer, and E_2 the maximum strength of the same ray after leaving the layer, then $E_2/E_1 = 1/10$. (Note that it is the maximum field strength value of the indirect ray which determines the interferences.)

"(3) That the absorption coefficient is constant for all angles of impinging rays.

"(4) That the field strength of the indirect ray varies inversely as the distance travelled from earth to layer and from layer back to earth, *i.e.* the distance travelled is TQP_1 or TQ_2P_2, etc. (Fig. 2).

"(5) That the angle of incidence of the ray to the layer is equal to the angle of reflection from it, *i.e.* that rays A, B, C, etc., always follow the path shown diagrammatically in Fig. 2.

"(6) That the height of the layer is 100 km.

"(7) That the value of the horizontal radiation (for a calculation of the indirect and direct ray values) shall be that given by P. P. Eckersley, T. L.

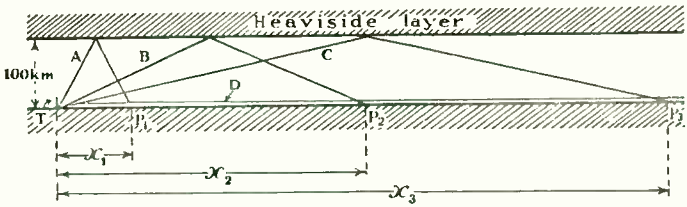


FIG. 2

Eckersley, and H. L. Kirke in a paper recently read before the Institution.

"The curves in Fig. 12 of that paper form the basis of this and subsequent calculations on the relative value of direct and indirect rays.

"It is appreciated that these are somewhat wide assumptions. The fact that they bring a result which agrees with observations must be some justification for their adoption. In support of the assumptions we have, under (1), most transmitting aerials at present in use have a semicircular vertical polar diagram. (2) The reason for choosing this value of absorption coefficient is explained later; it is sufficient at this stage to say that the figure is based on the results of observations. Under (3), Prof. E. V. Appleton has postulated a multi-layer structure of the electrified upper atmosphere. A shallow-angle impinging radiation (*i.e.* a ray nearly parallel to the under surface of the layers) would make a considerable penetration, even if it were better reflected, whereas a sharp-angle ray (*i.e.* one nearly normal to the layer), while it may be worse reflected, has a shorter path in the layer, and therefore loses less of its energy. The absorption coefficient 0·9 is chosen because it fits observed results. Under (4), it is fair to assume no ground attenuation. As to (5), it is probably quite wrong to state that the angle of incidence to the layer always equals the angle of reflection, but it is arguable, on what is known, that if the indirect ray does not always take this path it takes another of equal length, and its value on the earth's surface does not therefore greatly change. We are trying to find a maximum field-strength value of the indirect ray. Under (6), the height is derived from Prof. Appleton's calculations, and is taken as a round figure. It is admittedly an approximation, but for stated reasons this need not greatly upset the final calculations. Under (7) we are justified as the figures are the direct results of observation."

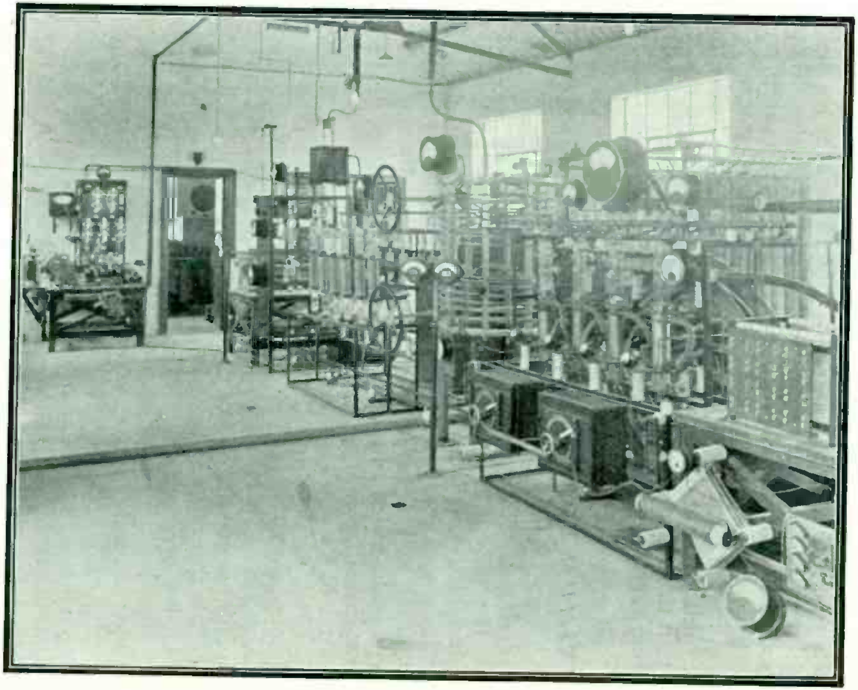
The authors found, by experiment and calculation, an average value of indirect ray of about 0·06 m.b. per metre for 1 k.w. radiated. Later observations and various other considerations make it appear wiser to put this at a somewhat higher value, and, still insisting that the figure merely gives the order of the quantity we shall assume that *for all distances between* 30 and 1000 *k.m. the value of the indirect ray is* 0.1 *m.v. per metre for* 1 *k.w. radiated.*

The simplicity and boldness of the assumption will, it is hoped, appeal to engineers. To justify the rough-and-ready character of the assumption one can say this: it is only necessary to know the value of the indirect ray to assess where severe fading sets in or to calculate the range of stations using the same wave-length. As the radiations along the ground are so difficult to calculate to a great accuracy, as "service" cannot be defined to a millivolt or so, as the whole calculations must take on a most rough-and-ready character, errors of 2 or 3 to 1 are allowable. Nevertheless, the calculations, made possible by the aid of the curves, are essential to the engineer mapping out a new scheme of distribution of transmitting stations.

THE DESIGN OF TRANSMITTING AERIALS

The curves of Fig. 1 are plotted on the basis of 1 k.w. radiated. This means that the radiation resistance of the aerial multiplied by the square of the aerial current gives a power of 1 k.w. But the design of the transmitting aerial must influence its efficiency as a radiator of the ground ray, and the engineer occupied with the particulars of broadcasting must know this efficiency, expressing and meaning his power as power in the aerial, not power radiated.

It can be shown that raising the height of the aerial until its physical height is equal to half a wave-length flattens the vertical polar diagram radiations, so that more energy is radiated along the ground and less upward towards the Heaviside layer. If consideration is given to a long vertical aerial made up of filaments containing equal strength and equal phase oscillatory currents, the effects of these currents



THE EVOLUTION OF THE TRANSMITTER

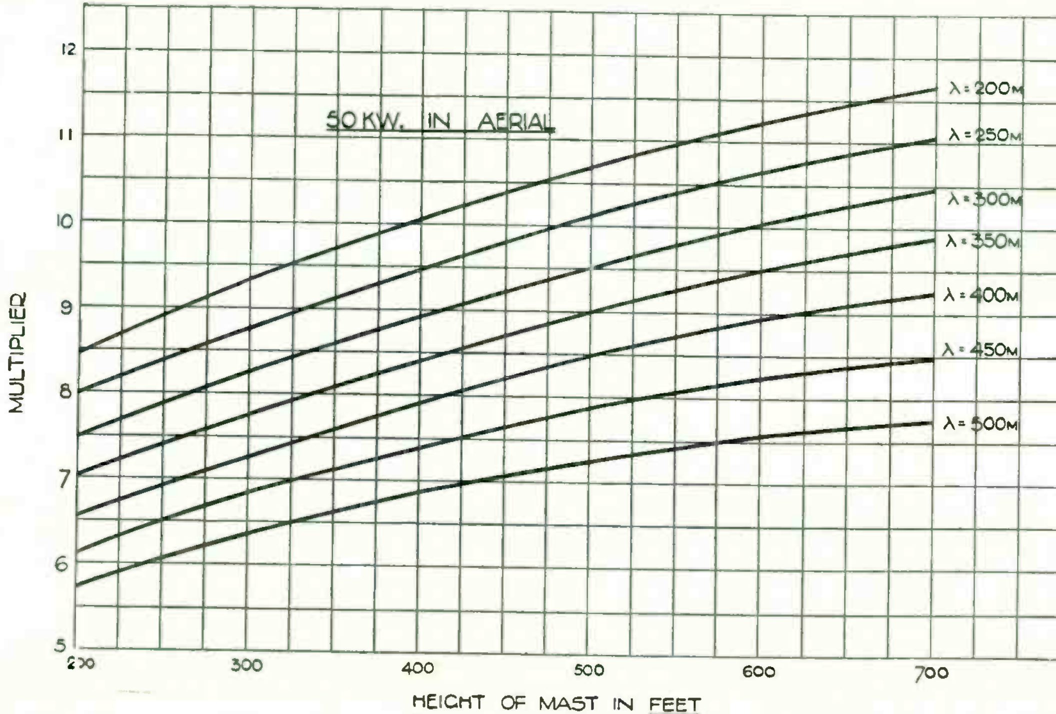
2. *The transmitter of Daventry Experimental Station (5GB)*

tend to add in a horizontal and to cancel in a vertical direction. This produces stronger horizontal and feebler vertical radiation.

Experiments were undertaken with a kite balloon quantitatively to test this theory, and it was found that the experimental results agreed very nearly with theory. By calculation it is possible to arrive at a set of curves which plot a multiplier against the mast height in feet; this multiplier is given for 50 k.w. in the aerial, but naturally bears a direct ratio to other multipliers of different powers. It is assumed in every case that the best aerial possible (that is to say, the T aerial) is supported by the mast of given height. This curve is shown in Fig. 3.

MAXIMUM ECONOMIC POWER OF A BROADCASTING STATION

Considering the foregoing, we see that it is useless to increase the power of a broadcasting station beyond that amount which will give service conditions at the point where the indirect ray becomes comparable with the direct. Obviously fading will be sufficiently pronounced at this point to prevent real service conditions, whatever the power of the station; if we double the value of the direct ray by increasing the power of the station we equally double the value of the indirect ray, and so the fading remains the same, independently of power. But the power of the station will determine the *absolute value of the direct ray* at this point of intolerable fading, and hence the degree of service just within the boundary. This theoretical boundary cannot be traced to a few miles; it is best, however, to proceed as though exact definition were possible, and then derive the orders of quantity desirable. Let us then confirm that, since we have assumed a high value of indirect ray, the boundary of the service area, whatever the millivolts per metre, will fall where the direct ray from the transmitting aerial is equal to the indirect ray from that transmitting aerial. The distance of this point from the transmitting aerial is given by the value of the abscissæ of curve 2 at the point of the intersection of the attenuation curve with the 0·1 m.v. per metre line, *i.e.* the place where the attenuation curve crosses the x axis. (The curves were purposely drawn in this way for this reason.)



50 KW. IN AERIAL
λ = 200M
λ = 250M
λ = 300M
λ = 350M
λ = 400M
λ = 450M
λ = 500M
MULTIPLIER
12
11
10
9
8
7
6
5
200
300
400
500
600
700
HEIGHT OF MAST IN FEET

FIG. 3

It is required, ideally, at any wave-length, to produce 2·5 m.v. per metre at this distance from the transmitting station, *i.e.* to produce the lower limit of "C" service conditions at the point where the direct and indirect rays are equal. Since the curves of Fig. 1 are for a power of 1 k.w. radiated, this power must be multiplied by $(2 \cdot 5/0 \cdot 1)^2$ to get the ideal theoretical power radiated to produce the above conditions. Thus, the power radiated for any wave-length must be 625 k.w. Naturally with higher aerials, for longer waves, and for greater earth conductivity the point at which the direct and indirect rays become equal is further and further away from the transmitter: nevertheless it should be particularly noted that the maximum economic power of a station is independent of all these variables.

A power of 625 k.w. radiated is quite impractical, even assuming the use of a $\frac{1}{8}\lambda$ aerial. We must realise, however, that it is seldom necessary to produce "C" service area conditions for every listener within range of a station. Thus, if a condition arose, using one of the shorter waves, that 90 per cent. of the people to be served lived within a very small radius from the station, it would be foolish, for the sake of a very small minority, enormously to increase its power. We could say that where minorities were found in the outer limits of the service area of the station it was sufficient to produce ·1 m.v. per metre at the point of intolerable fading. A simple calculation shows that in this case the maximum economic power radiated comes to 100 k.w. In sum it will be seen that the rigid definition of the maximum economic power of a station is impossible, and must depend upon conditions.

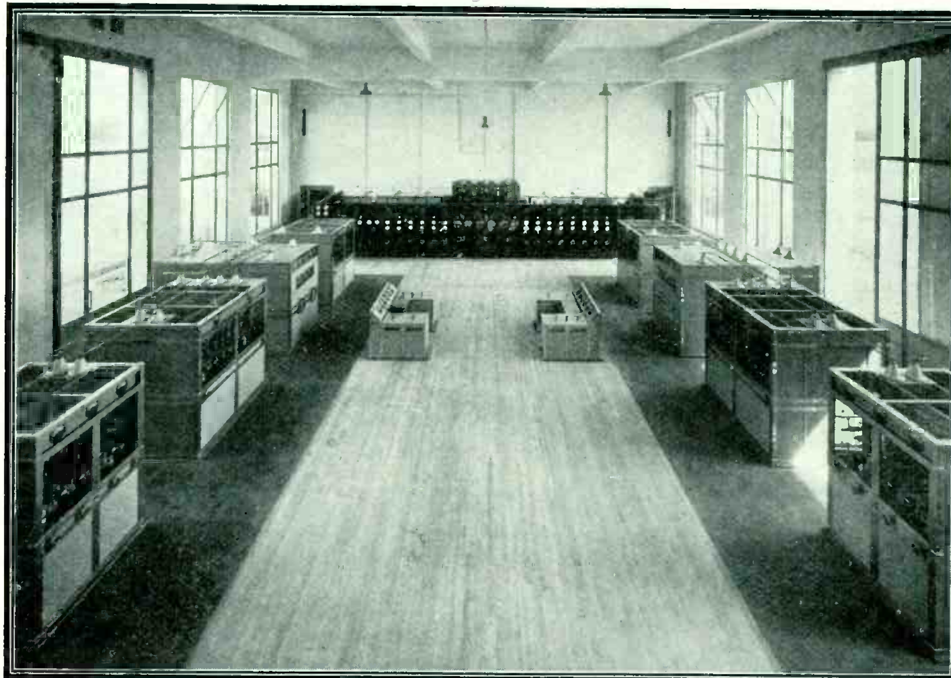
TABLE A

λ.	Suggested practical maximum power.
200–250	20 k.w.
250–300	50 k.w.
300–400	75 k.w.
Above 1000	200 k.w.

question has, however, a further important aspect. The reader will realise that the interference-producing qualities of a station are independent of wave-length, and yet directly dependent upon power (always assuming that the indirect ray has a constant value at all wave-lengths and at all distances between 50 and 1000 k.m.). Thus a 200-metre, 200-k.w. station has a very limited service area, and therefore does little good locally in most cases, but produces very severe interference in a continental area, and does much harm over large tracts of country. It is thus uneconomic and against the general interests unduly to increase the power of the shorter wave stations. Assuming European conditions of broadcasting, and realising that the figures will be taken only as a guide, it is suggested that Table A represents the maximum economic power (in the aerial) of typical broadcasting stations. Although it has been proved above that, theoretically, this figure is independent of wave-length, other considerations show that in the general interest it is important to keep the power to the low values when using the shorter wave. This point will be dealt with later when considering the unsuitability of the present wave-lengths allocated by Governments for broadcasting.

THE UNSUITABILITY OF THE WAVE-LENGTHS AT PRESENT USED FOR BROADCASTING

The reader of this section is referred in turn to certain outstanding problems in broadcasting, and to the impossibility of their solution in terms of present wave-length allocation. Perhaps it is best to illustrate the argument by an example. Take, for instance, the question of providing a national broadcasting service for Canada. Canada embraces a vast tract of country, mountainous in some parts, flat in others, densely wooded here, agricultural there, but throughout inhabited by a thinly scattered population, largely cut off from any recreation. These people would appear to deserve the advantages that broadcasting alone can bring. The numbers of free wave-lengths available for Canada (even if the North American continent solves its problem of station channel allocations, as has been done in Europe) might not exceed 25 out of the total 100 or so available. The largest wave available for broadcasting in the American continent is 545 metres. Assume that in general the earth conductivity



THE EVOLUTION OF THE TRANSMITTER

3. *The new twin-wave transmitter of the London Regional Station at Brookman's Park*

nada is $0{\cdot}5 \times 10^{-13}$. This will mean that the curves of Fig. 1 must alter their labelling, and that a wave-length of 545 metres in Canada has an attenuation represented by the 380 metres (roughly) curves of Fig. 1.

Let us with the aid of the foregoing data find out the total extent of possible service area in Canada, using the existing facilities. We will take 24 equally-spaced waves between 545 and 200 metres, each separated one from another by 40 kCs. We find that 260,665 square miles (approx.) of Canadian territory can be covered by service conditions if each station has sufficient power. (The limit chosen is set by fading conditions.)

Now let us assume that we start with the highest wave available as 2000 metres (150 kCs), and again take 24 waves 40 kCs apart, and again find the service area possible, using these much more suitable waves.

Taking the total area of Canada as 3,730,000 square miles, we see that existing facilities allow us to cover 6·9 per cent. of the surface by service conditions, whereas by using the same number of channels, but in a more suitable part of the waveband, we cover 83 per cent. of the surface, or twelve times as much.

No doubt critics of the conclusions reached in this section, will insist that by using the same wave-length for several stations* a much better case could be made out for the existing state of affairs. They will argue furthermore that 5 kCs separation between the east and west coast of Canada is perfectly possible, that a "little fading makes no difference really," and that people work in the daytime and only want the amusement of broadcasting at night.

It is true that the synchronisation of stations on the same wave-length does help to solve the difficult problem of the lack of sufficient facilities, but no one can suggest that this denies the essential fact that this would nevertheless cost more, and would not give universal service conditions; synchronisation economises channels, but those channels should be in the first case suitable for economic synchronisation. Synchronisation implies the radiation of the same programme from all stations synchronised, and it is essential to give regional to supplement national programmes.

* This system is now possible, but it has various limitations (see under "Technical Progress," page 63).

The argument that the indirect ray constitutes a service can be dismissed on two counts: first, that programmes throughout the world must in time have a cultural significance which could not tolerate so serious a technical imperfection as their periodic disappearance as coherent sound; and secondly, that, since indirect rays only form at night, this enormously limits service. Daylight broadcasting would seem essential in any community; in the highly developed industrial state for the night worker, the housewife, children (and even the idle!); in the sparse agricultural populations, for the housewife whose leisure is more probable in the afternoon hours, and for educational work. There is the further question of the older people, children, and invalids, to all of whom broadcasting is more than a casual evening pastime.

Broadcasting is a newcomer to wireless, and its presence is coming to be recognised by the officials of the State, who at world conferences and elsewhere decide the principles of ether partition among the claimant services. It is hoped that decisions as to its future will be based alone upon technical considerations.

We return therefore to the fundamental fact of the entire unsuitability of the 545-200 metre wave-band for broadcasting. The example given is sufficiently striking to require no argumentative embellishments. It should, however, be realised that for a given capital expenditure the running and capital cost per unit area is twelve times what it need be, if the present unsuitable waves are used. The present wavelengths are trebly wasteful in energy—they give poor relatively local service, great distant interference, and great waste of power.

We must naturally, before attempting to give the broadcasting service the more favourable treatment it so obviously deserves, see whether we make other important services suffer unwarrantably in the process.

Generally speaking, we find the ship and aviation wireless services occupying wave-bands ideally suitable for broadcasting. Speaking from the technical point of view ships could use the shorter waves; it has been shown that a 200-metre wave has an attenuation over the sea not greater than that of a 2000-metre wave over land. It seems wrong, therefore, to allocate waves for oversea transmission that are ideal for direct-ray broadcasting service over land, and waves for over-land transmission that are superlative for oversea communication! It will be argued that ships cannot change their apparatus, the money involved being too great. To this one can only suggest that most services have set aside a fund to cover obsolescence, and one wonders, in view of the demands upon the ether for equally important services, if such expenditure cannot in the general interest be faced as others have faced expenditure in their particular interest. It seems, therefore, that the question of expenditure alone stands in the way of progress. One should add that the problems of expenditure must in any case be faced by those responsible, since it is agreed that all spark transmitters shall be substituted by more modern apparatus before 1940.

Telegraph services between aerodrome and aerodrome could be perfectly well accommodated on wave-lengths above 2000 metres, and there is, with modern technique, no reason why a separation of 0·5 kCs or less between stations should not be undertaken, meaning that twenty telegraph stations could be accommodated in the space taken up by one broadcasting station. It is argued that the ground to aeroplane service must be by wireless telephone. It is not impossible to conduct commercial telephony on wave-lengths above 2000 metres.

In sum, given goodwill, the ether could be repartitioned to give each service good and sufficient facility. The above argument shows how in practice no service need suffer in the process if the rearrangement was based upon technical knowledge.

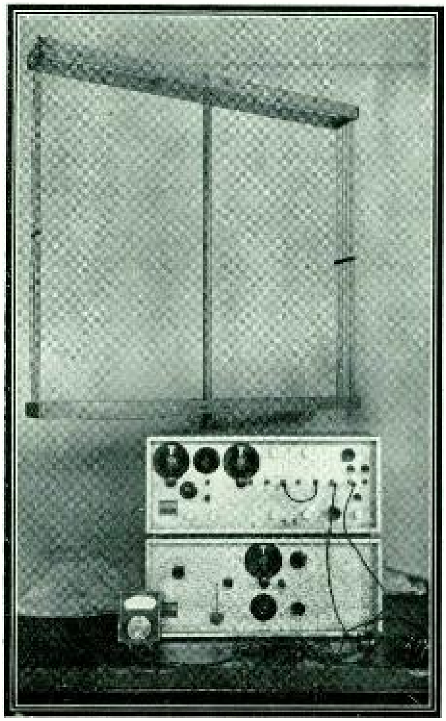
CONCLUSION

The conclusion arrived at as a result of these theoretical considerations and experimental verifications thereof, is that it is now perfectly possible, given a knowledge of the conductivity of the ground, given the data as to aerial design and mast height, and knowing the power of the station, to predict sufficiently accurately the service area of a broadcasting station.

It is not easy in all cases to guess the actual conductivity, and, where accurate results are to be obtained, it may be necessary to plot an attenuation curve from a station of known radiation, situated on the site chosen for the broadcasting station. Once curves for one-wave-length are taken, however, the service area can be predicted for any wave-length. This is a remarkable advance on previous knowledge.

The second important point is that a quantitative study of the attenuation of a wireless wave reveals that wave-lengths that in the past have been chosen haphazard should be re-arranged to give each service better facilities.

It is pertinent to this conclusion to say that the allocation of wave-lengths between claimant services is a matter where technical consideration should be the chiefly influencing factor.



THE INSTRUMENT FOR MEASURING THE "FIELD STRENGTH" OF A TRANSMISSION

THE N LONDON STATION

IN last year's Handbook a description was given of the new transmitting station at Brookman's Park near Potters Bar. When that description was written, all that was to be seen was a large field of some thirty-four acres covered with an excellent crop of grass. The only apparent signs of activity were a few pegs marking the positions which the building and masts were to occupy. By the time this book appears this station should be transmitting the daily London programmes, replacing the existing station in Oxford Street. It is thought, therefore, that some further notes on the station itself, together with a brief explanation of how it will affect listeners, will be of general interest.

The Oxford Street transmitter has a power of 2 kilowatts in the aerial, while the new station has two transmitters each capable of working at approximately 30 kilowatts in the aerial, there being a separate aerial for each transmitter. Thus the station is capable of radiating two entirely separate transmissions on different wave-lengths, the object being, of course, to give listeners a choice of two contrasted programmes each receivable under normal conditions at approximately the same strength.

At first only one programme will be sent out, and the change-over to the new transmitter will be made gradually, giving ample opportunity to listeners to adjust their receivers where necessary. Later on the second transmitter will radiate the alternative programme, but here again the innovation will be made gradually. Every possible precaution has been taken to ensure that the difficulty of separating the two programmes is reduced to a minimum. Information on the subject, written in as non-technical language as possible, is available gratis on request.

The question of the degree of selectivity which receivers will have to possess in order to separate the two transmissions is dealt with on pp. 326–333.

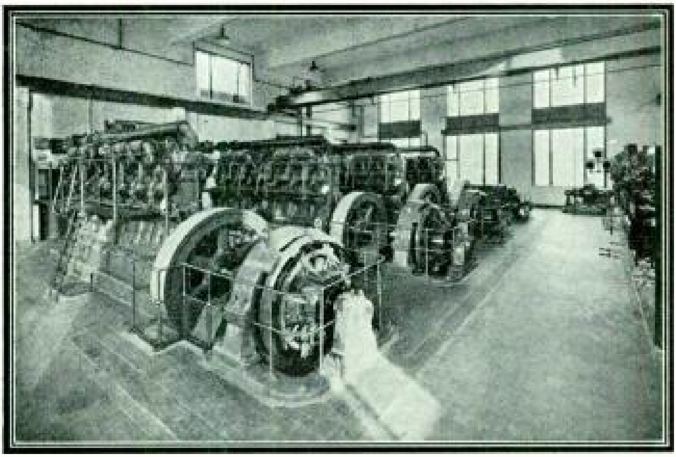
The new station is fifteen miles from the centre of London, and, therefore, it is inevitable that those listeners who live within about three miles of Oxford Street will receive a weaker signal. At the same time, however, every other listener who uses 2LO at present will receive greater strength.

It follows, of course, that many thousands of people living at still greater distances who cannot get satisfactory results from the present London station will find that the new station gives ample strength and much greater freedom from interference. However, it must be remembered that at a range of about a hundred miles the effect of fading will limit the useful range of the station, since this phenomenon is independent of the power of the station.

It is possible that some listeners living within the three-mile radius of Oxford Street will consider themselves badly treated when they find that the strength of the new station is insufficient to work crystal sets with an aerial consisting of six or eight feet of wire suspended from a picture rail. It must be realised, however, that a system of high-power stations is the best means of making the greatest use of the available broadcasting channels or wave-lengths. It is explained elsewhere (p. 357) why the number of wave-lengths allocated to British broadcasting is so very limited. It is fairly obvious, therefore, that broadcasting stations must use high power if the interests of the majority of listeners are to be studied. Apart from other considerations, such a station cannot be built in the centre of a city, where land is extremely costly, merely with the object of allowing a minority of people to have a superabundance of strength rather than something which will be definitely more than adequate for good reception with normal apparatus.

Again, some listeners living near to Brookman's Park who are in the habit of listening to foreign stations may find that it is not easy to eliminate the "local station." It is hoped that, should this be the case, it will be realised that such conditions cannot be avoided, and that for every listener who is inconvenienced perhaps as many as two or three hundred will enjoy greatly improved reception. The B.B.C. will be only too pleased to advise any listener who finds himself or herself in difficulties of any kind as the result of the new conditions.

Turning now to the station itself, the whole site is clearly visible from the Great North Road. The casual observer might wonder why the building is so much bigger than Daventry, which also contains two transmitters, namely 5XX and 5GB. There are two reasons for this. In the first place, the transmitters are each capable of a considerably larger out-



A GENERAL VIEW OF THE POWER HOUSE AT BROOKMAN'S PARK

put, and, secondly, the Brookman's Park station generates its own power by means of four crude oil engines each capable of delivering some 200 kilowatts.

As already stated, there are two separate aerial systems, each supported by two self-supporting masts 200 ft. high, this being the greatest height for which Government permission could be obtained.

The transmitters themselves have been designed by B.B.C. engineers, and are a result of experience gained in connection with 5GB, which was originally erected on an experimental basis with this object in view. However, in this case the power of each transmitter is about fifty per cent. greater than 5GB.

Much of the auxiliary plant has been specially developed by well-known manufacturing concerns in conjunction with B.B.C. engineers, in order to meet the particular requirements of this station, which in many respects will be unique among broadcasting stations throughout the world.

It only remains to be hoped, and with confidence, that the service which it provides will give as much enjoyment as possible to a greatly increased number of listeners.

THE ORIGINAL STUDIO AT SAVOY HILL, REDECORATED AND WITH FELTED WALL-PAPER SUBSTITUTED FOR THE FORMER HEAVY DRAPINGS

STUDIO AND RELAY

THE DESIGN OF STUDIOS

IT is desirable, in the art of broadcasting, that the various items making up the programme should be presented to the listener under such conditions that the effect produced is the counterpart of that which is experienced when the same items are heard under the best conditions without the intervention of the broadcasting medium. Thus it is necessary to design studios so as to provide a suitable environment for various types of programme material, and in particular for various types of music.

The two most important properties of a room in which music is to be performed are its echo and reverberation characteristics. If a certain sound occurs, such, for example, as a short blast on a whistle, and if after it has ceased we hear one or more definite repetitions of the sound at intervals varying from a fraction of a second to several seconds, the phenomenon is known as "echo," and is due to the reflection of the sound wave from one or more large flat surfaces, usually the walls of the room. It often happens, however, that instead of hearing a definite echo, we observe that, after the sound has ceased at the source, it is apparently continued, more or less steadily, for a few seconds more, gradually dying away to silence. This effect is known as "reverberation," and it is due, in reality, to the super-imposition of a very large number of minor echoes. Conditions may even be such that the volume of sound in the room or hall at first increases after the source of sound has ceased.

Now it is this quality of reverberation that determines, very largely, the suitability of a room for the broadcasting of a particular type of music. In particular it is the time taken for the sound to die away that is of importance. This time is known as the "reverberation period" of the room. In scientific terms it is measured as the time taken for the intensity of sound in the room to die away to one-millionth part of its initial value; for general purposes it may be taken to be the time necessary for a fairly loud sound to become inaudible.

Let us now see what are the best conditions for the transmission of various items. Speech obviously demands the maximum clarity in order to be intelligible, and needs practically no reverberation. Instrumental solos and chamber music are perhaps heard to the best advantage under the conditions obtaining in a large room in a private house. Such a room has a reverberation period of from 1 to 1½ seconds. Orchestral music is best heard in a concert hall, having a reverberation period of 2 or 3 seconds, whilst certain kinds of religious music give the best effect in a cathedral, where the reverberation may take as long as 5 or 6 seconds. Echo, in the strict sense, as defined above, is nearly always undesirable.

In designing a broadcasting studio the aim has therefore to be to make provision for the reproduction of all the various conditions which have just been described.

Experience has shown that it is not possible to modify a comparatively small room so as to reproduce directly the conditions of, for example, a concert hall. If we attempt, by means to be indicated later, to lengthen the reverberation period of an ordinary studio we get a very unpleasant effect due to the backwards and forwards reflection of sound from the pairs of opposite walls of the room. A solution of the difficulty is provided, fortunately, in the use of what is known as "artificial echo." Perhaps "artificial reverberation" would be a better description. This device, which makes use of the reverberation of a separate room specially set apart for the purpose, was fully described in the B.B.C. Handbook for 1929.

In using "artificial echo" we thus have to design a studio with very little reverberation of its own. In order to do this, use is made of the fact that, by the introduction into a room of sufficient material such as felt, curtains, upholstery, carpets, etc., all of which absorb sound, its reverberation period can be reduced to any desired extent. Formulæ have been developed connecting the volume of a room and the quantity of such materials present with the reverberation period, so that it is possible to predict what kind of treatment will produce a given result.

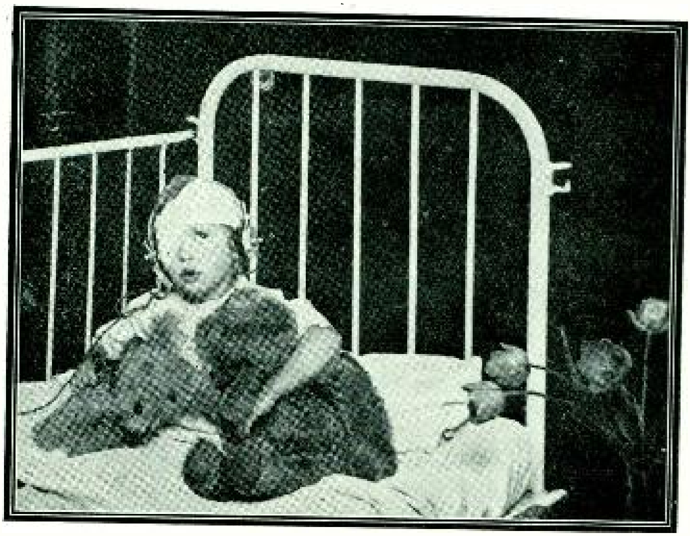
A very important factor which has to be taken into account is the psychological effect of a studio on the artist who is to perform in it. In the early days of broadcasting, studios were made with very short reverberation indeed by draping them heavily at the walls and ceiling with curtains. Such studios were very depressing to both the eye and the ear of the artist; to the ear because, owing to the lack of reflection from the walls, the artist could not hear the effect of the performance unless playing or singing more loudly than usual. Frequent complaints of the deadness of the studio were made.

To-day a compromise is effected with regard to reverberation, most studios being designed with a period of about one second, the rest of the effect being obtained by "artificial echo." Instead of the walls being covered with heavy drapings, they are lined with felt of the requisite thickness, or with one of the other acoustic materials which are now available, the whole being covered with a soft grade of wallpaper which is usually painted in some pleasing and bright design. The unfamiliar effect of the studio is thus almost completely eliminated, and efforts are made to compensate for any deadness so far as the ear is concerned by a bright effect to the eye.

General characteristics which are also necessary in a good studio are massive walls and ceiling, with no trace of drum effect; straightforward design, with no pronounced alcoves or ceiling recesses; and freedom from curved surfaces, apses, domes, etc., which produce undesirable concentrations of sound at certain points. Various modifications have been attempted from time to time with varying degrees of success, such as getting a certain amount of "hall effect" by the use of considerably increased height, or by the concentration of the absorbing material at one end of the studio, where the microphone is placed, leaving the other end relatively lightly damped to satisfy the ear of the performer.

Again, one of the difficulties of providing satisfactory absorption of sound in a studio is that most of the materials available absorb the higher musical frequencies more readily than the low, the result being a "boomy" effect. Advance in this direction lies in the use of better materials as they become available, or in combining the effects of various materials whose behaviour regarding the relative absorption of sounds of various frequencies is different.

Finally, the most hopeful line of advance in studio design is the determination, by employing scientific methods and apparatus, of the exact characteristics of any particular hall from which results pleasing to a musical ear are obtained. Experiments with this object in view are being undertaken by the B.B.C. in typical halls from which successful broadcasts have been made, and there seems little doubt that when the results have been fully analysed, information will be available which will be of material assistance in the design of future studios for broadcasting.



Fox Photos

THE CHILDREN'S HOUR AT MOORFIELDS EYE HOSPITAL

ADVANCES IN MICROPHONE CONSTRUCTION

READERS of the B.B.C. Handbook for 1929 will remember an article entitled "The Performance of Microphones," in which the desirable features of a microphone to be used for broadcasting are enumerated. These features may be briefly re-stated as follows:—

(1) Good frequency characteristic.

The microphone must respond equally to sound waves of all frequencies with which broadcasting is concerned.

(2) Linearity of response.

The electrical output of the microphone must be strictly proportional to the pressure of the sound wave over the whole range of sound intensities which it is desired to reproduce.

(3) Freedom from hiss or other background noise.
(4) Adequate sensitivity.
(5) Ease of maintenance and reliability of operation.

The same article states that in general it is necessary to compromise to some extent as regards these five qualities. This is well illustrated both by the special type of carbon microphone which, a year ago, was considered to be the nearest to perfection for the purpose of broadcasting, and by the condenser microphone which to-day tends to supersede it.

The carbon microphone, in its best form, has a good frequency characteristic, is sensitive, and is excellent in regard to maintenance. It has, however, a very definite and sometimes troublesome background hiss, and, more important still, loses its linearity of response when it has to deal with relatively loud sounds. The distortion which is so produced is often called "microphone blasting," and is sometimes heard when a large volume of sound, such as is produced by a full symphony orchestra or a large organ, is reproduced by the carbon microphone, and may even be heard if a singer with a very full voice is placed too close to the microphone.

The condenser microphone has also a good frequency characteristic, and, in addition, has almost completely linear response and very complete freedom from hiss. Difficulties, however, arise when we consider sensitivity and methods of installation.

This microphone consists of a tightly stretched thin metal diaphragm held very close in front of a thick metal back plate, thus forming a condenser of very small capacity. The value of this capacity varies as the diaphragm vibrates in accordance with the varying pressure of the sound waves which strike it, and is made to create corresponding fluctuations of voltage, which are amplified in the usual way. The microphone itself is relatively insensitive, and it will be readily seen that it will be rendered even less sensitive if it is connected in parallel with the "dead" capacity of long leads to an amplifier. In addition, such leads would be extremely liable to pick up any noises due to electrical interference present in the neighbourhood.

It is thus desirable to build the microphone itself into some form of compact amplifier unit which may be treated, as a whole, much in the same way as the carbon microphone alone is treated. It is possible to do this in various ways, but the B.B.C. has attained most success by using a single stage of low-frequency amplification of more or less conventional design, with an output transformer from which leads may be taken to the input transformer of the amplifier formerly used in conjunction with a carbon microphone. Matters are so arranged that only two additional leads have to be run to the microphone unit to accommodate the necessary L.T. and H.T. supply, and the whole unit is of a size comparable with that of the carbon microphone itself.

Difficulties have, of course, been encountered, due to the resonance of the box containing the unit, valve "pong" and similar troubles, but careful design can eliminate these, and it is hoped that the use of the condenser microphone will prove to be another step forward in the search for an ideal microphone for the purposes of broadcasting.

WIRELESS!

CONTROL ROOM DESIGN

IN 1922, on the top floor of Marconi House and adjoining the small room which served as the studio for the original 2LO, was a small room containing a low-frequency amplifier of very experimental design which amplified the speech currents received from the microphone next door and passed them on to the transmitter, which was in another room down the passage. It was possible to vary the amplification of this amplifier in order that the strength sent on to the transmitter might be regulated, that is to say, the transmission was controlled from this small room, which therefore became known as the Control Room, and was the forerunner of the very much bigger equipments in use at Savoy Hill, and in the provinces, at the present time.

The amplifier of those days was a very strange affair judged by to-day's standards. Its valves were suspended in mid-air by springs covered in cotton wool to prevent "ponging"! Extraordinary arrangements were necessary to prevent hum being induced on to the transmission. Once the equipment was ready for work, one dared not move any wires or even approach too near to it, otherwise something generally went wrong! In the original studios in the provinces arrangements were little better. In Newcastle, for example, an ordinary public telephone call box in the studio itself was used for some time as a Control Room. An engineer was shut up in this box from the time the programme started until it finished; with no ventilation, the state of the air inside at the end of a programme can be imagined!

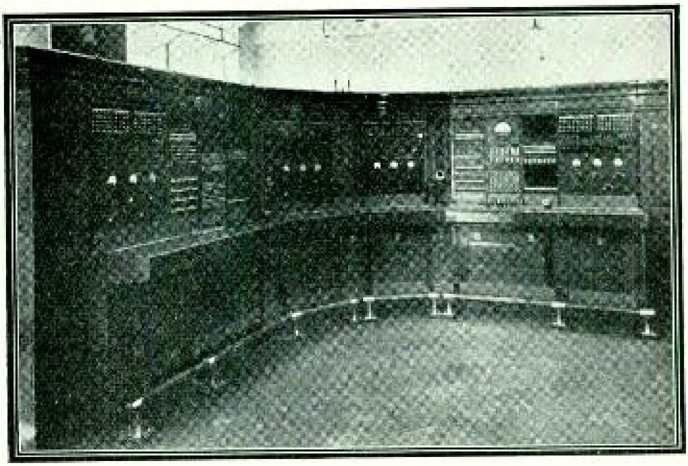
In seven years, however, much progress has been made. Amplifier design has improved out of all knowledge. Proper switching arrangements have become necessary owing to the number of studios and the multiplicity of circuits. Simultaneous broadcasting has to be catered for. Special provision has to be made for dramatic work, and the use of artificial echo, effects studios, silence cabinets, and a much higher standard in microphone technique and the presentation of programmes have all called for elaboration in equipment.

Consider for a moment some of the work that has to be handled by the London Control Room. In Savoy Hill there are nine studios, six of which are equipped with silence cabinets (these are small rooms adjacent to the studios from which the announcer can speak before switching over to the studio itself), one "effects" studio and two "echo" rooms. It is not unusual for all these studios to be in use at the same time for either transmissions or rehearsals, and as the latter are always listened to through the microphone, there may be seven or eight different programmes entering the Control Room and passing through amplifiers for control purposes. One or two transmissions are, perhaps, being sent to the provinces via the S.B. lines, while the others are being dealt with in a variety of ways. At the same time, tests are being taken of outside broadcasts or incoming S.B. which may be in the programme later in the day.

It is of the utmost importance that no interference or "cross-talk" should occur between different ransmissions. Whereas in commercial telephony one can frequently hear an unintelligible background of other people's conversations, in broadcasting this cannot be allowed. This means that special care has to be taken in designing the equipment, and in seeing that the strength or level of a programme does not at any time fall so low or become so high that induction from or into an adjoining circuit may occur.

No clicks or crashes must intrude on a transmission. The changing of studios and all other switching operations must be carried out when the control amplifier is sending nothing to the transmitter, that is to say, with the potentiometer controls faded right down. The desirability of smooth presentation has led to the development of "fade units" and "mixing units" to facilitate quiet and rapid changes between studios and between an announcement of a programme from a studio or silence cabinet, and the programme itself which may be coming from, say, the Grand Hotel, Eastbourne.

For dramatic work, especially for plays requiring rapid change of scene, a "mixing unit" is used which enables the Dramatic Producer to have under his control as many as ten programmes which may be coming from studios or from outside sources. He has in front of him ten handles, and by turning one of these he can vary the strength of any input relative to the other nine. For example, in a recent play the actors were supposed to be in an aeroplane, and the listener heard the drone of the engine behind the voices. Now this



THE NEW CONTROL DESK AND SWITCHBOARD OF THE NORTH REGIONAL STATION AT MANCHESTER

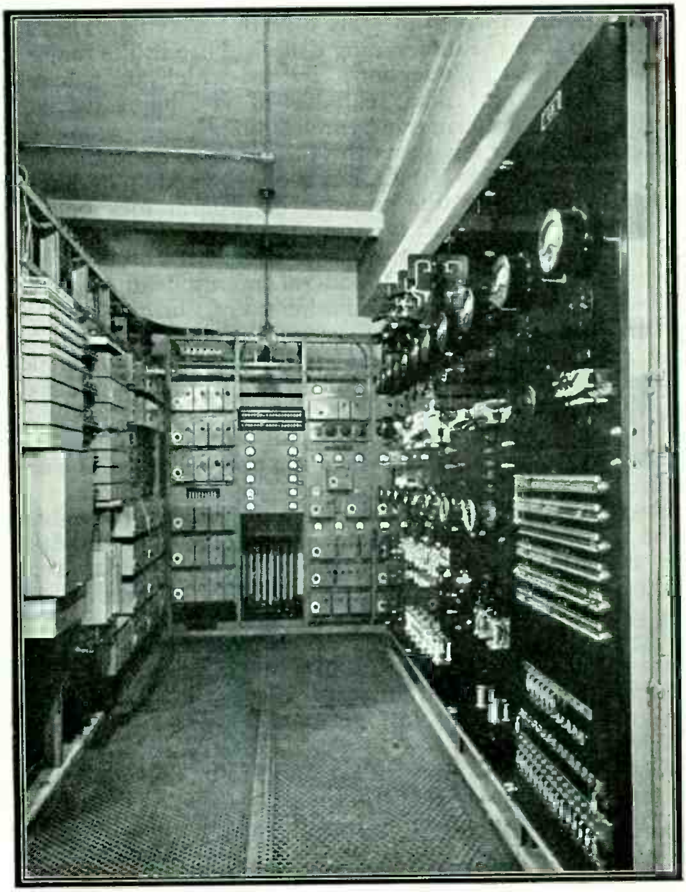
"effect" was made in the "effects studio" in another part of the building from the studio in which the characters were speaking. The superimposition was done by the producer on the mixing panel, the relative strengths being varied according to the effect required. Each studio has a cue light, operated by the producer, to show the occupants when to begin.

It is impossible in the scope of one short article to consider anything but the general principles of Control Room design. From what has already been said, it is seen that there are two main operations to be performed: first, the switching or setting-up of the speech and music circuits, and, secondly, the "control" of transmissions. Now the second operation really divides itself again into two parts, ensuring that the transmitter or S.B. line is fed with the programme at a proper strength having regard to the limitations of the transmitter or the line as the case may be, and the artistic balancing and musical controlling to maintain the light and shade of the music without going beyond the limits of satisfactory technical performance of the equipment.

Consider for a moment the switching problem. To connect a studio in London with all the provincial stations for the News Bulletin means that a large number of connections have to be made, amplifiers switched on, volume meters and other checking circuits brought into operation. All this can be done in a variety of ways, by the most elementary method of open-knife switches, by plugs and jacks or, better still, by key switches occupying very little space. An even better way is by a system of automatic switching in which the operating keys do not carry the music circuits, but cause relays and pre-selectors away from the operating desk itself to complete the circuits required. In such a system it is impossible for a wrong connection to be made or for a circuit to be interfered with when in use. The extra cost and complication of this system is, however, warranted only when the traffic to be handled is considerable. A Control Room on this principle has recently been installed in Manchester, and a photograph of the control desks is shown on p. 311. It is interesting to compare this equipment with that in the London Control Room, most of which is over five years old. The latter employs the now old-fashioned plug and jack, and has the amplifiers and control circuits on the control posi ions themselves, whereas in Manchester the switching, control and test desks are in a different room from the other equipment.

For balance and control of programmes, a section of specialists exists. They are, primarily, musicians, but know enough of the engineering side to appreciate the technical limitations of the equipment. A volume control handle varies the input to the control amplifier, and consequently the strength passed to the transmitter or S.B. lines. By means of a volume indicator, an instrument calibrated to show the relative strength passed on, and a second meter which shows distortion should it be allowed to occur, the controller is able to do his work. He listens to the transmission either by loud-speaker or headphones which are fed from the check receiver. In the new Manchester equipment, the controlling can be done either from the control desk itself or from a separate cubicle where the specialist can concentrate his whole attention on his job without being concerned with switching or other activities that may be going on at the same time.

The great difficulty in Control Room design, and in the actual controlling, is to reconcile the frequently divergent views of the musician and the engineer. Microphones, amplifiers, ransmitters, and telephone lines are not yet perfect, and the musician has of necessity to model his arrangements to compensate, if possible, for the difficulties which the engineer has not yet been able to overcome.



ANOTHER PART OF THE CONTROL ROOM AT MANCHESTER

LAND-LINE CIRCUITS

NEARLY all listeners must be aware that a large percentage of the programmes reach them not from the studio of their local station, but from outside points which may be hundreds of miles from the transmitter from which they are directly receiving. They are aware also that the intervening distances are in the majority of cases bridged by telephone circuits, which are generally more reliable and more capable of yielding satisfactory results than the alternative "wireless link."

During the last few years the B.B.C. in co-operation with the engineers of the G.P.O. has evolved a system of circuits which to-day allow the transfer of programmes between practically any two points within Great Britain, and can, if necessary, be linked by submarine cable with other circuits across the Channel to give broadcast communication for considerable distances across the mainland of Europe. An ideal system of this type would be one capable not only of providing easy, immediate, and absolutely reliable interconnection between the microphone and the transmitting station located anywhere within the boundaries of the system, but would, in addition, ensure that this interconnection is in every way equivalent to that obtained when the microphone and transmitter are immediately adjacent.

Two types of problems arise when telephone circuits have to be adapted for these purposes: first, those of organisation and switching, and secondly, those involved in the transmission of programmes without distortion or interference. The problems of organisation and switching are being solved by similar methods to those adopted in ordinary telephone exchanges, and developments in the use of an automatic system are now being attempted. There is little doubt that perfectly satisfactory solutions of these problems can be achieved.

A large amount of work still remains to be done, however, before it can be stated that transmissions over the lines available occur without affecting in any way the quality of the programme being transmitted. There are many ways in which telephone lines adversely affect broadcast programmes, and most of these result from the following causes.

ATTENUATION

It is a well-known fact that electrical energy applied at the beginning of a telephone line is gradually reduced in strength as it progresses along the line, so that amplifiers, or repeaters, as they are sometimes called, become necessary at the two ends and frequently at intermediate points to keep up the strength of the current. This occurs to a certain extent with all circuits and to a very marked degree with underground circuits, which have generally to be "repeatered" every fifty miles or so. One great problem that arises in this connection is that telephone circuits nearly always "attenuate" electrical currents differently according to the musical note to which those currents correspond. In fact, unless special precautions are taken, very many lines would completely obliterate the piccolo and other high-toned instruments from the programme! In general, these special precautions consist of using extra apparatus (technically known as equalisers and correctors) designed to cut down the strengths of those currents corresponding to the bottom end of the musical scale in exactly the same way as the telephone circuit cuts down the higher notes; so that by combining this extra apparatus with the line and associated amplifiers, it is generally possible to restore all frequencies in the programme at the far end of the line to their original values.

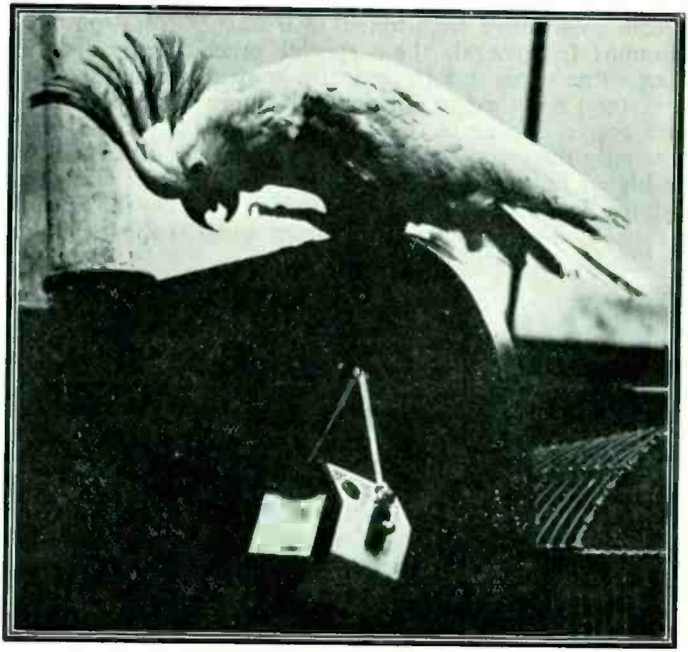
INTERFERENCE

All lines suffer from the fact that various unwanted currents flow in them as the result of their proximity to other telephone circuits, telegraph circuits, power or tramway systems, etc.; and if these unwanted currents are strong enough to compare with the currents due to the programme, then obviously objectionable noises will be heard. Special precautions in the way of the careful balancing of lines, and in some cases the use of extra apparatus to eliminate particular undesired noises, are taken to reduce this trouble to a minimum, but such interference is always possible on overhead circuits and forms a very serious drawback to their use for broadcasting.

There is, in addition, always the possibility that trouble will be caused to neighbouring telephone circuits by sending too strong currents along the broadcast circuits, so that it is necessary that the strengths of the broadcast currents should be carefully controlled between definite limits. Some idea of the problem involved may be gauged from the fact that it is not an unusual occurrence for the electrical energy in the microphone to vary from instant to instant by as much as a hundred thousand times. This involves the development and installation of special testing apparatus to make the necessary measurements at various points along the lines.

LINE DELAY EFFECTS

Few people realise that electrical currents take perfectly definite times to travel along the line from the microphone to the transmitting station. The currents which correspond to the human voice may, as an example, travel at velocities

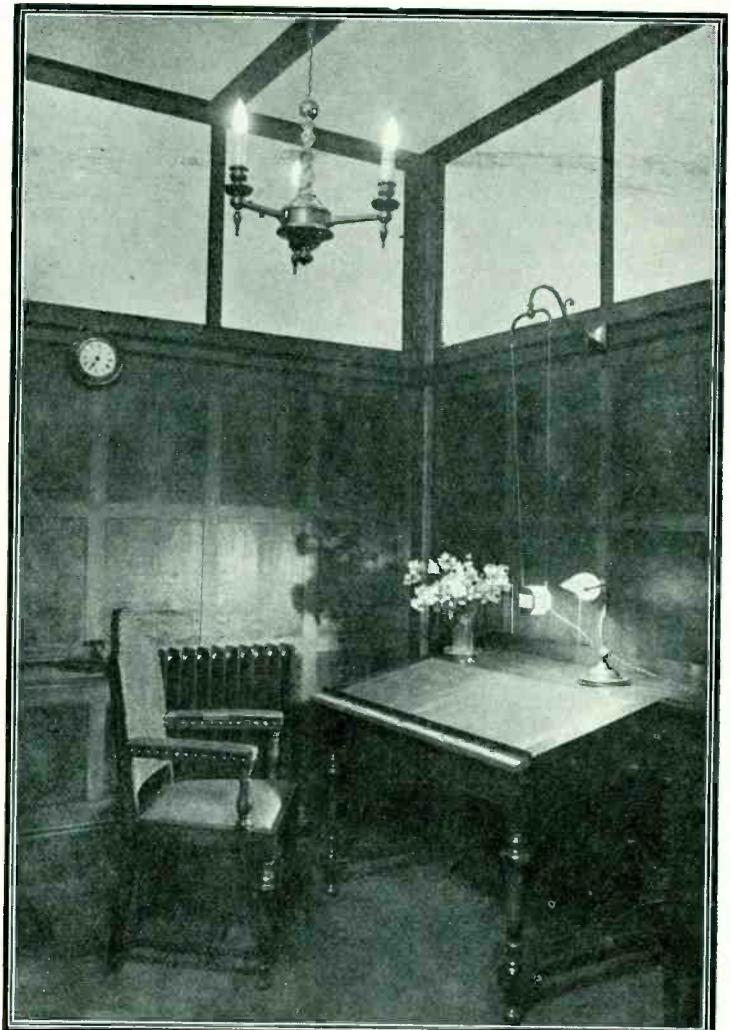


THE COCKATOO BROADCASTS

At the London Zoo

which vary from 10,000 miles per second up to as much as 180,000 miles per second, depending upon the particular type of line employed for their transmission. A source of distortion which is becoming increasingly important is due to the fact that the velocities of the currents corresponding to various notes of the musical scale are different, so that on extremely long lines it may actually happen that the top notes of a chord arrive at the other end of a line before the bottom notes, with consequent distortion of the music. It is fortunate that the human ear is very insensitive to this particular effect, except in the case of very long circuits, when special precautions have to be taken. Here again these precautions take the form of using apparatus designed to delay the higher frequencies by an amount equal to that by which they would otherwise have outstripped the lower frequencies. A most unfortunate consequence of this fact is that at all points at which the nature of the circuit changes so as to change the velocity of the electrical current, part of the current, instead of travelling on along the line, is reflected back towards the point from which it started. This phenomenon is one which occurs throughout Nature, and is in fact the same as occurs when light falls upon a reflecting sheet of glass. As a result of this, currents arriving at the receiving end of a line at frequencies corresponding to various notes along the musical scale, may be very materially reduced in strength owing to repeated reflections of these particular currents at intermediate points; and certain frequencies may be reflected backwards and forwards between two intermediate points in the line and arrive finally at the end so long behind the bulk of the programme that very unpleasant echo effects would result, unless steps were taken to overcome the trouble.

The telephone circuits which are at present almost exclusively used for musical transmission are overhead lines liable to troubles of interference and mechanical breakdown in bad weather. For these reasons underground circuits specially designed to avoid the troubles caused by attenuation and line delays may eventually be employed as soon as the large amount of work involved in their design and installation is completed. It is confidently anticipated that this will prove a very great step towards achieving the ideal in land lines for relaying.



THE TALKS STUDIO AT THE NEW MANCHESTER PREMISES

RECEPTION

PROGRESS IN RECEIVER DESIGN

BEFORE regular daily broadcasting started, late in 1923, the only receivers on the market, apart from those intended for commercial telegraphy, were designed to meet the needs of amateur wireless enthusiasts who spent most of their time searching for the comparatively feeble signals from distant high-power stations working on a very long wave-length. Usually these receivers consisted of a grid leak detector with either one or two low-frequency stages using what would now be called high impedance valves. It was quite usual to work in the oscillating condition in order to get great sensitivity and to supply the necessary heterodyne for continuous wave signals. In those days there were hardly any telephony stations, and the question of "quality" was not even mentioned. Naturally there were hardly any loud speakers in existence, and such as there were were quite unfit for the reproduction of music.

Quite suddenly designers were faced with the problem of producing a receiver which would continue to work in the hands of people possessing no technical knowledge, who, moreover, were not even interested in scientific matters. Added to this difficulty there was the problem of the faithful reproduction of music and speech.

It was unfortunate in some ways that at this time there was a large quantity of wireless components on the market which had been sold in bulk by the Disposals Board. This apparatus was of good quality but it was never designed for the purpose for which it was being used. At first some manufacturers copied this ex-service apparatus somewhat slavishly, which possibly to an extent retarded true progress.

This influence soon disappeared and, ever since, the great factor governing the design of the receiver has been the steady progress in the design and manufacture of the thermionic valve. The most important advance in this direction was the introduction of the so-called dull emitters, that is to say, valves employing filaments so treated that a large emission of electrons was possible with the expenditure of a comparatively small heating current.

This soon resulted in the production of the low impedance valve for audio-frequency magnification working with its grid at a negative potential with respect to the cathode, thus avoiding the distorting effect of grid current, which was always present in the early receivers to a disastrous extent.

The capabilities of resistance capacity coupling for audio-frequency magnification were soon recognised as giving a great advance on the performance of the transformers which were designed without strict reference to the band of frequencies which they ought to transmit. Until quite recently only a very few manufacturers sold transformers which could be said to compete with resistance coupling from the point of view of faithful reproduction. For instance, it was usual to find that a transformer reproduced no fundamental frequencies below about 250 cycles per second.

Almost before the necessary requirements for distortionless reception were generally realised, and put into practice, the demand for portable sets arose, and the energy and ingenuity of designers were concentrated on compressing the essential components, including the batteries, into the smallest possible space.

Generally speaking this requirement is likely to result in a sacrifice of quality. Naturally, if all the batteries have to be contained in the cabinet and if the whole is to be carried about without an excessive effort, it is usual to use valves which employ very little filament current, which, in conjunction with a somewhat low value of anode voltage, can give only a very limited output.

In spite of this disability, portable sets enjoy great popularity for obvious reasons, but the quality obtained on the average genuinely portable set is good only if the volume is

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small, and for a listener who takes music seriously an ordinary set of generous design will be more satisfactory for regular listening.

The majority of these portable sets have a self-contained "frame" aerial and, therefore, high-frequency magnification is practically essential. This has resulted in the development of very efficient and ingenious high-frequency circuits, including two stages of magnification, the whole of the tuning being carried out by one handle only. One tuned stage followed by a semi-aperiodic stage is a circuit commonly adopted, but great use is now being made of screened grid valves which have a high magnification factor accompanied by stability, the lack of which is the great bugbear of high frequency circuits using three electrode valves.

The screened grid valve is also used in ordinary non-portable sets, frequently tending to replace the famous neutrodyne circuit, although the latter was never used in England to the same extent as in America, where almost all sets include tuned high-frequency magnification as a matter of course in order to get the selectivity necessary in that country.

In practically all the thickly populated areas of the territory served by the B.B.C., high-frequency magnification is not essential to obtain one programme, but with it, greater selectivity can be obtained, which is daily becoming more important. It is also being used in sets intended to include reception from continental stations, but it must be remembered that no amount of amplification can reduce the fading which begins to spoil the programme from all stations working in the "medium" broadcasting wave-band (200 to 545 metres) at distances greater than about 100 miles.

At the time of writing the most recent development affecting receiver design is once more following on the introduction of an improved type of valve. In this case the object is to obtain a distortionless output from the final audio-frequency magnifier valve without using an anode voltage of more than about 100 to 150. The pentode, as the new valve is called, because it has five electrodes, has the advantage of giving a high magnification factor coupled with a very large output without the danger of distortion by grid current or non-linear conditions in the anode circuit. It has a very high impedance, usually about 50,000 ohms, and unfortunately this means that it cannot legitimately be connected to a loud speaker having a normal impedance of, say, 2,000 ohms. Of course a transformer can be connected in the output circuit of the pentode, but the design of such a transformer is not easy if the whole band of musical frequencies is to be included. No doubt this difficulty will be overcome in course of time.

Another development which has gained much ground during the past year, but which has been in a state of gradual improvement for several years, is the all-mains set. It is hardly necessary to point out that this line of progress is inevitable. It seems highly probable that all valve sets will work from the electric mains in a few years.* Until recently, however, the difficulty has been to remove entirely all background noise under all conditions, and at the same time keep the price comparable with a set designed for battery working. Again, special valves have paved the way to simplicity, and it may be said that the problem is practically solved.

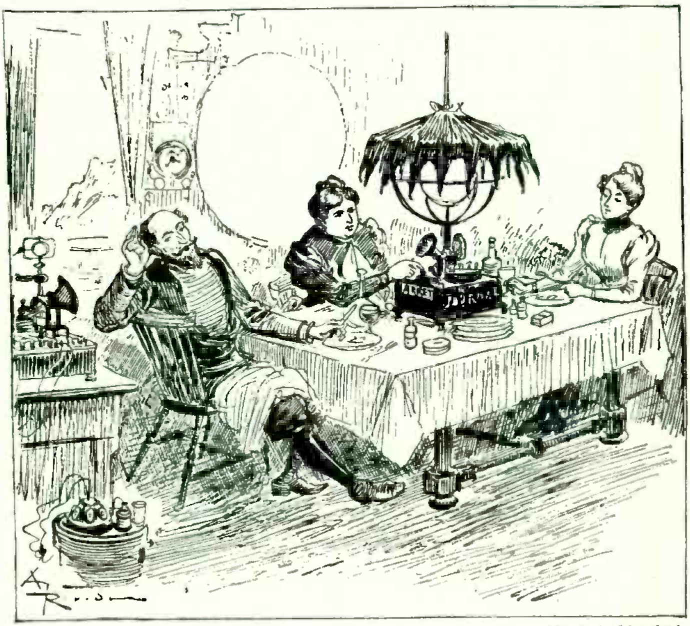
Perhaps the most remarkable feature of broadcasting receivers on sale in Britain is the extraordinary diversity of types. Let us take for example portable sets. They most frequently employ five valves, but the number of different ways in which these valves are arranged by the various manufacturing firms are far too numerous even to mention. The same thing applies to an ordinary three-valve non-portable set.

Setting aside the question of the design and arrangement of components, there must be a best way of using three valves to receive a broadcasting station within its service area, and it might have been expected that standardisation would have become established. However, this standardisation is probably a long way off. Before it comes, valve design will have to become more stable. Again, the system of broadcasting stations is undergoing change, and finally there is the steady improvement in loud-speaker design, which in turn demands a higher standard of performance from the receiver. There is no doubt that for some time the shortcomings of loud speakers tended to discourage the perfection of receiver design from the point of view of faithful reproduction. This condition, however, is rapidly disappearing (as will be seen on pp. 335–338, which are devoted to the design of loud-speakers).

When considering the future development of receivers, the

* For mains unit, see p. 345.

question naturally arises, How will this be affected by changes in the transmitters? It has always been the policy of the B.B.C. to strive towards the ideal and send out all musical frequencies at their correct relative amplitude, irrespective of whether there was an appreciable number of receivers in use which would reproduce the transmission faithfully. This ideal has not always been attained by any means, but 5GB closely approaches it, and the new system of high-power stations now under construction will reach what one might almost dare to call finality in this respect.



Historia Mondiale

AN ANTICIPATION OF THE WIRELESS RECEIVER

A futuristic sketch, by Albert Robida in 1883, of a telephonic installation by which newspaper reports are to be transmitted. The apparatus is constructed in the table lamp and is marked "Journal" and "Stop (Arrêt)." On the neighbouring table is another apparatus which transmits information

SELECTIVITY AND THE REGIONAL SCHEME

WHEN the Regional Scheme comes into operation, listeners in the service area of each station will have the choice of two alternative programmes from that station. These programmes will be transmitted on different frequencies (wave-lengths) from the same point, and the signal strengths will be of the same order. It will be necessary, therefore, for satisfactory reception of either programme, that the receiving installation employed should be capable of cutting out the unwanted programme. The degree of selectivity required will, of course, depend on the difference in frequency of the two transmissions, and owing to the scarcity of available wave-lengths this difference will be smaller in the case of some areas than others. The degree of selectivity required will therefore not be the same in all cases. In addition, the degree of selectivity required in the tuning circuits will depend on the distance from the transmitters, as the selectivity of a receiver depends considerably on the strength of the input to the detector, owing to the fact that a detector, whether it be crystal, anode bend, leaky grid, or diode, does not behave in the same way for all values of input.

Fig. 1 shows a characteristic curve for a typical detector, the working point on the curve being *P*. Owing to the change in curvature at *P*, a small oscillatory input will be partially rectified, and will cause a slight increase in the output. If in addition to the small input a large input of a different frequency be now applied to the detector, the effect of the small input will be to cause variations in amplitude of the larger carrier. If the amplitude of the latter is such as to cause these variations to occur about the points P_1 and P_1^1, oscillations about P_1^1 will have no effect on the rectified output. The rectified output due to the variations about P_1 will be greater than the rectified output due to the original variations about *P*, since the curve just beyond P_1 is rising above the continuation of the curve with the same curvature as at *P* (shown dotted).

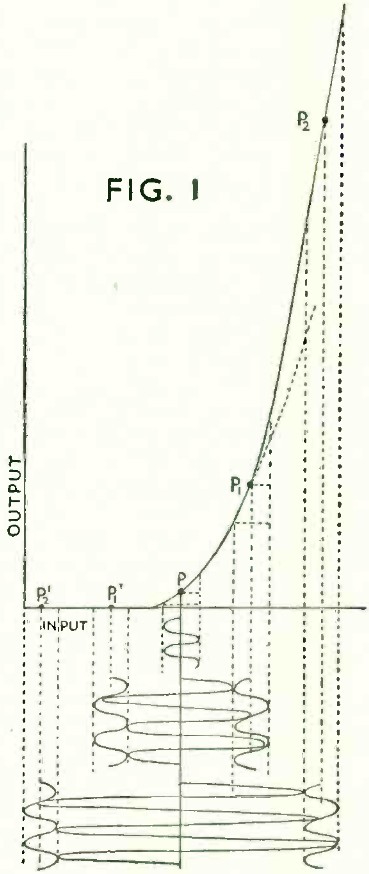
If the large carrier is not strong enough to cause the oscillations to sweep beyond P_1, it will have no effect on the rectification of the smaller oscillations, as the curvature remains the same from P to P_1.

In cases where the large carrier is sufficiently strong to cause the variations in amplitude due to the smaller carrier to occur about P_2 and P_2^1 where the characteristic has become a straight line, there will be no rectification provided the variations do not sweep on to a curved portion either above or below P_2 and P_2^1.

Hence with a very strong local carrier under certain conditions interfering signals will be wiped out. With a carrier of weaker strength interfering signals will be assisted, and with a much weaker carrier there will be no effect on the strength of interfering signals.

The effect of a wanted carrier on a smaller interfering carrier will therefore depend on the absolute value of the wanted carrier, as well as on the relative strengths of the two carriers and on the shape of the characteristic of the detector.

FIG. 1



Hence the selectivity of a receiving installation is improved by making the two inputs so small that rectification is confined to the lower portion of the detector characteristic where the larger carrier is much more efficiently rectified than the smaller one and does not assist the latter.

The various methods of improving selectivity may therefore be divided roughly into two classes:—

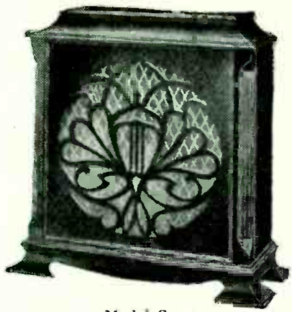
(1) Those which reduce the wanted and unwanted inputs to the detector in more or less the same proportion so that the unwanted input is so small that no audible signal is produced;

(2) Those which reduce the unwanted input to the required degree whilst affecting the wanted input as little as possible.

The first class includes the use of a small aerial, and little or no high-frequency amplification. When the field strength is large enough to permit of a reduction in size of the aerial, this method has the advantage of requiring no alteration to existing receivers and can be easily tried. In extreme cases where the reduction in size of the aerial causes considerable decrease in its capacity, a slightly larger aerial tuning coil or condenser may be necessary.

Where a high-frequency stage is employed, increased selectivity can often be obtained by removing it and adding an extra low-frequency stage, if necessary, to compensate for the loss in signal strength, provided that the selectivity obtained by the additional tuned circuit usually employed with a high-frequency stage is retained by adapting this to a loosely coupled circuit, as described later.

Methods included in the second class depend on the arrangement of the various tuned high-frequency circuits in the receiver, so that maximum impedance is offered to the unwanted transmission and minimum impedance to the wanted transmission. This is done by keeping the damping of the various circuits low by avoiding high values of resistance in the aerial and coils, and by suitable values of inductance and capacity. The detector introduces considerable damping except in the case of a valve used as an anode bend detector, in which case the damping introduced, although it may be appreciable, is usually considerably less than with other types of detector. The relative overall impedance offered to the unwanted transmission is increased by increasing the number of circuits tuned to the wanted frequency, but this, of course, increases the number of tuning controls. Where the maximum degree of selectivity is required without loss in signal strength, this method is by far the best, and fortunately only two tuned circuits should be necessary in



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CELESTION

The Very Soul of Music

LOUD-SPEAKERS

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order to separate two alternative programmes of equal strength under the Regional Scheme. The practical arrangement (Fig. 2 *a*) consists in tuning the aerial by means of a coil and condenser in the usual way, but instead of connecting the detector or H.F. valve across the coil and condenser, a separate coil and condenser are used for this purpose. The two tuned circuits are loosely coupled together by placing the two coils near each other, an ordinary two-way coil-holder being suitable for the purpose so that the coupling can be adjusted. The correct method of adjustment is to tune the two circuits with the weakest possible coupling necessary to give audible signals, and then to tighten the coupling to the necessary degree without again altering the tuning controls. This method of adjustment minimises any tendency to cause distortion through reducing the strength of the higher notes when lightly damped circuits are used. If variable reaction is used, however, by coupling a reaction coil to the coil in the second tuned circuit, this method of adjustment will not be satisfactory if the tuning is affected by the degree of reaction employed.

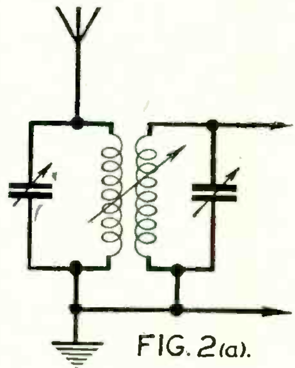


FIG. 2 (a).

The foregoing method of improving selectivity, although by far the most satisfactory, is not by any means always essential. It can be adapted to existing receivers, however, fairly simply by placing the aerial coil near the existing coil in the receiver which was previously the aerial coil, and moving it about by hand until the best position is found. A slightly larger value of capacity or slightly larger coil will be necessary to tune the circuit which was the original aerial circuit, since the aerial capacity will now be removed from it. If it is not convenient to employ electromagnetic coupling between the two coils, they can be shielded or separated from each other to avoid stray magnetic coupling and capacity coupling employed by connecting a small variable condenser of the neutrodyne type between the new aerial terminal and the old aerial

terminal, the old and new earth terminals being connected together as shown in Fig. 2 (*b*). (The latter connection may be desirable even when electromagnetic coupling is employed.)

A simple, and very often sufficiently effective, method of obtaining the required degree of selectivity is to insert a low-value condenser in the aerial lead. This must usually have a value of not greater than about ·0001 microfarad to be effective. Its action depends partly on reducing the input to the detector and partly on reducing the effective damping due to the aerial and earth resistance.

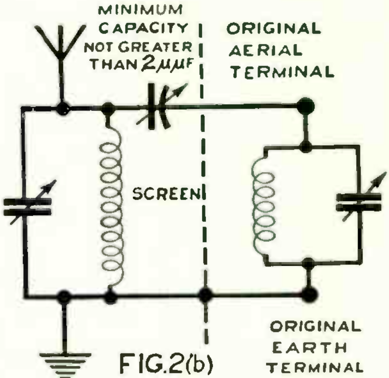
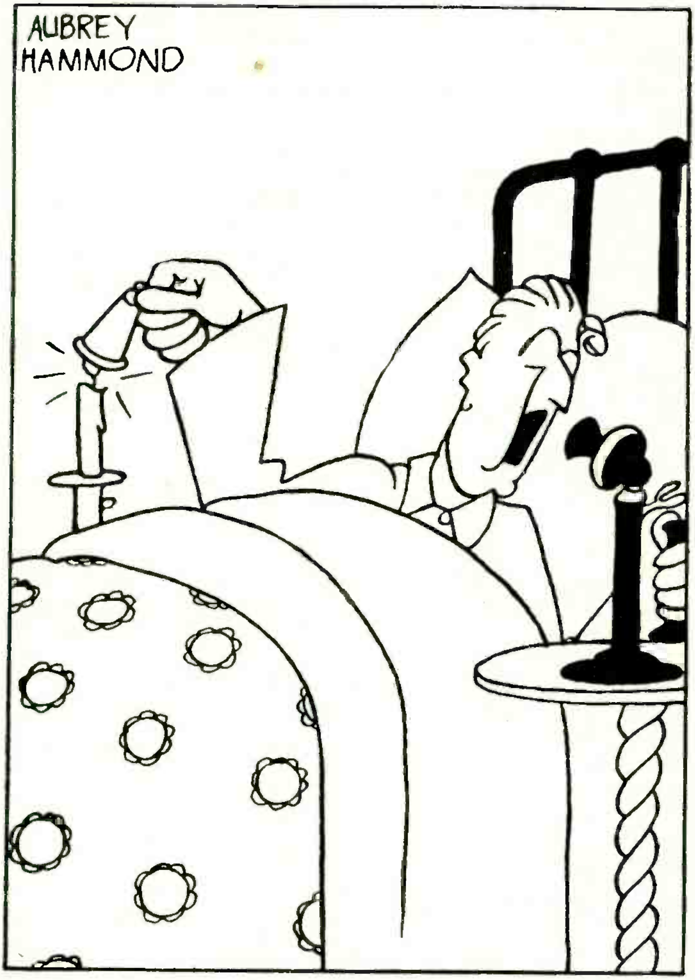


FIG. 2(b)

Various forms of wave-trap will enable the interfering programme to be cut out, but they suffer from the disadvantage of not preventing possible interference from other sources. In addition, they have considerable effect on the tuning of the receiver, and are not so simple to operate as the arrangement utilising a loosely coupled tuned aerial. If desired, the same apparatus can be arranged to function as a wave-trap or as a loosely coupled tuned aerial circuit.

WHAT BROADCASTING APPARATUS HAS TO COPE WITH

The Modulation Meter Chart of a tenor singing the last few bars of "Che Gelida Manina" followed by applause in the form of clapping and encores



A DAY IN THE LIFE OF AN ANNOUNCER

IV. "GOOD-NIGHT, EVERYBODY, GOOD-NIGHT"

LOUD-SPEAKERS

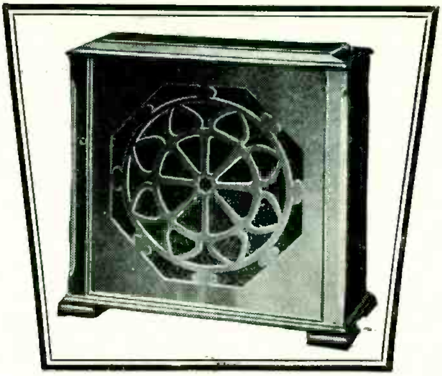
THEORETICAL CONSIDERATIONS

HELMHOLTZ postulated that the ear was not sensitive to the phase relation between the component oscillations of a complex but sustained musical sound. Lord Kelvin (then Sir William Thompson) published a Paper in 1878 in which he stated that "the quality of harmony depends upon the amplitudes of its different constituents and on the relation of their phases." Recent experiments and researches appear to agree with the Helmholtz theory. There still seems to be doubt in some circles as to which theory is true. It has been suggested that the results of such an experiment may be marred, but the fact is that few present-day loud-speakers, even moving-coil types, are capable of reproducing without inventing overtones. The ear finds it extremely difficult to judge the purity of a tone, except when the tone is compared directly with a known pure tone.

Whichever theory is true, however, there is no doubt that music and speech seldom consist of sustained sounds. The amplitude is changing all the time—sometimes slowly, sometimes suddenly. Any changes of amplitude are called transients, that is to say, they are not steady states. It is being accepted both in this and other countries that phase relation, at any rate in transient conditions, is important; how important is not yet known.

There seem to be two ways of improving the ability of a loud-speaker to handle "transients." One of these is to make the moving parts as light as possible. There would, however, appear to be great difficulties in developing much further along these lines, since already moving parts have been made almost incredibly light. The other way of dealing with the problem is by compensation. It will be interesting to observe improvements which should result from a greater exploitation of compensation. It will also be of interest to observe by what means various types of loud-speaker are given the ability to deal more correctly with transients now that the importance of accurately reproducing them is realised.

There is, of course, no doubt that in order to reproduce



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The Very Soul of Music

LOUD-SPEAKERS

ANNOUNCEMENT OF CELESTION LTD., (Dept. B.H), KINGSTON-ON-THAMES transients correctly, the loud-speaker must be capable of dealing efficiently with high frequencies, since a transient condition implies a rapid change of state. Also, it is important in dealing with transients that there should be no resonances in the loud-speaker, since any resonance implies a time lag in building up the maximum amplitude and a time lag in dying away. This can also be stated in a different way—that any resonance implies a rapid phase change with frequency over at any rate a certain band of frequencies.

Insufficient attention has been paid in the past to purity of reproduction as regards invention of harmonics by loud-speakers. This is more important than frequency characteristic. Luckily for designers the ear is extremely tolerant in regard to frequency characteristic, else broadcasting would not have come into its own so rapidly. The invention of harmonics and combination tones has the effect of clouding the reproduction and not reproducing the detail, particularly in the case of more complicated sounds. In bad cases of harmonic invention of course the reproduction becomes harsh. A property of loud-speakers suffering from this defect is the modulation of one note by another. This results in a most unpleasant effect, and is particularly noticeable in a large number of reed-driven loud-speakers. It is not unknown in moving-coil instruments. It is due to the fact that the instrument is more sensitive when the reed is near the pole-piece and less sensitive when further away. Before any serious attempt at a good frequency characteristic and good reproduction of transients is made, this defect must be overcome.

In conclusion, the writer thinks it desirable to point out that, while the increase of scientific measurement on loud-speakers (such as the taking of frequency characteristics) is all to the good, the frequency characteristic by itself is probably not a complete guide to performance as judged by the ear, particularly since pure tones are seldom if ever met with in music, and the performance of a loud-speaker in reproducing two pure tones separately may give no indication of the performance of the loud-speaker when reproducing the same two tones simultaneously. Great care is also required in selecting conditions for taking frequency characteristics to make sure that they are such as would obtain in practice, in particular as regards amplitude at various frequencies, since the energy at the various frequencies in any piece of music is by no means the same. Methods which rely upon readings taken only at previously selected frequencies are apt to be misleading. It is desirable to be able to observe and record any sudden changes of amplitude with frequency. It is therefore desirable that the tone source used in testing loud-speakers should be continuously variable in frequency. Further, it is desirable to record on paper all that the ear can hear, and possibly even frequencies which are inaudible as pure tones, for the human ear appears to be able to notice some of these when accompanied by other frequencies.

Certain authorities have recently stated that frequencies above 5,000 are unimportant in music or speech. Tests carried out in the presence of the writer, however, show that while music or speech having no frequencies higher than 5,000 is quite pleasant to listen to, frequencies as high as 10,000 and higher play an important part in reproduction even with present-day loud-speakers, which are notably lacking in efficiency at the higher frequencies.

Tests have also been carried out to determine what was the percentage of second harmonic to fundamental and the minimum amount of second harmonic which can be detected when accompanied by a pure tone. These tests were conducted with a modern good type of commercial loud-speaker, such as can be purchased to-day. It was found that with a fundamental frequency of 900 cycles at normal strength it was possible to detect a change in timbre when a second harmonic (*i.e.* twice the frequency) of 3 per cent. was added to this fundamental frequency. The following table shows percentages for other frequencies:—

Fundamental Frequency.	Minimum % of Second Harmonic that can be detected Aurally.
900	3·0
2000	4·3
3000	5·5
4000	17·0
5000	48·0
6000	76·0

SHORT-WAVE RECEIVERS

WITH the ever-increasing number of short-wave telephony transmitting stations in all parts of the world, there is a corresponding increase in the number of broadcast listeners who are desirous of receiving the programmes from these far-distant stations, and the present demand for suitable receivers calls for a few details regarding the construction of such sets.

When contemplating the building of a short-wave receiver it must be borne in mind that the chief object in view is to reduce di-electric losses wherever possible; in other words, use reliable components, and construct the receiver so that whilst the various parts are placed as close as is convenient, undue crowding and doubling back of the wiring should be avoided.

The wiring of the set calls for special care and the most direct method should be employed, as this has been found to be the most successful in practice.

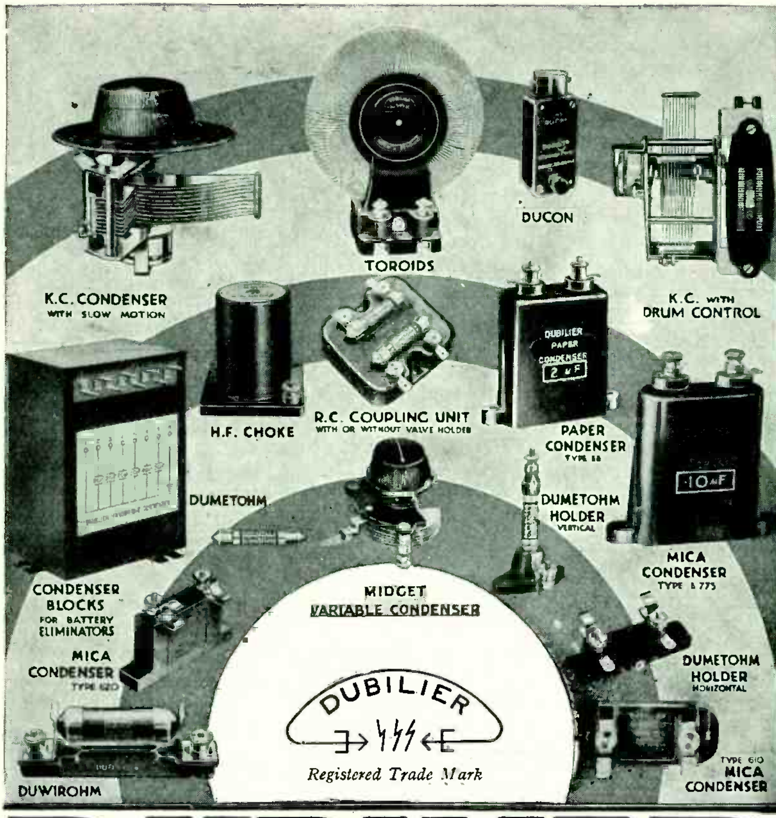
The average listener will find that a three-valve receiver, employing a straight circuit, will meet all requirements, and a suitable arrangement may consist of a detector stage followed by two stages of audio-frequency amplification.

This arrangement is mainly used by short-wave enthusiasts, as a good range of wave-lengths can be covered without interchanging of coils, and with the least amount of tuning; only two condensers being required for this purpose.

Short-wave receivers are mostly constructed on the baseboard and panel principle, with all the components affixed to the baseboard with the exception of the two variable condensers and the filament switch.

A copper sheet shield may be fixed to the rear of the panel for screening purposes, or, as an alternative, a metal front panel may be used and earthed, but when this method is employed the constructor must take care that the insulation of the variable condenser plates from the metal panel is good.

Various types of plug-in coils are at present on the market for use in short-wave receivers, and it will be found worth while purchasing a set of such coils rather than to attempt to construct them at home.



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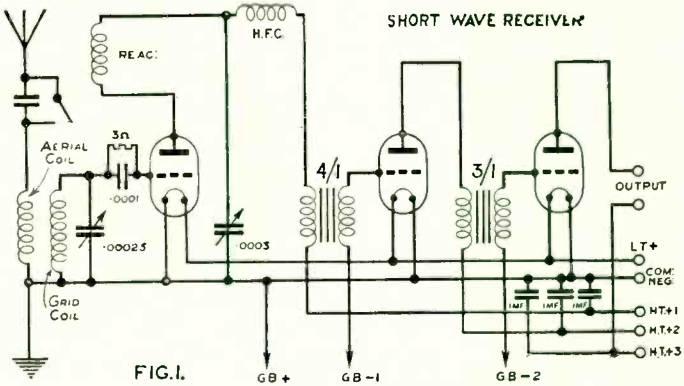


FIG. 1.

A simple but efficient short-wave circuit is shown in Fig. 1, and the values of the component parts should be as near as possible to those given.

Should the listener desire to construct a somewhat more sensitive receiver, embodying a high-frequency stage of amplification, then a suitable circuit is given in Fig. 2.

It will be seen that this arrangement includes a screened grid valve in the first stage followed by a detector stage, and having a pentode type valve for low-frequency amplification. Such a receiver should give loud-speaker strength from the

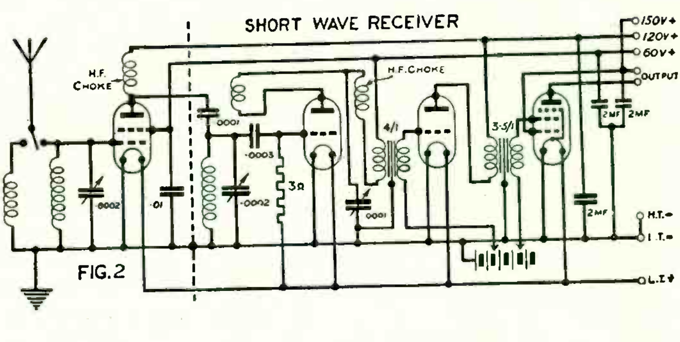


FIG. 2

more reliable short-wave broadcasting stations.

It may be noticed that the amplification produced by the high-frequency stage will be proportionately less than a similar arrangement gives on the medium broadcast waveband, but nevertheless there is an appreciable increase of amplification over the ordinary detector method, and with the power valve in the last stage, ample strength should be forthcoming.

With this arrangement, either loose or direct coupling to the aerial may be employed, as the high-frequency stage facilitates this, and minimises the "dead spot" trouble which is often noticeable when receiving on short waves.

For those readers who wish to have a more efficient receiver than the two already dealt with, the super-heterodyne set described in the B.B.C. Handbook 1929 is to be recommended, and has proved to be a very reliable and efficient set, but, of course, the cost of construction and the upkeep of such a receiver is considerably heavier than that of the two circuits described in this article.

The table opposite shows the short-wave Stations, whose programmes should be received under favourable conditions.

FIXING MICROPHONES FOR THE BROADCAST FROM THE CENOTAPH

SHORT-WAVE BROADCASTING STATIONS

W/Lth. Metres.	Call.	Station.	Location.
16–8.	PHOHI.	Huizen.	Holland.
19–56.	W2XAD.	Schenectady. (Relays WGY programme.)	U.S.A.
21–96.	W2XO.	Schenectady. (Experimental.)	U.S.A.
25–4.	W8XK.	Pittsburg. (Relays KDKA programme.)	U.S.A.
25–53.	G5SW.	Chelmsford. (Relays Daventry 5XX experimentally.)	England.
25–6.	CJRX.	Winnipeg.	Canada.
30–91.	W2XAL.	New York.	U.S.A.
31.	7LO.	Nairobi.	Kenya Colony.
31–28.	2FC.	Sydney.	Australia.
31–4.	PCJ.	Hilversum.	Holland.
31–48.	W2XAF.	Schenectady. (Relays WGY programme.)	U.S.A.
31–55.	3LO.	Melbourne.	Australia.
40.		Radio Vitus.	Paris, France.
60.		Radio L.L.	Paris, France.
67–65.	AFK.	Doberitz.	Germany.

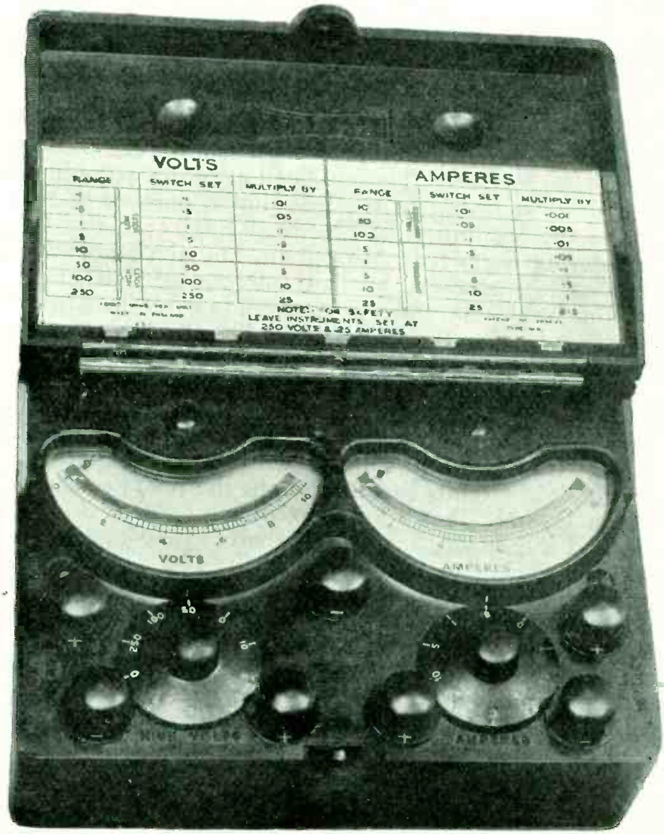
POWER SUPPLY FOR RECEIVERS

NO receiver can give really good quality reproduction if the power supplied to it is inadequate. Since broadcast receivers first came into use by the general public there has been a tendency gradually to increase the power supply to the last stage of amplification. Electric light supply mains provide a constant and convenient source of power for wireless receivers, but in no circumstances should the mains be connected direct to the receiver without the use of an intermediary mains-unit.

A year ago the B.B.C. drafted a pamphlet which describes the many ways in which electric light supplies can be utilised for wireless receivers. The publication of this pamphlet has been delayed owing to the fact that a number of bodies, such as the Institution of Electrical Engineers, the British Engineering Standards Association, and the Radio Manufacturers' Association, are all interested in its contents, and the B.B.C. naturally is anxious to conform with their views and wishes. It will, however, be published as soon as possible.

The B.B.C. wishes to take this opportunity to warn listeners most seriously against the direct connection of their receivers to supply mains, and also strongly recommends that no listener who is unacquainted with handling power and electric light circuits should attempt the home construction of a mains-unit. It is a far more difficult matter to build a safe and satisfactory mains-unit than it is to build a valve receiver. Owing to the danger to life if a number of improperly designed and constructed mains-units come into use by the listening public, the Institution of Electrical Engineers, in collaboration with the other bodies concerned, has drawn up a set of regulations which govern the use of electric power supplies to wireless receivers. One set of regulations by the Institution of Electrical Engineers has already been published, but new and more detailed regulations are now under consideration. These new regulations, if agreed, will be written in formal technical language, and it is thought that many listeners will not be able to follow them conveniently. It is therefore probable that in its mains-unit pamphlet the B.B.C. will print an explanation written in more simple terms.

In conclusion listeners are reminded that they are likely to have some difficulty in the future with electricity supply contractors, fire insurance authorities, and other similar bodies, if they are using a mains-driven receiver which does not conform with the agreed regulations.



A COMBINED TESTING SET AS DESCRIBED ON P. 354

MEASURING INSTRUMENTS

IN the past the use of measuring instruments in receiver circuits has been confined mostly to designers and those listeners who are technically interested in their receivers. Many modern receiving equipments, however, include one or more measuring instruments, or meters, which are mounted in the receiver as an indication of satisfactory reproduction, constancy of power supply, and the other essentials for good performances.

It is thought that the owners of such receivers may wish to know what to expect of any meter which is installed on their equipment, or that others who are anxious to obtain the best possible results from an existing receiver may wish to install some form of measuring instrument. It is impracticable to enter too deeply into the reasons why measuring instruments connected in various circuits of a wireless receiver should behave in the way stated. If the reader is sufficiently interested he can obtain the information from one of the many text-books.

The three main indications which measuring instruments fulfil are:—

1. Overloading of a receiver by its being adjusted to give a louder volume than it can handle.
2. The degree of constancy of the power supply to the valves.
3. The presence of a fault in the circuits of a receiver.

As a general rule it may be taken that no measuring instrument connected in a broadcast receiving circuit should move in sympathy with the received programme; by this it is meant that they should remain at their steady reading, and be quite unaffected by even the loudest of passages. We will consider in turn the more common types of measuring instruments, their position in the circuit, and the information which they supply.

ANODE CURRENT MILLIAMMETER

This is, perhaps, the most useful of all meters and its position in the circuit is shown in Fig. 1.

If the output volume of a receiver is gradually increased,

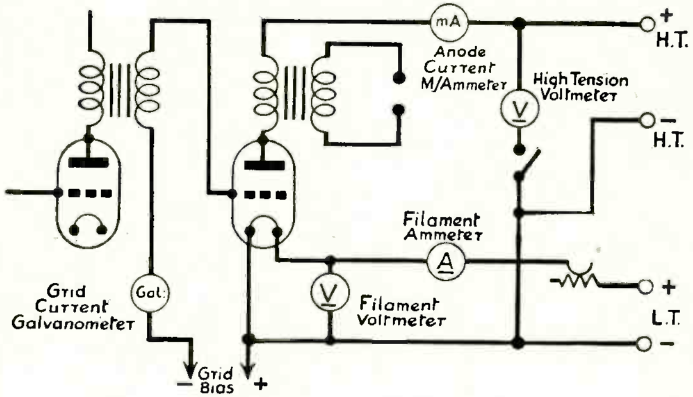
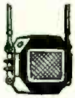


FIG. 1

it will be found that a condition is reached when the loud passages of the programme will result in a slight movement of the milliammeter's pointer. This is the limiting volume which can be obtained without distortion.

The anode current milliammeter should read the same from day to day. If it does not, it shows a variation in the High Tension supply; such as is caused by batteries running down, valves working with low emission resulting from age or insufficient filament current, or a fault in the anode circuit. The standing feed (*i.e.* the normal reading of the anode current meter) should remain constant within 5 to 10 per cent. of its average reading, and the output volume of the receiver should be kept down to a level which causes no "flicks" or instantaneous movement of the pointer during loud passages.

Should it be desired to adjust the grid bias voltage on a low-frequency amplifying valve, a milliameter connected in the anode circuit of that valve will be a great help. If an increased volume of output causes the pointer to kick upwards in reading, it indicates too much grid bias, and if it kicks downwards, too little. When the correct grid bias has been found and the volume increased to the condition of distortion, the pointer should flick both above and below its steady reading.



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One night it is the preacher. Another night it may be the Premier. Yet another night and it is just the programme. But all's one to the Exide Battery. Whatever the listeners are listening for, the Exide Battery pays it out in full volume and unfluctuating flow. And if you instal the Exide Battery you will be following the highest wireless authorities and making sure of the best results.

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G. 9

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If the anode current and grid bias voltage of any particular valve are known, the H.T. voltage at the anode of the valve can be gauged by reference to the grid volts-anode current curve which is usually supplied with the valve.

Anode current milliammeters of attractive appearance which are made suitable for mounting on the control panel of a receiver can be purchased for about £2. Cheaper instruments for portable use are obtainable for about 10*s.*, and are generally of the pocket or watch type.

THE HIGH-TENSION VOLTMETER

High-tension voltmeters for wireless receivers are employed rather more for testing than permanent use. If they are mounted permanently in a receiver they should always be provided with a switch, so that they are in circuit only when a reading is required. The press-button or bell-type switch is probably the most satisfactory type, as it prevents the voltmeter accidentally being left in circuit after the reading has been taken. H.T. voltmeter-switches should always be connected on the earthy side of the voltmeter, as is shown in Fig. 1.

The cheap watch type H.T. voltmeter is perfectly satisfactory for measuring the voltage of batteries, but is frequently unsuitable when it is required to measure the output voltage of Mains Units. If it is desired to measure the output of Mains Units, or to obtain an indication of the voltage *at the anodes* of low-frequency valves in their working condition it is necessary to use a more expensive type of instrument, as the internal resistance of the voltmeter must be extremely high. An instrument having an internal resistance of at least 1,000 ohms per volt is required for this purpose.

In no circumstances should the manufacturers' figure for maximum anode voltage or power dissipation of a valve be exceeded. This has already been set by the manufacturer as high as the valve will stand.

RECTIFIED CURRENT METER

Rectified current meters are a convenient method of checking the constancy of a rectifier or the input to the low-frequency amplifier. Milliameters which give a full-scale deflection for a current of 1·0 to 5·0 milliamps., depending on the type of rectifier, are suitable for this purpose. If a "rectified

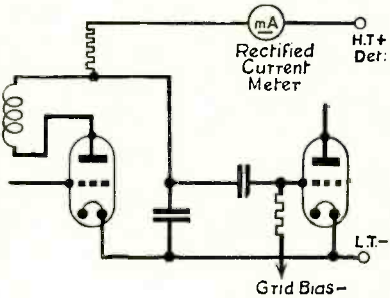


FIG. 2

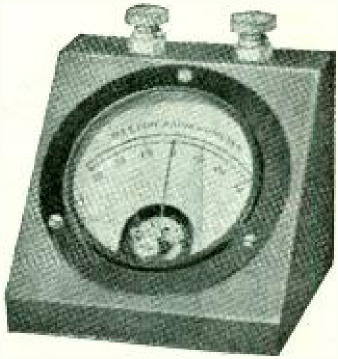
current" meter is employed, it should be connected in the anode circuit of the rectifier or detector valve, as is shown in Fig. 2.

If the filament current and high tension is switched on to the detector valve, anode current will flow in the usual way and the meter will take up a steady reading of, say, 1 milliampere. When the carrier wave of a broadcasting station is tuned in there will be a change in the anode current of the rectifier to, say, 1·3 or 0·8 milliamps., depending upon whether the rectifier is working on the anode bend or grid leak method. This change in anode current is the rectified current (in the example $1{\cdot}3 - 1{\cdot}0 = 0{\cdot}3$, or $1{\cdot}0 - 0{\cdot}8 = 0{\cdot}2$). If you are within, say, 60 miles of the transmitting station to which you are normally tuned (except stations under 250 metres in wave-length) the rectified current should remain practically constant, and is a measure of the performance of that part of your receiving apparatus which precedes the low-frequency amplifier.

GRID CURRENT GALVANOMETER

This method of ascertaining whether distortion or overloading is taking place is not frequently employed, except by the designers, as an extremely sensitive and, consequently, rather expensive meter has to be used.

If the positive cycle of the received signal voltage at the grid of a valve exceeds the negative grid bias, a minute current will flow from the grid of the valve to its filament. This current, known as grid current, is invariably accompanied by distortion. An ammeter, or galvanometer, having a quick movement and a full-scale deflection for, say, 0·5 milliampere, is necessary to show the presence of grid current. A meter such as this is likely to cost at least £3. Grid current indicators or galvanometers should be connected at the earthy end of the grid circuit, as shown in Fig. 1, and not between the grid and the grid leak.



WHAT A GALVANOMETER LOOKS LIKE

FILAMENT VOLTMETER

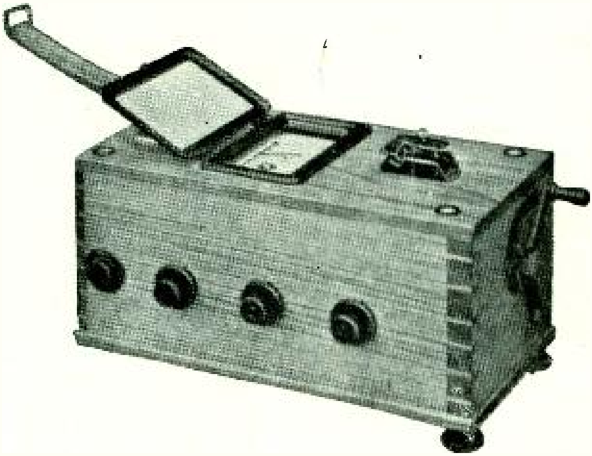
Some mention should be made of instruments for the measurement of filament heating.

It is usually unnecessary to measure both the filament voltage and current of a valve. If the filament or heater current is in accordance with the manufacturer's rating, it is almost certain that the voltage will be correct also, and vice versa. In the case of valves of the ordinary direct-current type no difficulty should be experienced in the purchase of a suitable voltmeter. For valves of the separately heated cathode type an alternating current voltmeter, giving a full-scale reading for 5 volts, will have to be employed. If there is difficulty in obtaining such a voltmeter it is better to adopt the other alternative of using an alternating current ammeter and measuring the heater current.

In measuring the filament voltage of a valve it should be borne in mind that the voltmeter should be connected as near to the valve-holder as possible, and not across battery terminals or low-tension terminals of the receiver, as errors will otherwise arise owing to the ohmic drop in filament resistances, leads, and joints. The method of connection of a filament voltmeter and filament current ammeter is shown in Fig. 1.

HIGH-TENSION VOLTMETER FOR USE WITH ALTERNATING CURRENT MAINS

Those listeners who do not possess alternating current mains voltmeters or know how to use them, are strongly recommended not to attempt such measurements; for that reason no more will be said about them here.

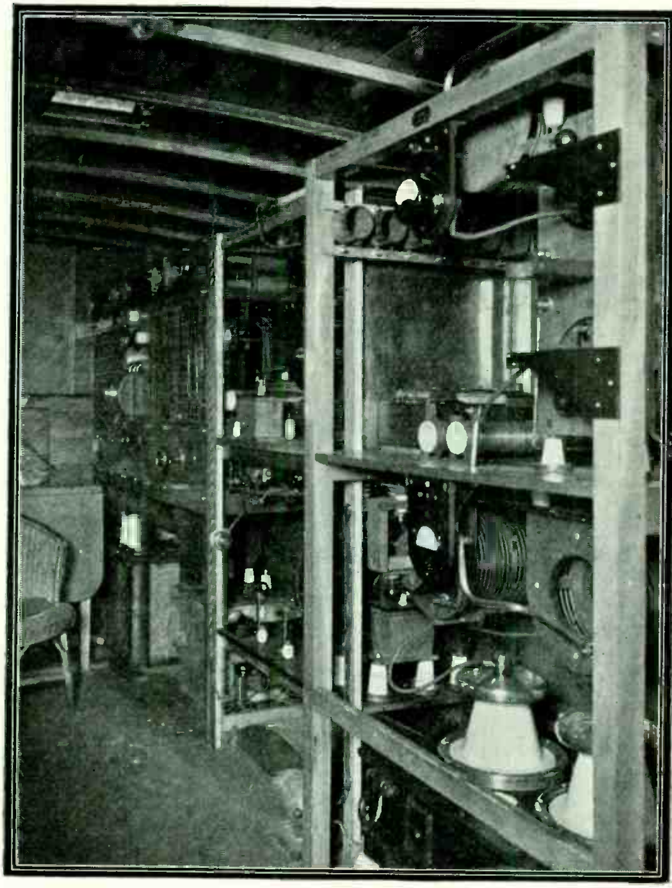


MEGGER

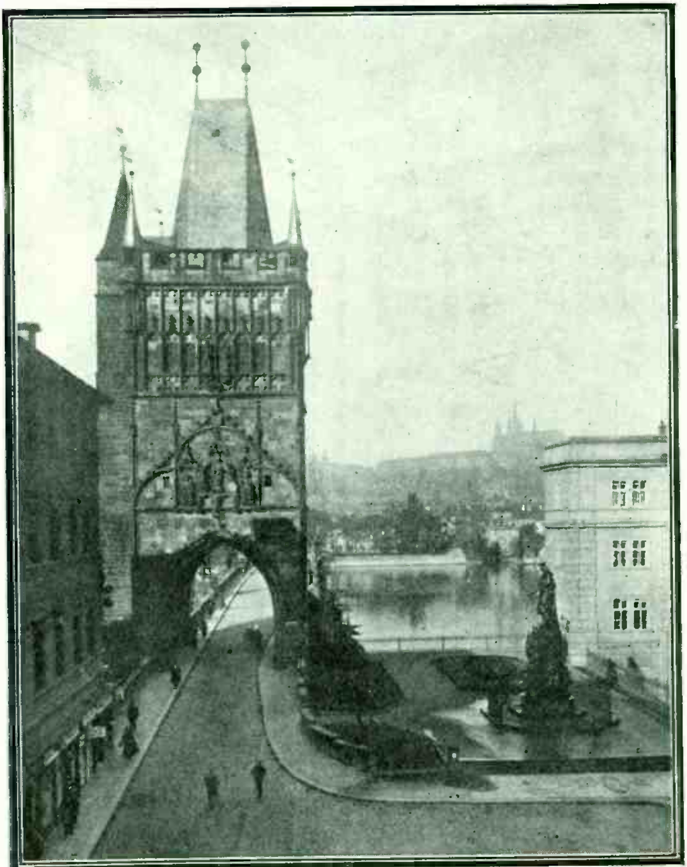
The megger is a most useful instrument, but one which is, unfortunately, rather prohibitive in price. It gives a direct measurement of insulation and high resistances. It is, however, hardly the type of instrument which unskilled listeners are likely to buy.

CONCLUSION

The possession of a set of high-class measuring instruments is an asset to anyone who is sufficiently technical to know how to use them properly. The location of an obscure fault in a receiver is always simplified, and sometimes only made possible, by the use of measuring instruments. The purchase of the necessary number of separate instruments for all emergencies is a little impracticable to anyone but the professional wireless engineer, as they would cost at least £30. The makers of such instruments, however, market testing sets which contain one or more instruments only, but with the necessary shunts and series resistances for all normal requirements. Testing sets of this nature can be obtained at almost any price, according to their sensitivity, guaranteed degree of accuracy and number of ranges. They make an ideal gift to a fellow-listener with a technical interest in wireless which, perhaps, he periodically extends to your own receiver.



THE INTERIOR OF THE B.B.C.'S TRANSMITTER VAN



E.N.A.

PRAGUE

The Alstadt Tower and Karl's Bridge across the Moldau: the palace of Aradcany in the distance

INTERNATIONAL

THE PRAGUE PLAN

THE CHARTER OF EUROPEAN BROADCASTING

"THE European telegraph administrations recognise the necessity that exists for them to act in common to protect the interests of each one of them in the matter of radiodiffusion. They will take the necessary steps to conform, as soon as possible, to the Plan for the repartition of wave-lengths which has been established by the Prague Conference (see Annexe)."

So runs the first paragraph of the final Protocol of the Prague Conference, which was signed by representatives of twenty-seven European administrations on April 13th, 1929.

How does this wave-length plan, agreed to at Prague, differ from the previous plans of Brussels and Geneva established by the Union Internationale de Radiodiffusion? In sum not very greatly, for it is but an evolution from its predecessors and is based on the same general principles. But the previous plans did no more than register amicable agreements between the majority of European broadcasters concerning wave-length allocations amongst their stations. These agreements, secured by an unofficial body, were not inclusive of all European broadcasters, some of whom did not, for one reason or another, join the Union. The Union's unofficial status was at once its strength and its weakness—its strength in that an agreement among technicians could be speedily translated into action without delays which are inevitable in inter-governmental negotiations; its weakness in that it had no power to enforce its decisions.

The Prague Plan, therefore, is free from the two great defects of its predecessors—first, it is inclusive of all European broadcasting authorities, and, secondly, administrations have power to make the stations for which they are responsible conform to it. It therefore has the maximum chance of success in practice, and experience of its first few weeks of working augurs well for the future. All stations are not yet exactly on their allotted frequencies, and there is a very small minority which has not as yet made the necessary change. The interferences produced by stations working off their allotted waves may not be serious in the summer, when the indirect or reflected ray is not received at great strength till late at night, due to prolonged daylight. It is hoped that the present errors will be corrected before such interferences become evident towards autumn.

Turning to the Prague plan itself (printed in full on p. 362), it will be seen that provision is made for certain stations of the U.S.S.R. (those situated on or to the west of the meridian passing through Moscow) by arranging for them to work at $4\frac{1}{2}$ kilocycles per second frequency difference from stations in Western Europe. This should give the minimum chance of interference, the possibilities of which were already slight. For the medium waves (between 200 and 545 metres) the frequency separation of 9 kilocycles per second, which, in the Brussels plan, obtained for waves down to 300 metres, was extended down to 214 metres, thus giving four more channels. In order further to increase the facilities, especially in the long-wave band (above 1000 metres), the Administrations granted as much relief as possible by allowing certain specified broadcasting stations to work outside the wave bands allotted to broadcasting services by the Washington Convention—a possibility admitted by this Convention, providing that no interference is thereby caused to other services. (Art. 5, para. 1, of the General Regulations annexed to the Convention.) In addition, certain countries (notably Germany, Great Britain and Sweden) who, due to their early start in broadcasting, were more favourably placed in point of the quality of their waves, agreed to make sacrifices in quality of waves for the benefit of those less well placed.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G. 14

Great Britain's sacrifice involved the acceptance of a wave of 1148 kCs (261 metres) in place of one of 928 kCs (324 metres). Thus agreement was reached after much negotiation and embodied in the final Prague protocol.

It should be pointed out that the Prague Plan does not allot waves to definite stations, except in a few particular cases, it being left to the national administration concerned to make detailed allocations within the total of waves allotted to its country. The plan, as printed on p. 362, contains, however, for the sake of completeness, the names of individual stations as their positions have been notified since the inauguration of the Plan on June 30th last. Modifications may be made from time to time, as experience shows to be advantageous, by direct arrangement between the countries concerned, provided that no trouble is caused to third parties. It is recommended that these direct arrangements should be made with the advice of the Union Internationale de Radiodiffusion, and that they should be brought to the notice of all other administrations through the International Bureau of the Telegraphic Union at Berne. Thus although the Prague Plan has the advantage of general stability, being terminable only on denunciation by a majority of European administrations, yet it is not so rigid that small advantageous changes cannot be made as and when required.

Two further quotations from the Prague Protocol are of interest. The first endorses a point on which the Union Internationale de Radiodiffusion has repeatedly insisted since the inauguration of its original "Plan de Genève"—*i.e.* the necessity for broadcast transmitters to ensure a constancy of emitted wave, if any wave plan is to succeed. The second has resulted in official recognition of the Union's wave-length checking station at Brussels, which has been officially requested by the Belgian Telegraph Administration to measure the wave-lengths of all European broadcasting stations and to communicate the results to all administrations through the International Bureau of the Telegraph Union at Berne. In the words of the Protocol:

"Transmitting stations shall be held to maintain a stability of emitted wave with all the accuracy which technical means permit."

"The Belgian Administration shall be asked, provisionally and without cost or responsibility on its part, to be so good as to have measured, by organs chosen by itself, the wave-lengths emitted by broadcasting stations and to communicate the results of these measurements to all Administrations through the intermediary of the International Bureau of the Telegraphic Union."

The above statement is purely factual, but one may end by expressing the hope that European broadcasting may, now that its technical ideals have been officially recognised, expand at an even greater rate than in other continents, where, in spite of the implications of freedom, fewer channels have been definitely cleared of interference.

PRAGUE WAVE-LENGTH PLAN

Put into Force on June 30th, 1929

Frequency in kCs	Wave-length in metres (approx.).	Country.	Station.
160	1875	Holland	Huizen
167	1800	Finland	Lahti
174	1725	France	Radio-Paris
183·5	1635	Germany	Zeesen
193	1553	Great Britain	Daventry 5XX
202·5	1481	U.S.S.R.	Moscow*
207·5	1444	France & Aviation	Eiffel Tower
212·5	1411	Poland	Warsaw
217·5	1380	Aviation	—
222·5	1348	Sweden	Motala
230	1304	U.S.S.R.	Kharkov *
250	1200	Turkey	Stamboul †
		Iceland	Reykjavik †
260	1153	Denmark	Kalundborg
280	1072	Norway	†
297	1010	Switzerland	Basle †
320	938	U.S.S.R.	Moscow (C.C.S.P.) *
364	825	U.S.S.R.	Moscow *
375	800	U.S.S.R.	Kieff *
385	778	U.S.S.R.	Petrozavodsk *
395	760	Switzerland	Geneva †
442	680	Switzerland	Lausanne †
527	572	Germany	Freiburg †
527	572	Yugoslavia	Ljubljana †
531·5	565	U.S.S.R.	Smolensk *
536	560	Germany	Augsburg †
			Hanover †

Frequency in kCs	Wave-length in metres. (approx.).	Country.	Station.
545	550	Hungary	Budapest ‡
554	542	Sweden	Sundsvall
563	533	Germany	Munich
572	525	Latvia	Riga
581	517	Austria	Vienna
585·5	511	U.S.S.R.	Archangel *
590	509	Belgium	Brussels No. 1
599	501	Italy	Milan
603·5	497	U.S.S.R.	Moscow *
608	493	Norway	Oslo
617	487	Czechoslovakia	Prague I
621·5	483	U.S.S.R.	Gomel *
626	479	Great Britain	Daventry 5GB
630·5	476	U.S.S.R.	Simferopol *
635	473	Germany	Langenberg
644	466	France	Lyon-la-Doua
653	459	Switzerland	Zurich
666·5	450	U.S.S.R.	Moscow S.P. *
662	453	International Common No. 1	Aachen (Germany)
			Danzig (Germany)
			Klagenfurt (Austria)
			Tampere (Finland)
			Bolzano (Italy)
			Upsala (Sweden)
			Porsgrund (Norway)
			Tromso (Norway)
			Alesund (Norway)
			Salamanca (Spain)
671	447	France	Paris P.T.T.
680	441	Italy	Rome
689	436	Sweden	Stockholm
			Malmberget

* The U.S.S.R. did not participate in the Washington Conference.

† The use of these waves, which are situated in a band not allotted to broadcasting by the Regulations annexed to the Washington Convention, is authorised provisionally, under the express condition that the stations using them do not interfere with the services occupying this band. (See Art. 5, paragraph 1 of the Regulations.)

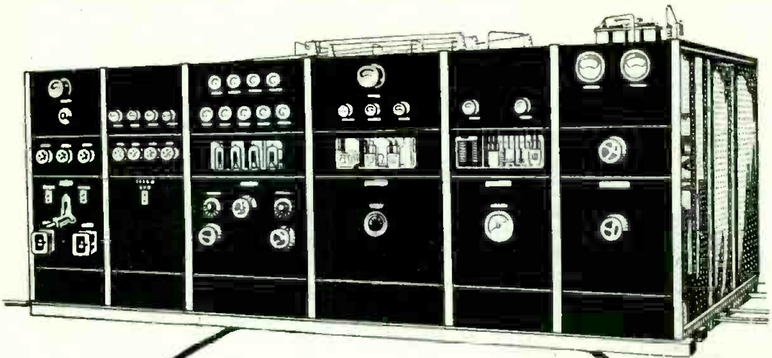
In particular the transmissions of these stations must not interfere with distress signals, alarm or urgency broadcasts on 500 kCs (600 metres) and on 333 kCs (900 metres).

In cases of interference, the Administrations concerned will have to find another solution.

‡ The wave-length allotted to Hungary will be brought back into the band exclusively allotted to broadcasting at the first opportunity.

§ Exclusive wave shared, if there is no mutual interference.

Frequency in kCs	Wave-length in metres. (approx.).	Country.	Station.
698	429	Yugoslavia	Belgrade
702·5	427	U.S.S.R.	Kharkov *
707	424	Spain	Madrid
716	418	Germany	Berlin I
725	413	Ireland	Dublin
729·5	411	U.S.S.R.	Odessa *
734	408	Poland	Kattowitz
743	403	Switzerland	Berne
747·5	401	U.S.S.R.	Koursk *
752	399	Great Britain	Glasgow
761	394	Roumania	Bucarest
770	390	Germany	Frankfurt
779	385	Poland	Vilna §
		Italy	Genoa §
783·5	383	U.S.S.R.	Dnepropetrovsk *
788	381	France	Radio Toulouse
792·5	379	U.S.S.R.	Artemovsk *
797	377	Great Britain	Manchester
806	372	Germany	Hamburg
810·5	370	U.S.S.R.	Tver *
815	368	Spain	Seville
819·5	366	U.S.S.R.	Nikolaiev *
824	364	Norway	Bergen
833	360	Germany	Stuttgart
842	356	Great Britain	London
851	352	Austria	Graz
855·5	351	U.S.S.R.	Leningrad *
860	349	Spain	Barcelona (EAJ 1)
			San Sebastian
869	346	France	Strasbourg
878	342	Czechoslovakia	Brunn
887	339	Belgium	Brussels II. (temporarily used by Bremen Germany)
891·5	337	U.S.S.R.	Ivan-Voznesensk *
896	335	Poland	Posen
905	332	Italy	Naples
914	329	France	Montpellier
923	325	Germany	Gleiwitz
932	322	Sweden	Göteborg
941	319	Bulgaria	Sofia (temporarily used by Dresden, Germany)
950	316	France	Marseilles
959	313	Poland	Crawcow
968	310	Great Britain	Cardiff
977	307	Yugoslavia	Zagreb
986	304	France	Bordeaux-Lafayette

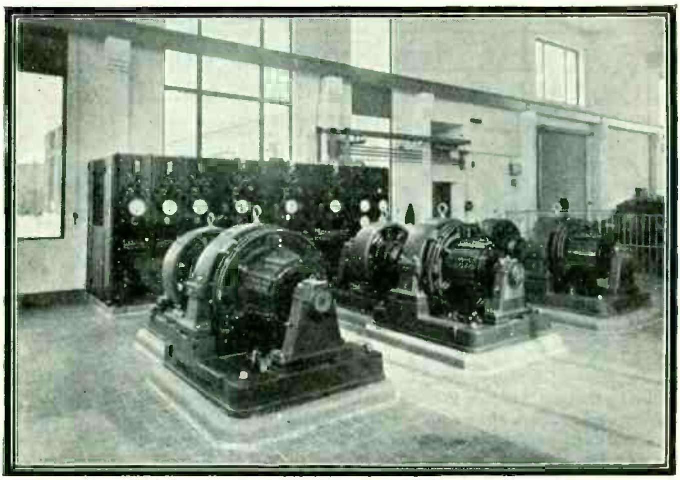


Frequency in kCs	Wave-length in metres. (approx.).	Country.	Station.
995	301	Great Britain	Aberdeen
1004	298	Holland	Hilversum
1013	295	Estonia	Tallinn
1022	293	France	Limoges
		Czechoslovakia	Kosice
1031	291	Finland	Viborg (Vupuri)
1040	289	Great Britain	Bradford
			Bournemouth
			Dundee
			Edinburgh
			Hull
			Liverpool
			Plymouth
			Sheffield
			Stoke-on-Trent
			Swansea
1049	286	France	Rheims
1058	283	Portugal	Temporarily used by:—
			Berlin Relay, Stettin, Magdeburg (Germany)
			Innsbruck (Austria)
			Uddevalla (Sweden)
			Notodden (Norway)
1067	281	Denmark	Copenhagen
1076	279	Czechoslovakia	Bratislava
1085	276	Germany	Konigsberg
1094	274	Italy	Turin
1103	272	France	Rennes
1112	270	Greece	Temporarily used by:—
			Kaiserslautern (Germany)
			Nörrkoping (Sweden)
			Hudiksvall (Sweden)
			Trollhättan (Sweden)
1121	268	Spain	Barcelona (Radio Catalana)
1130	265	France	Lille
1139	263	Czechoslovakia	Moravska-Ostrava
1148	261	Great Britain	Newcastle
1157	259	Germany	Leipzig
1166	257	Sweden	Horby
1175	255	France	Toulouse P.T.T.
1184	253	Germany	Breslau
1193	251	Spain	Almena
1202	250	Czechoslovakia	Prague II.
1211	248	Italy	Trieste

Frequency in kCs	Wave-length in metres. (approx.).	Country.	Station.
1220	246	International Common No. 2	Kiel (Germany) Cassel (Germany) Linz (Austria) Pietassari (Finland) Turku (Abo) (Finland) Elskilstuna (Sweden) Kalmar (Sweden) Kiruna (Sweden) Säffle (Sweden) Carthagena (Spain)
1229	244	Albania (provisionally Poland).	—
1238	242	Great Britain	Belfast
1247	240	Norway	—
1256	239	Germany	Nuremburg
1265	237	Monaco-Nice-Corsica (shared)	Temporarily used by:— Orebro (Sweden)
1274	235	Norway	—
1283	234	Poland	Lodz
1292	232	Yugoslavia	—
1301	231	Sweden	Boras, Halsingborg, Malmo, Umea.
1310	229	Spain	—
1319	227	Germany	Cologne
1328	226	Roumania	—
1337	225	Ireland	Cork
1346	223	Luxembourg	—
1355	221	Finland	Helsingfors
1364	220	France	—
1373	218	International Common No. 3	Flensburg (Germany) Pori (Bjorneborg) (Finland) Karlstad (Sweden) Ornsköldsvik (Sweden)
1382	217	International Common No. 4	—
1391	216	International Common No. 5	Halmstad (Sweden)
1400	214	Poland	Warsaw II
1410	213	Italy	Palermo
1420	211	Roumania	Jassy
1430	210	Hungary	—
1440	208	Belgium	—
1450	207	International Common No. 6	—
1460	206	International Common No. 7	—

Frequency in kCs	Wave-length in metres. (approx.).	Country.	Station.
1470	204	International Common No. 8	Gävle (Sweden)
1480	203	International Common No. 9	Kristinehamn (Sweden)
1490	202	International Common No. 10	Jönkoping (Sweden)
1500	200	Free	Leeds (Great Britain)

NOTE.—The Conference has taken note of the existence of the station at Kaunas (Lithuania), which has used different wave-lengths for broadcasting between 155 kCs (1935 metres) and 151 kCs (1990 metres). This station having interfered with the mobile services carried out by Portishead (Great Britain) using the wave of 149 kCs (2013 metres) situated in the band reserved exclusively for mobile services, the Conference has requested the Administration of Great Britain to get into touch with that of Lithuania, with a view to finding a wave-length for the Kaunas station which will not interfere with these mobile services.



THE FILAMENT CURRENT GENERATORS AT BROOKMAN'S PARK

TATSFIELD RECEIVING STATION

TOWARDS the end of 1924, when relays from America were a novelty and were carried out with apparatus installed in a more or less "lash-up" state at a private house, it became necessary to consider the provision of a central receiving station at which this and similar work could be carried out. Eventually, after considerable searching, a suitable site was found, consisting of a large flat field of about thirty acres, situated at Fairchilds, Kent, looking over the valley to Biggin Hill Aerodrome. This field was rented by the British Broadcasting Corporation, and on it were erected two wooden huts—one of two small rooms to contain an engine and central battery for lighting and general power supply by charging small batteries, and the other of four rooms to provide a central receiving room, an office, a store, and a workshop. The installation of expensive apparatus in wooden huts on an exposed site is not ideal, but the future of the art was at the time so uncertain that the provision of more expensive and permanent buildings could not have been warranted.

The work of this receiving station—called the Keston receiving station for convenience—is already well known to listeners. It should be pointed out, however, that developments have resulted in Keston becoming more a wave-length (or frequency) checking laboratory, working in conjunction with that of the Union Internationale de Radiodiffusion at Brussels, and less a receiving station for relaying distant programmes. In particular, the difficulties of carrying out accurate calibration work with sub-standard apparatus have made it more and more important to avoid great changes of temperature, and during last winter it became necessary to consider afresh the provision of a permanent building more suited to this accurate work.

The erection of a permanent building implied security of tenure, and it was not found possible to achieve this in the existing site. A new site was, therefore, sought—and ultimately found near Tatsfield, Surrey, some three miles from the present site. It is interesting to note that this new site is in a field adjacent to one which was seriously considered when the original search was made in 1924. The new site is some

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THE MICROPHONE IN THE SNAKE HOUSE AT THE LONDON ZOO

850 feet above sea level, and measurements made indicate that greater field strengths are obtainable from many stations than at the present site.

The new building, which is of brick with a tiled roof, is now nearly complete, and it is hoped to move there during September. Cavity walls have been provided and other special precautions have been taken to ensure that a fairly constant temperature will be maintained throughout the year—especially in the wave-meter room. As a public power supply will be used, an electric radiator controlled by a thermostat is to be installed in this room in addition to hot-water radiators. The temperature will, therefore, be maintained to within a few degrees Fahrenheit. The frequency sub-standard (a valve-maintained tuning-fork) and the multi-vibrator gear will be installed in an iron rack bolted to the concrete floor, while brick pillars supporting a concrete bench will carry the frequency meters. Thus it is hoped, in the absence of temperature variation and mechanical vibration, to ensure greater accuracy than is at present achieved.

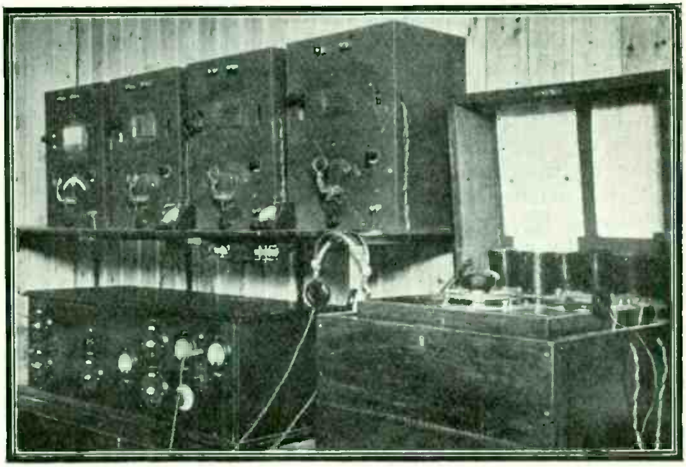
The receiving-room is larger than at Keston, and in addition to much of the old apparatus, certain new gear is being designed to bring the station up to date, so that it will be completely equipped for relaying European stations if and when a land line is not available, as it will be for the really important wave-length checking work. A general view of the exterior of the building is shown in the photograph, while a description of the method and a photograph of some of the apparatus used in wave-length measurement appears on pp. 377–8 in the article "Measuring Distant Wave-lengths."

MEASURING DISTANT WAVE-LENGTHS

MEASUREMENT of the wave-lengths, or frequencies of the carrier waves, of broadcasting and other wireless transmitting stations has become increasingly important with the many additions to the number of stations of all kinds during the past four or five years. Before the days of broadcasting, parts of the æther were relatively uncongested and fairly large errors in the frequencies used by wireless stations were tolerable.

British broadcasting stations first began to experience interference from other broadcasting stations in 1924, and the Union Internationale de Radiophonie was formed in 1925, having as one of its most important objects the allocation of available waves among European broadcasters so as to avoid this mutual interference. The Union was able to arrange the so-called Geneva and Brussels plans, the latter forming the basis of the so-called Plan de Prague (described on p. 357). Accurate and stable wavemeters were designed by the Technical Committee of the Union, who charged its President, M. Braillard, with the task of construction. The design and construction was therefore done at Brussels under the direct supervision of M. Divoire of the University of Brussels, Secretary of the Committee. A majority of European stations were supplied with these wavemeters, and a considerable amelioration of interference immediately resulted.

Some interferences remained, and, although small in comparison with what they undoubtedly would have become without this action, it became necessary to set up a central receiving station to check the frequencies of broadcasting stations at a distance, in order to find the cause of each particular trouble and to provide a record of the day to day frequency variations of stations. This receiving station was established at Brussels in 1927 and has been assisted in its work by a similar station at Keston, belonging to the B.B.C., and by the German Telegraph administration's laboratory in Berlin. Standards of frequency have been compared and very close agreement has been observed in the simultaneous measurements taken. The degree of accuracy attained is of the order of 1 or 2 parts in 10,000.



MEASURING INSTRUMENTS AS USED BY THE B.B.C. AT TATSFIELD

Above, the four U.I.R. wavemeters: below, the check receiver and (right) the Sullivan heterodyne wavemeter

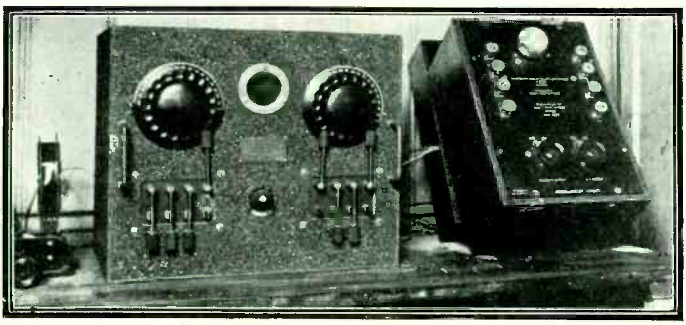
THE BRUSSELS CONTROL STATION

There are two well-known methods of measuring radio frequencies—one the absorption method, and the other the heterodyne method. After preliminary work it was decided to use the latter as giving a greater degree of accuracy with but little extra complication in operation. Ease of operation is a factor to be considered, for between 100 and 150 measurements are taken each day in a period of only a few hours.

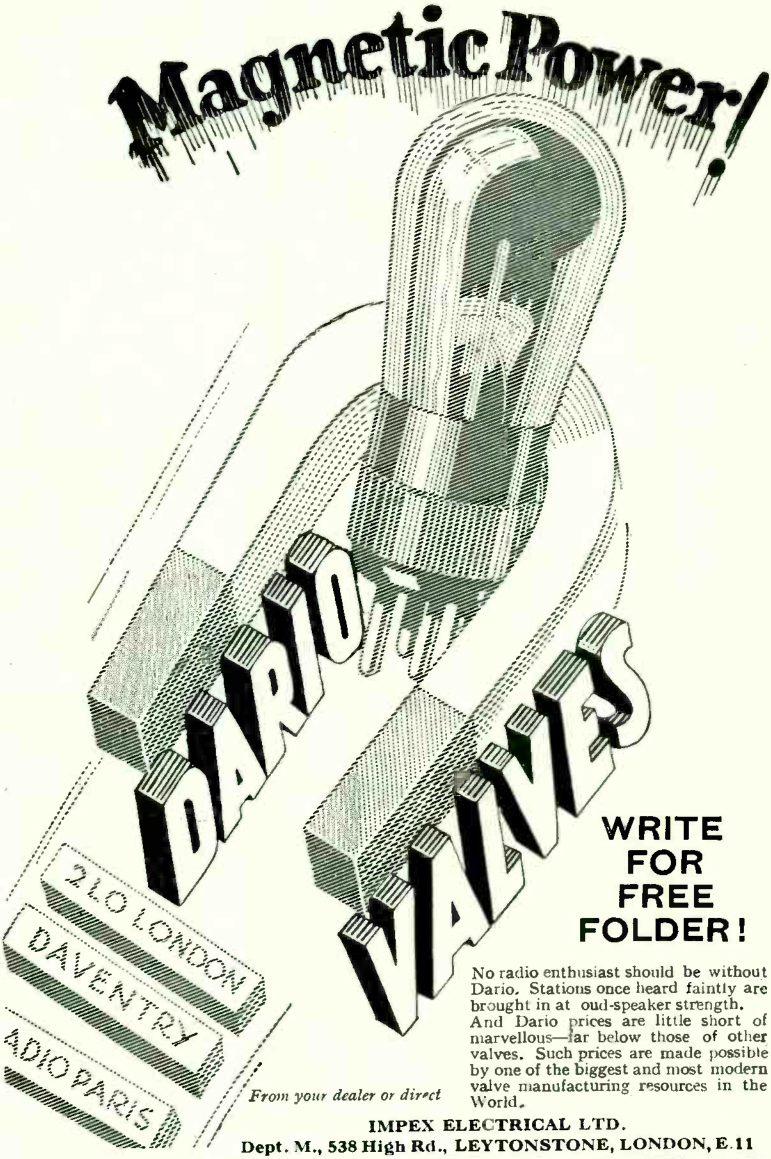
The heterodyne method consists in adjusting the frequency of a local and calibrated oscillator to that of the distant station's received carrier wave, so that after rectification of the combined oscillations no beats are produced between the two. At this point of zero beat-note the two frequencies will be equal, and that of the local oscillator being known, that of the distant station will also be known. The essentials of this system are, therefore, a sensitive and selective receiver, and a stable and calibrated local oscillator.

In practice the system enables measurements to be made on weak carrier waves of distant stations and great accuracy to be obtained in matching the two frequencies. If the low frequency side of the receiver is designed to amplify very low frequencies, beats down to the order of 10 or less a second can be appreciated, the accuracy of this part of the operation then being 10 parts in 1,000,000 for a wave-length of 300 metres, or 1 part in 100,000. However, the over-all accuracy of the measurement is not as great as this, for the local oscillator itself will not remain sufficiently constant. In practice it is found that the largest individual error is in reading the scale of the local oscillator. Space does not permit a consideration of the detailed errors and the steps taken to minimise them; it suffices to say that an over-all practical accuracy of about 1 or 2 parts in 10,000 has been achieved.

In order to cover the whole band of frequencies from 1,500 kilocycles per second (200 metres) to 550 kCs (545 metres), it was found necessary to use four separate local oscillators each having three ranges. The calibration of these oscillators was originally made and is periodically checked by the selection of harmonics of an Abraham & Bloch multivibrator, the fundamental frequency of which is determined by a valve-maintained tuning-fork made by Messrs. Sullivan and calibrated by Dr. Dye of the National Physical Laboratory. This latter is the final frequency standard and gives an accuracy of 1 part in 100,000. In practice one check measurement is taken every day on each range of the four local oscillators, and a correction factor is thus found for all measurements taken on that day. It is usually very small.



THE MULTIVIBRATOR—THE TUNING-FORK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DISTANT RELAYS BY LAND LINE

THE enduring interest in broadcasting for the majority of listeners is in what is received and not in the method of its reception. Certain technical facts, now well established both in theory and in practice, limit the distance over which broadcasting stations can be received perfectly, reliably, and uninterruptedly. Thus it is now possible to predict the size of the area over which a broadcast transmitter can be expected to give a *service* in terms of the wave-length and power employed. In general it may be said that 50 to 100 miles, depending upon wave-length, is the limit of *service* range from stations using the medium wave band (200 to 545 metres), whatever the power of the station.

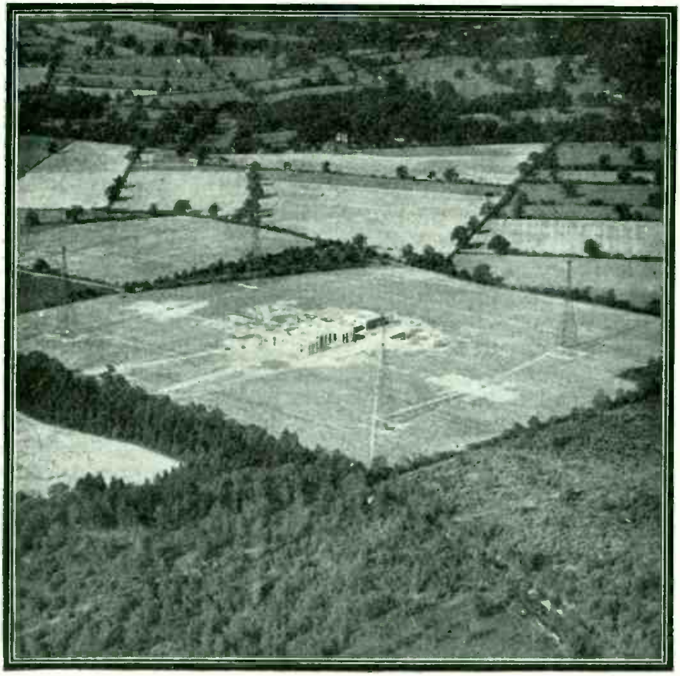
It follows from the foregoing that the majority of broadcasting stations can only give a perfect national, as opposed to international, service. Nevertheless, a certain class of listener is content to get reception, inferior to the local station, from foreign stations which appeal to them from the romantic aspect. This insistence by the broadcaster on the perfect service aspect of local or national broadcasting does not, in fact, constitute a denial of its international aspect. Rather does it underline the importance which the broadcaster attaches to it by ensuring that the listener shall be provided with a *service* of programmes from other countries which can be received *through the local station* without distortion, without interruption, and without entailing the use of a costly and complicated receiver. Thus the future of international broadcasting lies in interlinking national systems by suitable and stable links and radiating "distant" programmes by "local" stations.

From this it follows that wireless seldom proves as suitable or stable a link as a telephone line for carrying broadcast programmes of distant origin to a local transmitter. The lack of available wave-lengths, the interference caused by other services, atmospherics, and fading, all combine to make the wireless link unsuitable and unreliable for medium and short wave-lengths. Hence, in practice, wireless is not used as a link if a suitable line is available, and relays relying on the wireless link are usually declined unless of considerable programme value.

The provision of suitable telephone lines for the successful transmission of music over long distances has been studied by the C.C.I. ("*Comité Consultatif International des Communications Téléphoniques à grande distance*") for the past three or four years. This body has now prepared its recommendations, after consultation with European broadcasting engineers, represented by members of the Technical Committee of the Union Internationale de Radiodiffusion. This augurs well for the future: but for the present a comprehensive system of cables which comprises circuits specially designed for broadcast transmission has been built up in Central Europe, and especially in Germany, which was ready for use in the summer of 1929. The experience already gained has, of course, been embodied in the recommendations for the future made by the C.C.I.

British listeners will participate in this European system through Belgium (La Panne, Ostende, Bruges, Ghent, Brussels, Liège) to Cologne, where connection can be made to the rest of Germany and to Central Europe. This link, as listeners have had opportunities of hearing, has been tried out experimentally on several occasions, and the past year has seen it pass from the experimental stage to a maintenance basis. The Belgian telephone administration has, through Radio Belgique, provided the necessary repeaters and correction networks which are installed at points along the line, so that it is now possible, at relatively short notice, to get a good music circuit between Brussels and London. The extension to Germany, on a maintenance basis should also have been provided by the time this article appears in print. Listeners can, therefore, expect to find a number of relays of Central European stations included in the British programmes for the broadcasting season 1929–30. Music lines through Belgium to the whole of Germany, with possible extensions to Austria, Czechoslovakia, Holland, Hungary, and Poland, are envisaged for the autumn of 1929, while it may also be possible to link up to Scandinavia through Hamburg. British listeners have already heard a relay over part of this last route, for that of the Oslo Royal wedding in March 1929 was conveyed by cable from Oslo to Kalundborg (Denmark), whence it was radiated and picked up at the B.B.C.'s receiving station at Keston. (It is to be noted that the interference experienced during this relay was picked up on the wireless part of the link and not on the cable section.)

The provision of suitable cable circuits for music relays over long distances is thus proceeding, but it is not the work of only a few days or even weeks. That progress, rapid in the circumstances, is being made should be evident to listeners during the course of the present year; indeed the great increase in ordinary continental telephone facilities that has been announced by the Postmaster-General from time to time in the past year or more, may well be followed in the near future by a comparable increase in the facilities for broadcast music transmission.



Ærofilms

AN AERIAL VIEW OF THE LONDON REGIONAL TRANSMITTER

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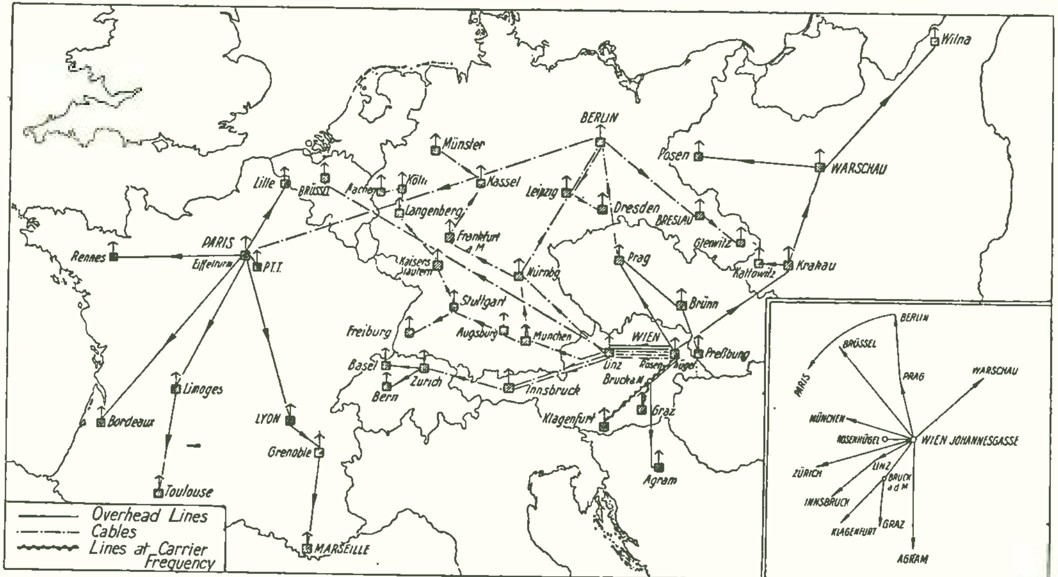
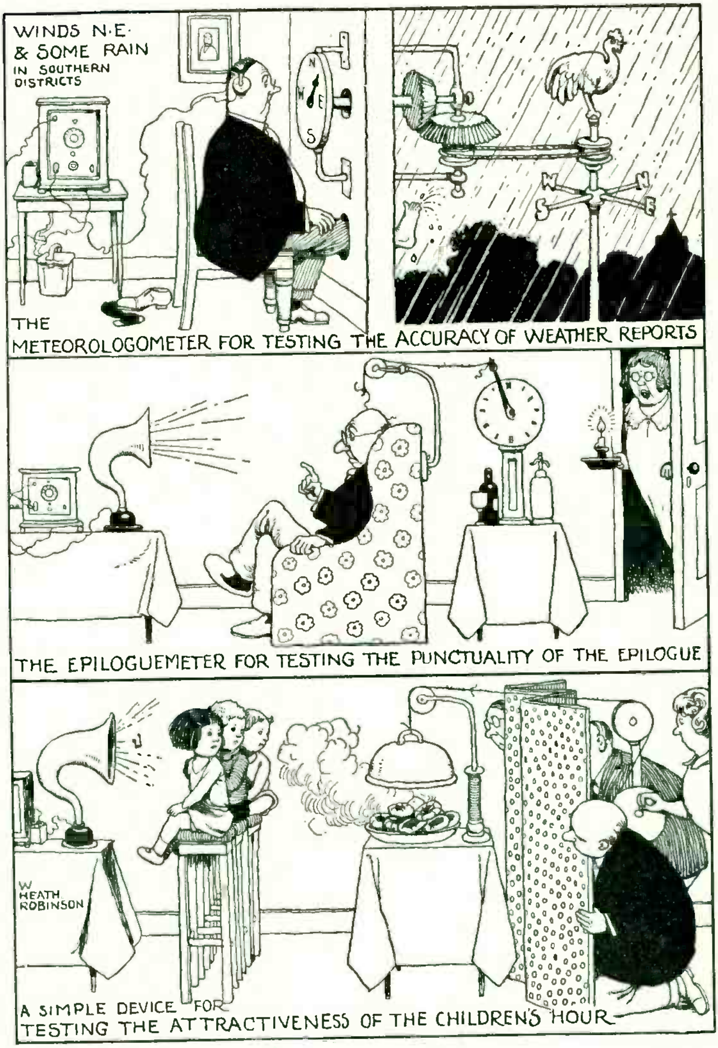


A MAP SHOWING THE COMPLICATED ARRANGEMENTS FOR THE RELAY OF THE SCHUBERT CENTENARY CELEBRATIONS FROM VIENNA (WIEN)



SOME NEW WIRELESS TESTS

GENERAL

WIRELESS RESEARCH

By O. F. Brown, M.A., B.Sc.

Secretary of the Radio Research Board of the Department of Scientific and Industrial Research

DURING the past year two important new designs of valves have been brought into general use, namely, the screen-grid valve and the pentode. The fundamental research work on which these valves are based was carried out some years ago, and the immediate problem which has now been solved by manufacturers is the satisfactory mass production of the valves and the design of suitable circuits to work with them. The general use of the screen-grid valve is likely to put high-frequency amplification upon a more satisfactory basis and to reduce considerably disturbance by oscillation. The pentode is likely to have a future as a power valve giving a high output for a moderate high-tension voltage. Considerable progress has also been made in the development of durable oxide-coated filaments, and these are now employed in many British receiving valves.

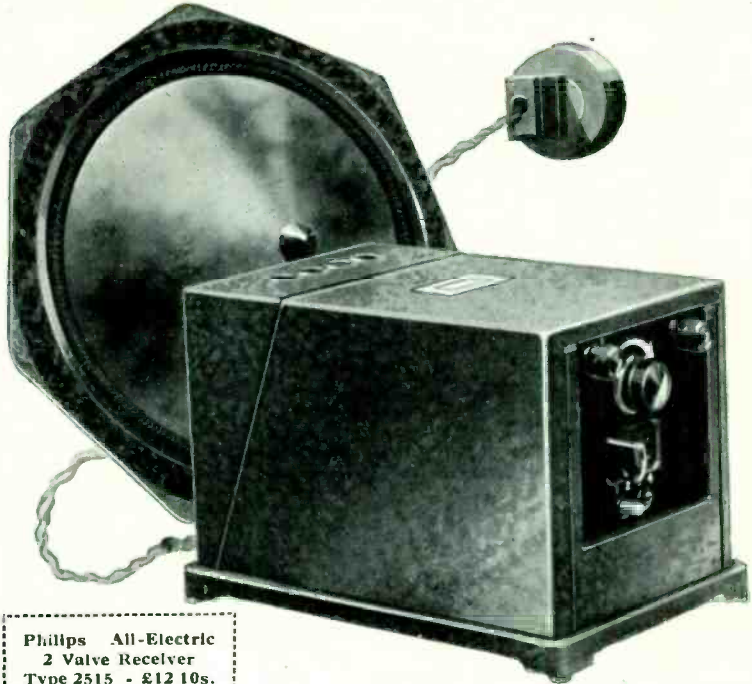
Recent improvements of loud-speakers have mostly been in the direction of improvements in the design of the driving mechanism or, in the case of moving-coil loud-speakers, in the details of the coil suspension, rather than in the application of new acoustic principles. Methods for the measurement of the output of loud-speakers on various frequencies have been developed which will be of considerable assistance in improving design.

Although in the last year a good deal of theoretical work has been published dealing with the mathematical analysis of the phenomena occurring in valve circuits, this work is not likely to have a considerable influence on design. The confirmation of the theoretical results is a long and difficult process owing to the minuteness of the currents and voltages to be measured, and as a general rule it has been possible for manufacturers to surmount difficulties by trial and error rather than by detailed scientific study.

In studying the reliable range of stations, the B.B.C. has been assisted by the work of the Radio Research Board on the measurement of the attenuation of signals. In a recent paper Barfield published a contour map giving the strength of 2LO during the day at various places around London. The work has lately been extended to show the amount of absorption of wireless waves by wooded country and by towns. It is interesting to note that the collection of aerials tuned for the reception of broadcasting in suburban districts was found to produce a very noticeable effect on the attenuation of signals on the wave to which the aerials were tuned.

The experiments on attenuation of waves referred to above were primarily carried out by the Radio Research Board as part of their general researches on the propagation of waves. The modern hypothesis of wave propagation is that the energy at a receiving station is the result of the forces in waves which have travelled along the ground and in waves which have been radiated to the upper atmosphere and deviated down again. Fading has been shown to be due to interference between these two sets of waves, and at times to variation in the down-coming waves, while the large variable errors met with in direction-finding are possibly caused by the action of the earth's magnetic field in changing the direction of the magnetic components in down-coming waves.

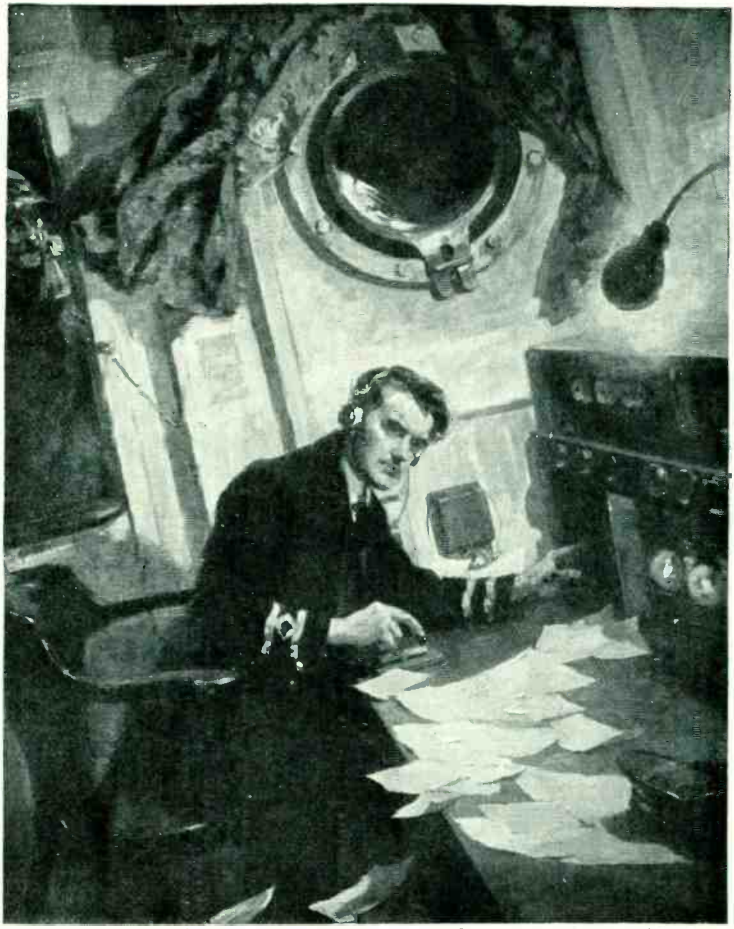
Working in co-operation with the Radio Research Board, Professor E. V. Appleton of King's College, London, has recently shown that two ionised layers exist by which waves are deviated downwards, one at a height of about 100 kms., the other at a height of 220 to 300 kms. The lower layer has



most effect on the deviation of the longer waves, but during the night the ionisation in this layer is reduced by the absence of sunlight, and shorter waves pass through, to be deviated at the more strongly ionised upper layer. On waves of 100 metres this sometimes happens during the day. In the daytime an ionised region is formed below the lower layer which tends to absorb the waves passing through it, but does not deflect them to any great extent.

T. L. Eckersley of the Marconi Company has recently published an important paper dealing with propagation of short waves. He has found that if an attempt is made to determine the direction of a beam transmitter by a wireless direction finder at a place where the ground wave from the station has become negligible, the direction finder indicates that energy is coming not from the transmitter but from the opposite direction. This he explains as being caused by diffuse reflection of the energy of the beam at the ionised layer much as a searchlight beam is seen reflected by a cloud. Eckersley has also shown a close correlation between magnetic storms and fading.

The Radio Research Board has carried out important work on the nature and origin of atmospherics. In this work the cathode ray oscillograph is largely used, as an instantaneous direction finder which gives the direction of arrival of individual atmospherics. To study the range of atmospherics a series of experiments will shortly be carried out with the co-operation of the B.B.C., in which pictures of a piece of graph-paper will be transmitted by the Fultograph apparatus. Observers in various places in the British Isles, Europe and North Africa will receive the transmission on picture receiving apparatus and will return the records to the Radio Research Board. Any atmospherics present will produce marks on the picture as received, and by noting the position of these marks it will be possible to find the area over which the same atmospheric was audible. In this way information will be obtained as to whether most atmospherics are of local origin or come from a considerable distance. This question is of importance in designing apparatus to mitigate the effect of atmospherics.



Courtesy of the Blackpool Corporation

"S.O.S."

A picture by Fred Roe which was exhibited at the Royal Academy in 1929

COMMERCIAL WIRELESS

FROM the listener's point of view the activities of wireless stations not engaged in broadcasting programmes to the public are usually looked upon as an unmitigated nuisance. In fact they are frequently the cause of indignant letters to the B.B.C. demanding that something be done to remove the "Morse interference." Of course all such interference does not necessarily come from commercial stations. There are numerous stations operated by various Government services which also occupy a considerable proportion of the ether. However, it is a most fortunate fact that in these days authorities in charge of all types of wireless stations are doing their utmost to prevent interference to broadcast programmes, at any rate so far as this country is concerned. Nevertheless, where a station using the "spark system" is operating in a populous area, it is not possible to prevent serious interference in its neighbourhood without rebuilding the station altogether. As a rule funds for carrying this out expeditiously are usually not available, and the improved plant can only be installed gradually over many years.

It may be of interest briefly to trace the evolution of wireless communication as applied to commercial undertakings. The first practical use of wireless telegraphy was made in about the year 1898, and signals were first received across the Atlantic in the year 1901. Thus it will be seen that wireless telegraphy was used for commercial purposes rather more than twenty years before broadcasting to the public by means of telephony was considered a practical proposition. Wireless telephony, however, was actually accomplished on a practical basis about the year 1915, seven years before broadcasting.

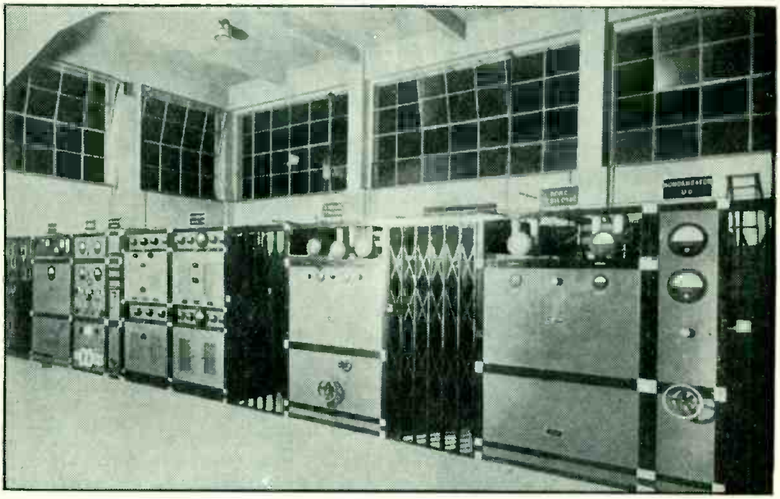
These facts are mentioned because apparently some people have the impression that broadcasting was the first important application of the discovery. Obviously this is hardly the case, although it is undoubtedly true that broadcasting is the most far-reaching of all the applications so far as the general public is concerned. In the early days the most obvious practical use of the discovery was for communication with ships, and quite naturally the headway made in this direction was very rapid. A tremendous impetus was given to this by various disasters at sea in which wireless played an important part, such as the sinking of the *Titanic* in 1912.

The early type of ship transmitter suffered very badly from what is called "flat tuning," which means that the transmissions from a certain station were not confined to a narrow band of frequencies, but were spread over a much wider band than was really essential for satisfactory communication. The reason for this was that at that time the thermionic valve had not been discovered and the usual method of generating high-frequency oscillations was by means of the spark discharger. These transmitters were capable of transmitting very long distances, having regard to their power and the type of receiver in use. Partly for this reason, and partly for financial reasons, the spark transmitter is still very widely used on ships. Valve transmitters, however, are very much more sharply tuned, but, taken on an equal basis, they are more costly and are usually not so robust. All these facts tend to make the change-over for which all coastal broadcast listeners are clamouring rather slow, but it was agreed by the International Wireless Convention at Washington in 1927 that all ship stations should abandon the spark method before 1940.

Turning now to long-distance point-to-point communication. At first spark transmission was used in various forms all based on the same principle. This system was soon replaced for this purpose by arc transmitters, *i.e.* stations generating continuous or undamped waves by means of an arc between two electrodes. The aerials required for these long wavelengths often extended over a mile or more, and the plant required for such stations was very extensive, using up to as much as 500 or 1,000 kilowatts. The Post Office station near Rugby was one of the last of these high-power, long-wave stations to be built, but in this case thermionic valves are used to generate high-frequency energy instead of the electric arc.

It is, of course, a well-known fact that the transmissions from a wireless station reach a distant point along two distinct paths. In the first place there is what is usually called the "Ground Ray," which is simply the direct propagation over the surface of the earth, and then there is what is called the "Reflected Ray," which travels upwards at an angle with the earth's surface until it reaches the "Heaviside layer" and is reflected back again so that it meets the earth's surface at con-

A NEW MARCONI STATION



MARCONI TYPE PA5 BROADCASTING TRANSMITTER AT BRATISLAVA, CZECHO-SLOVAKIA

The Type PA5 transmitter illustrated is one of a series developed by the Marconi Company using the method of low power modulation. In common with all other Marconi products the set conforms in every respect to the technical requirements of modern practice, and provides broadcast transmissions of the highest quality. An achievement in the design of this transmitter is compactness combined with adaptability to various layout arrangements, in order to suit differences in shape and size of accommodation available. The transmitter is rated at 12 kilowatts unmodulated carrier energy.

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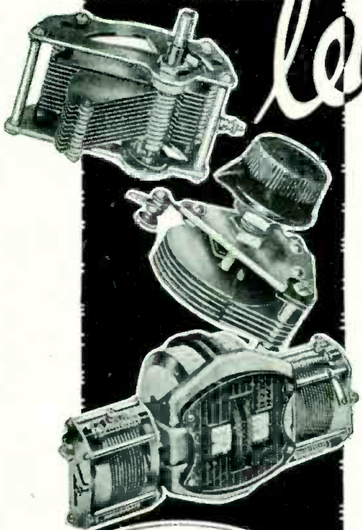

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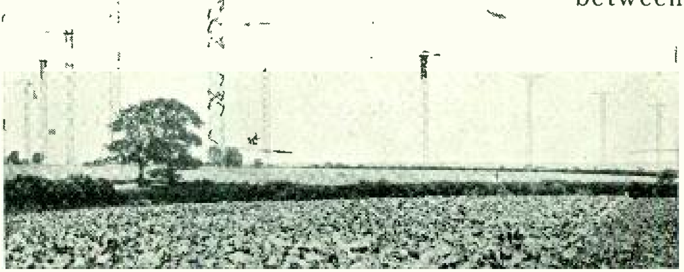
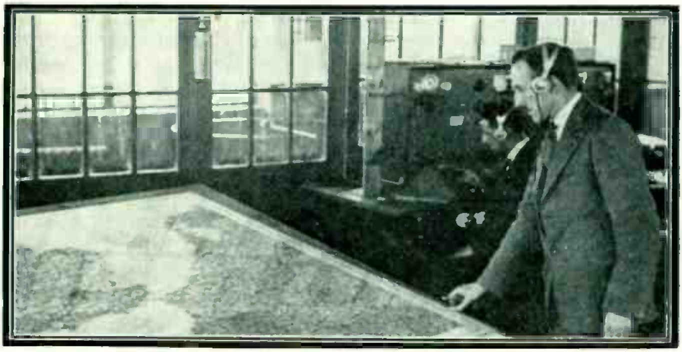
siderable distances from the transmitter. At first all long-distance transmissions were by means of the direct or ground ray. It was soon realised that the attenuation of this ray over land was very much less the longer the wave-length used. Thus the tendency at first was to build stations of very high power to work on very long wave-lengths.

The latest trend of development for very long distance communication depends on the use of wave-lengths between, say, fifteen and forty metres. Long-distance transmission on wave-lengths of this order depends entirely on reflected or indirect radiation. Transmitting stations working on this principle are very frequently referred to as "beam stations" owing to the fact that the Marconi Company has built several stations which, in addition to working on short waves, have aerials which project the greater part of their energy in the direction of the receiving point. However, all short-wave long-distance stations do not necessarily use directional aerials and, therefore, all of them should not be called beam stations.

Some of the advantages which the short-wave system possesses over the long-wave system are that the plant costs considerably less to erect in the first instance and the running costs are lower, and the speed of transmission when automatic working is used is several times quicker. This means that a greater number of words can be transmitted between



A FAMILIAR SIGHT IN PARTS OF THE COUNTRY
A Beam Receiving Station



THE OPERATORS AT THE CROYDON AIR STATION ARE IN TOUCH WITH AIRCRAFT WITHIN A RADIUS OF 1,000 MILES, KEEPING THEIR POSITIONS MARKED ON THE MAP

two given points taken over the whole twenty-four hours. Generally speaking also there is greater freedom from atmospheric disturbances.

Of the above, probably the most important commercially is the great speed at which Morse code messages can be transmitted with accuracy. Again, it is this property which makes the short-wave stations serious competitors with the submarine cables on which many millions of pounds have been spent during the last half-century. Some idea of the revenue-earning capabilities of these stations will be realised when it is said that under favourable conditions this article could be transmitted from this country and received in Canada on an automatic printer in about four minutes.

Fortunately short-wave stations do not interfere with broadcasting, except perhaps in their immediate surroundings, and, therefore, listeners have little to fear from development in this direction.

AIRCRAFT AND WIRELESS

MANY listeners who are able to tune in to the 900-metre wave-length will perhaps have overheard the telephone messages passed to and fro between the Croydon Aerodrome Station and the cross-channel air-liners.

Listening on this wave-length will reveal the existence of an extensive network of telephone stations, installed at the European air ports, for the services of commercial aircraft.

By the aid of these and other telegraph stations, a signalling system has been developed somewhat akin to that used by the railways for traffic control. Messages are sent by ground stations, giving particulars of weather conditions, machines on the various routes, arrivals and departures, etc., whilst aircraft report progress and positions from time to time.

No private calls from passengers are yet allowed, the service being confined solely to the transmission of messages connected with the operation of air route traffic.

Modern air-port wireless stations are equipped with Direction Finding Receivers; by the aid of these instruments the ground station operators can instantly give the pilot his bearing, while two or more stations working together are able to calculate his position with remarkable accuracy and rapidity. Thus, a pilot setting out on a day when fog is prevalent and weather uncertain, derives invaluable aid in his responsible task of bringing his machine, his passengers, and freight safely to their destination.

Before he leaves the ground he consults a weather chart showing conditions reported by wireless along the route. Any change can be notified to him during flight, and he can be warned of the proximity of other machines. If visibility is bad and he is unable to recognise familiar landmarks, he can be given his position and correct course to steer on.

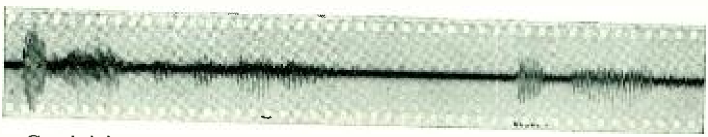
He can be warned to land at an alternative aerodrome, if his home port is fogbound; and should he find himself forced to land he can notify his home officials of his intentions, whilst in case of distress, due to engine failure over the sea, the word "Mayday"—equivalent to the S.O.S. used by ships—transmitted through the microphone, will summon immediately all possible help.

Wireless telephony, in preference to Morse telegraphy, is employed on British and many continental air liners, because it enables messages to be sent and received direct by the pilot, and therefore avoids the necessity of carrying a skilled operator. It is also quicker and generally more suited to the needs of fast-moving aircraft.

Special apparatus, which is maintained in a high state of efficiency by routine ground inspection, is employed on the machines. Its high efficiency is the outcome of years of research, dating back to the war period when, before the development of broadcasting technique, wireless telephony was first applied to aircraft services (for formation control), and a solution found for the transmission and reception of intelligible speech, through the deafening noise created by high-powered aircraft in flight.

In the big flying boats used on Empire air routes, wireless operators are carried, and telegraphy is used for long-distance working and telephony for emergencies. Wireless Direction Finders may also be carried.

In America a different system is being developed. On the transcontinental air routes a chain of wireless directive beacons is being installed to create a wireless "path" along which the machines can find their way in thick weather or by night.



Goodnight ev - ry - bo - d - y Good - night.

REFERENCE SECTION

GENERAL INFORMATION

TECHNICAL SYMBOLS

TECHNICAL TABLES

TECHNICAL DICTIONARY

B. B. C. ADDRESSES

Headquarters

HEAD OFFICE AND STUDIOS	Savoy Hill, London, W.C.2.
DAVENTRY (5XX) STUDIOS AND OFFICES	Savoy Hill, London, W.C.2.
DAVENTRY (5GB) STUDIOS AND OFFICES	282, Broad Street, Birmingham and also partly Savoy Hill.

Regional Centres

BELFAST	31, Linenhall Street.
CARDIFF (West Region)	39, Park Place.
GLASGOW (Scottish Region)	21, Blythswood Square.
MANCHESTER (North Region)	Broadcasting House, Piccadilly.

Relay Offices

ABERDEEN—
15, Belmont Street.

BOURNEMOUTH—
72, Holdenhurst Road.

DUNDEE—
1, Lochee Road.

EDINBURGH—
87, George Street.

HULL—
26 & 27, Bishop Lane.

LEEDS-BRADFORD—
Cabinet Chambers, Basinghall Street, Leeds.

LIVERPOOL—
85, Lord Street.

NEWCASTLE—
54, New Bridge Street.

PLYMOUTH—
Athenæum Chambers, Athenæum Arcade.

SHEFFIELD—
Castle Chambers, Castle Street.

STOKE-ON-TRENT—
Majestic Buildings.

SWANSEA—
Oxford Buildings (Corner of Union Street & Oxford Street).

Wireless Societies

THE INCORPORATED RADIO SOCIETY OF GREAT BRITAIN

53, Victoria Street, London, S.W.1.
Hon. Secretary: H. Bevan Swift, A.M.I.E.E.

THE RADIO ASSOCIATION

22, Laurence Pountney Lane, E.C.4.
Hon. Secretary: S. Landman, M.A.

THE WIRELESS LEAGUE

INCORPORATING

THE WIRELESS ASSOCIATION OF GREAT BRITAIN

7, Southampton Street, Holborn, London. W.C.1.
Hon. Secretary: A. E. Parnell.

Wireless Trade Associations

RADIO MANUFACTURERS' ASSOCIATION

Astor House, Aldwych, London, W.C.2.
Hon. Secretary: D. Grant Strachan.

THE WIRELESS RETAILERS' ASSOCIATION OF GREAT BRITAIN

70, Finsbury Pavement, London, E.C.2.
Hon. Secretaries: Messrs. Clifford & Clifford.

BRITISH RADIO VALVE MANUFACTURERS' ASSOCIATION

59, Russell Square, London, W.C.1.
Hon. Secretary: H. Howitt.

RADIO WHOLESALERS' FEDERATION

35, Sicilian House, Sicilian Avenue,
Southampton Row, London, W.C.1.
Hon. Secretary: J. Macfarlane.

THE RADIO CIRCLE

The Radio Circle consists of two sections:

1. The Junior, for listeners up to eighteen years of age.
2. The Senior, for listeners over eighteen years of age.

Membership is for one year only, but may be renewed. The annual subscription of ninepence is due on January 1st in each year, but newcomers may join the Circle at any time. The first subscription entitles the newly-joined member to a badge, which takes the form of an enamelled device, common to all Stations—with a special pendant for each local branch. Subsequent subscriptions entitle rejoining members to a calendar or some other token. Membership of the Junior Section gives the privilege of a broadcast birthday greeting. There are now no membership numbers. Applications for membership should include full name, full address, and, for the Junior Section, the day, month and year of birth. Some Stations have printed forms which are sent on request and facilitate registering. All applications should be accompanied by the subscription of ninepence.

DISPOSITION OF RADIO CIRCLE FUNDS

The balance of the subscriptions (over and above the cost of the badge and postage) is paid into the local Radio Circle Funds, which are further increased in various ways such as by the sale of "silver paper." Up to the end of last year the amount distributed to Charity by the London and Daventry Radio Circle had reached a total of £1,240.

HOW TO APPLY FOR A BROADCAST APPEAL

Write, enclosing a copy of the latest report of the charity you are interested in, to:—

THE SECRETARY,
APPEALS ADVISORY COMMITTEE,
THE BRITISH BROADCASTING CORPORATION,
SAVOY HILL, W.C. 2.

NEW MUSICAL COMPOSITIONS

The B.B.C. is always ready to consider new music for broadcasting. Such music should be good enough to be worthy of performance on its own merits—and only works for orchestra and military band, or choral works, should be submitted. Scores (not parts) should be sent in. Chamber music, short instrumental pieces, and songs, as well as dance music and pieces, even if for orchestra, of a trifling nature, cannot well be used; the B.B.C. leaves the choice of all such items to artists, and such pieces have a better chance of performance if introduced direct to them.

For plays see p. 77.

S.O.S. RULES

In view of the greatly increasing number of S.O.S. messages that the B.B.C. is asked to broadcast, listeners are reminded of the rules and procedure which must be adhered to, careful attention to which will save a great deal of time and trouble to all concerned.

The B.B.C. will broadcast messages requesting relatives or friends to go to a sick person only when the Hospital Authority or the Medical Attendant certifies that the patient is *dangerously ill*, and *if all other means of communication have failed.*

In no case can an S.O.S. be broadcast requesting the attendance of relatives, etc., *after* death has occurred.

Originators of S.O.S. calls would help considerably if they would let their nearest Station know if the S.O.S. has been successful or not.

S.O.S. calls for "missing" people cannot be broadcast unless the B.B.C. is directly requested to do so, in the case of London or Daventry, by New Scotland Yard, and, in the case of provincial Stations, by the Chief Constable of the district in which the Station is situated.

No S.O.S. can be put out regarding lost animals or property.

WEATHER FORECASTS

10.30. Daventry 5XX. Weather Forecast for ships and farmers. Read twice—first at natural speed, second time at long-hand dictation speed.
6.15. General Weather Forecast.
9.0. General Weather Forecast, including a summary of the day's weather.
9.30. Daventry 5XX. Weather Forecast for ships only.
10.0. Daventry Experimental 5GB. General Weather Forecast, including a summary of the day's weather.

In addition:—

Gale Warnings are broadcast at 1, 4.45, and 6.15 p.m., and on Sundays at 3.30 p.m., as and when received from the Meteorological Office.

Forecasts of sea passages are at certain seasons of the year included in the Weather Forecasts at 6.15, 9, and 10 p.m.

MARKET BULLETINS, ETC.

The following Bulletins are broadcast at regular intervals. The actual time will be found in the B.B.C.'s published programmes in the *Radio Times*.

Weekly.	Market Prices for Farmers.
	Horticultural Bulletin.
	Foreign Exchanges.
	Empire Marketing Board Bulletin.
Fortnightly.	Agricultural Bulletin.

B.B.C. TIME SIGNAL CHART

WEEK-DAY SERVICE

Station.	10.15 a.m.	10.30 a.m.	11.0 a.m.	Noon.	1.0 p.m.	2.30 p.m.	3.0 p.m.	4.45 p.m.	5.15 p.m.	6.0 p.m.	6.15 p.m.	7.0 p.m.	9.0 p.m.	10.0 p.m.	Conclusion of Programme.
2LO	**Big Ben**			**Big Ben** N.S.	G.T.S.	Big Ben	Big Ben		Big Ben	Big Ben	**G.T.S.**	Big Ben	G.T.S.		Big Ben
5XX	**Big Ben**	**G.T.S.**	**Big Ben**		Big Ben G.T.S.	Big Ben	Big Ben	**G.T.S.**	Big Ben	Big Ben	**G.T.S.**	Big Ben	G.T.S.	**G.T.S.**	Big Ben
5GB							Big Ben				**G.T.S.**		G.T.S.		Big Ben
Other Stations.											**G.T.S.**	Big Ben	G.T.S.		Big Ben

SUNDAY SERVICE

Station.	10.30 a.m.	3.30 p.m.	8 p.m.	9 p.m.	10 p.m.
2LO		G.T.S.	Big Ben	**G.T.S.**	
5XX	**G.T.S.**	G.T.S.	Big Ben	**G.T.S.**	**G.T.S.**
5GB		G.T.S.	Big Ben	**G.T.S.**	
Other Stations.		G.T.S.	Big Ben	**G.T.S.**	

Reference.—N.S. indicates Not Saturdays. Heavy type indicates Compulsory, *i.e.* invariably broadcast. Ordinary type indicates Optional, *i.e.* only broadcast if an interval occurs in the programme at the time. G.T.S. = Greenwich Time Signal, which takes the form of a broadcast by electrical contact of the last six seconds before the hour, the "beat" of each second being represented by a sharp "pip," the last "pip" being the actual time signal.

STANDARD SYMBOLS

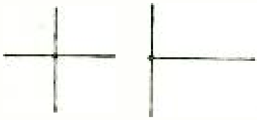
LETTER SYMBOLS

In the first two pages of the Technical Tables (pp. 413, 414) will be found a list of symbols for various electrical units. These symbols take the form of the letters of either the English or the Greek alphabet. A note explains the difference between a symbol and an abbreviation.

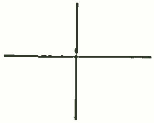
GRAPHICAL SYMBOLS

In addition to these letter symbols, a large number of graphical or picture symbols are used in the drawing of electrical plans. The International Electrotechnical Commission has issued a standard list of graphical symbols for use in all forms of electrical engineering. The B.B.C. has extracted the symbols most often required for diagrams connected with broadcasting, and has adopted them for standard use in all its work.

It is felt that these symbols might be useful both to readers of B.B.C. publications and to listeners who have at any time themselves to draw diagrams. They are therefore reproduced for ready reference on the four pages that follow.



WIRES IN CONTACT



WIRES NOT IN CONTACT

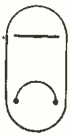
TWISTED PAIR

RESISTANCE FIXED

RESISTANCE VARIABLE BY SLIDER

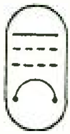
RESISTANCE VARIABLE BY STUDS

RESISTANCE NON-INDUCTIVE

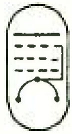


2 ELECTRODE VALVE

3 ELECTRODE VALVE



4 ELECTRODE VALVE

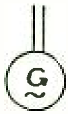


PENTODE VALVE

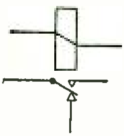
THERMO-COUPLE

GENERATOR, D.C.

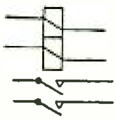
MOTOR, D.C.



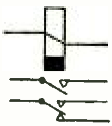
A.C. GENERATOR, SINGLE PHASE



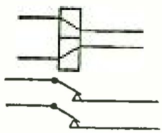
RELAY WITH SINGLE COIL



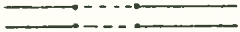
RELAY WITH TWO COILS



SLOW ACTING RELAY



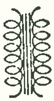
DIFFERENTIAL RELAY



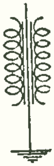
JUMPERED CONNECTION

U. LINKS

IRON CORE CHOKE

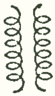


IRON CORE TRANSFORMER

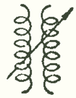


TRANSFORMER WITH SCREEN BETWEEN PRIMARY AND SECONDARY

AIR CORE CHOKE



AIR CORE TRANSFORMER



VARIABLE MUTUAL INDUCTANCE

HEADPHONES

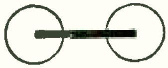
MICROPHONE

LOUD SPEAKER, GENERAL SYMBOL

LOUD SPEAKER, MOVING COIL

A.C. GENERATOR, THREE PHASE

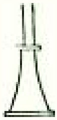
INDUCTION MOTOR, THREE PHASE



MACHINES COUPLED MECHANICALLY

LAMP

TELEPHONE TRANSMITTER



TELEPHONE RECEIVER

MAGNETO BELL


FIXED CONDENSER


VARIABLE CONDENSER

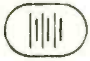

NEUTRODYNE CONDENSER

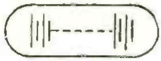

EARTH CAPACITY


EARTH


AERIAL


CRYSTAL DETECTOR


PRIMARY BATTERY

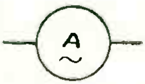

PRIMARY BATTERY, MULTI CELL


SECONDARY BATTERY

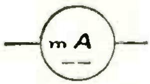

SWITCH


FUSE


TERMINAL



AMMETER, A.C.



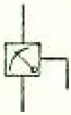
MILLIAMMETER, D.C.

MICROAMMETER, D.C.

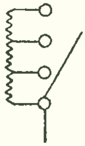
VOLTMETER, A.C.

MILLIVOLTMETER, D.C.

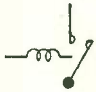
GALVANOMETER



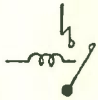
RHEOSTATIC STARTER, COMPOUND MACHINE



RHEOSTATIC STARTER, MULTIPLE CONTACT SWITCH TYPE

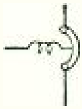


CONTACTOR



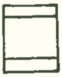
CONTACTOR WITH BLOW OUT

AIR BREAK CIRCUIT, BREAKER MAXIMUM



AIR BREAK CIRCUIT, BREAKER MINIMUM

RHEOSTATIC STARTER, SERIES MACHINE



BUZZER

2 WAY PLUG

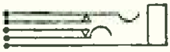
3 WAY PLUG

PLUG NO. 404

3 POINT JACK

PLUNGER KEY

2 POSITION LEVER KEY



5 POINT JACK

3 POSITION LEVER KEY

NOTE.—The letters L or NL are to be used in conjunction with keys to show locking or non-locking positions. The movement of the levers in above examples is vertical.

TECHNICAL TABLES AND FORMULÆ

1. UNITS (FUNDAMENTAL)

THE fundamental units, on which all practical units are based, are those of length, mass and time. In the C.G.S. System these are the centimetre, gramme and second respectively, and in the British System the foot, pound and second.

2. UNITS (DERIVED)

Unit of	C.G.S. electro-magnetic unit.	C.G.S. electro-static unit. (approx.)	Practical unit.	Abbreviation for practical unit.	Symbol.
Current .	10 ampères	$\frac{1}{3\times 10^9}$ ampere	1 ampere	A	*I*
Resistance .	$\frac{1}{10^9}$ ohm	9×10^{11} ohms	1 ohm	Ω	*R*
Electromotive Force .	$\frac{1}{10^8}$ volt	3×10^2 volts	1 volt	V	*E*
Potential Difference .	$\frac{1}{10^8}$ volt	3×10^2 volts	1 volt	V	*V*
Quantity .	10 coulombs	$\frac{1}{3\times 10^9}$ coulomb	1 coulomb	C	*Q*
Energy	1 cm.-dyne = 1 erg = $\frac{1}{10^7}$ joule	$\frac{1}{10^7}$ joule	1 joule	J	*W*
Power	$\frac{1}{10^7}$ watt = 1 erg per sec.	$\frac{1}{10^7}$ watt	1 watt	W	*P*
Capacity .	10^9 farads	$\frac{1}{9\times 10^{11}}$ farad	1 farad	F	*C*
Inductance .	$\frac{1}{10^9}$ henry	9×10^{11} henry	1 henry	H	*L*

1 coulomb = 1 ampere for one second.
1 joule = 1 watt for one second.
= 10^7 ergs.
= 0·7372 ft.-lb.
1 kilowatt = 1000 watts.
1 horse power = 746 watts.
= 33,000 ft.-lb. per minute.
= 550 ft. per second.

1 Board of Trade Unit = 1 kilowatt-hour.
= 36×10^5 joules.

$$1 \text{ dyne} = \frac{1}{981} \text{ gramme}$$

$$= \frac{1}{445{,}000} \text{ lb.}$$

The above abbreviations and symbols follow the recommendations of the International Electro-Technical Commission which meets periodically to make such recommendations.

In addition, the following prefixes have been standardised :—

m for milli-	*e.g.* mA	means	milli-amperes	= $1/10^3$ ampere
k ,, kilo-	,, kW	,,	kilo-watts	= 10^3 watts
μ ,, micro- or micr-	,, μF	,,	micro-farads	= $1/10^6$ farad
$\mu\mu$,, micro-micro-	,, $\mu\mu$F	,,	micro-micro-farads	= $1/10^{12}$ farad
M ,, mega- or meg-	,, MΩ	,,	megohms	= 10^6

It is important to note the different uses of the abbreviations and the symbols. The symbols are used *by themselves*, whereas the abbreviations are used in conjunction *with quantities*.

Thus, Ohms Law is given by

$$I = \frac{E}{R}$$

But, to express in equation form the fact that 5 amperes pass through a resistance of 2 ohms when an electromotive force of 10 volts is applied to the ends of the resistance, it is shown :—

$$5\text{A} = \frac{10\text{V}}{2\Omega}$$

The abbreviation kC/s is used to denote the frequency of an electro-magnetic wave in kilocycles per second.

3. CONVERSION FACTORS

1 inch	= 2·54 centimetres.
1 foot	= 30·48 centimetres.
	= 0·3048 metre.
1 yard	= 0·914 metre.
1 mile	= 1609·3 metres.
1 kilometre	= ·62 mile.
1 lb.	= 453·6 grammes.
1 ounce	= 28·35 grammes.
1 kilogram	= 2·2 lbs.
1 gallon	= 4·55 litres.
1 B.Th.U.	= 0·252 calorie.
1 litre	= 28·3 cubic feet.
1 gallon of water	= 10 lbs.
1 mile per hour	= 88 feet per minute.

1 horse-power hour = 1,980,000 foot-lbs.
1 foot-lb. = 1·356 joules.
1 knot = 6080 feet per hour.
1 radian = 57·3 degrees.
π = 3·1416.
ϵ = 2·7183.
1 cubic foot of water weighs 62·3 lbs.
1 atmosphere = 14·7 lbs. per square inch = 760 millimetres of mercury.
A column of water 2·3 feet high corresponds to a pressure of 1 lb. per square inch.
1 centigrade heat unit = 1400 foot-lbs.

4. WIRE GAUGE AND STANDARD COPPER CONDUCTORS

IMPERIAL STANDARD WIRE GAUGE

No.	Diameter (ins.).	Sectional area (sq. ins.).	No.	Diameter (ins.).	Sectional area (sq. ins.).
0	0·324	0·0824	26	0·018	0·000255
1	0·300	0·0707	27	0·016	0·000211
2	0·276	0·0598	28	0·015	0·000172
3	0·252	0·0500	29	0·014	0·000145
4	0·232	0·0423	30	0·012	0·000121
5	0·212	0·0353	31	0·0116	0·000106
6	0·192	0·0289	32	0·0108	0·0000916
7	0·176	0·0243	33	0·0100	0·0000785
8	0·160	0·0201	34	0·0092	0·0000665
9	0·144	0·0163	35	0·0084	0·0000554
10	0·128	0·0129	36	0·0076	0·0000454
11	0·116	0·0106	37	0·0068	0·0000363
12	0·104	0·00850	38	0·0060	0·0000283
13	0·092	0·00665	39	0·0052	0·0000212
14	0·080	0·00503	40	0·0048	0·0000181
15	0·072	0·00407	41	0·0044	0·0000152
16	0·064	0·00322	42	0·0040	0·0000126
17	0·056	0·00246	43	0·0036	0·0000102
18	0·048	0·00181	44	0·0032	0·0000080
19	0·040	0·00126	45	0·0028	0·0000062
20	0·036	0·00102	46	0·0024	0·0000045
21	0·032	0·000804	47	0·0020	0·0000031
22	0·028	0·000616	48	0·0016	0·0000020
23	0·024	0·000452	49	0·0012	0·00000113
24	0·022	0·000380	50	0·0010	0·000000785
25	0·020	0·000314			

STANDARD COPPER CONDUCTORS

No. and diameter of wires.	Area (sq. in.).	Amperes at I.E.E. standard.	Resistance (ohms per 1000 yds.).	Nearest old standard size.
1/·036	0·0010	4·1	24·5	1/20
1/·044	0·0015	6·1	16·4	1/18
3/·029	0·0020	7·8	12·8	3/22
3/·036	0·0030	12	8·26	3/20
1/·064	0·0030	12·9	7·76	1/16
7/·029	0·0045	18·2	5·49	7/22
7/·036	0·0070	24	3·53	7/20
7/·044	0·0100	31	2·36	7/18
7/·052	0·0145	37	1·69	7/18
7/·064	0·0225	46	1·12	7/16
19/·044	0·0300	53	0·864	19/18
19/·052	0·0400	64	0·624	19/18
19/·064	0·0600	83	0·412	19/16
19/·072	0·0750	97	0·326	19/14
19/·083	0·100	118	0·245	19/14
37/·064	0·120	130	0·212	37/16
37/·072	0·150	152	0·167	37/14
37/·083	0·200	184	0·126	37/14
37/·093	0·250	214	0·100	37/12
37/·103	0·300	240	0·0818	37/12
61/·093	0·400	288	0·0608	61/12
61/·103	0·500	332	0·0496	61/12
91/·093	0·600	384	0·0408	91/12
91/·103	0·750	461	0·0333	91/12
127/·103	1·00	595	0·0238	127/12

5. SPECIFIC INDUCTIVE CAPACITY

The specific inductive capacity of a substance is the ratio of the capacity of a condenser with the substance as dielectric to the capacity of an air condenser of the same size.

Substance.	Specific inductive capacity.
Plate Glass	6–8
Flint glass	7–10
Paraffin wax	2
India-rubber	2–3
Mica	6
Ebonite	2·5
Shellac	3–3·5
Porcelain	4–6
Insulating oil	2–3
Turpentine	2·3
Air	1

6. SPECIFIC RESISTANCE

The specific resistance of a conductor is the resistance of a cm. cube between opposite faces.

Conductor.	Specific resistance in microhms per cm. cube.
Copper	1·6
Silver	1·6
Tin	10
Mercury	94
Platinum	9
Phosphor bronze	8
Zinc	6
Distilled water	7×10^{18}

7. DIELECTRIC STRENGTHS

Material.	Volts per mm.
Glass	8,000
Paraffin	12,000
Micanite	40,000
Ebonite	30,000
Porcelain	10,000
Empire cloth	10,000
Presspahn	5,000

Two sharp points in air, 10 inches apart, will flash over at approximately 100,000 volts.

8. RESISTANCES, CAPACITIES AND INDUCTANCES IN SERIES AND PARALLEL

Units.	Total in series.	Total in parallel.
Resistances: r_1, r_2, r_3	$R = r_1 + r_2 + r_3$	$R = \dfrac{1}{\frac{1}{r_1} + \frac{1}{r_2} + \frac{1}{r_3}}$
Capacities: c_1, c_2, c_3	$C = \dfrac{1}{\frac{1}{c_1} + \frac{1}{c_2} + \frac{1}{c_3}}$	$C = c_1 + c_2 + c_3$
Inductances: l_1, l_2, l_3	$L = l_1 + l_2 + l_3$	$= \dfrac{1}{\frac{1}{l_1} + \frac{1}{l_2} + \frac{1}{l_3}}$

9. OHM'S LAW

In a D.C. circuit: Current (amps.) $= \frac{\text{E.M.F. (volts)}}{\text{Resistance (ohms)}}$, *i.e.* $I = \frac{E}{R}$.

In an A.C. circuit: Current (amps.) $= \frac{\text{E.M.F. (volts)}}{\text{Impedance (ohms)}}$, *i.e.* $I = \frac{E}{Z}$.

Circuit containing Inductance (L) only: $I = \frac{E}{\omega L}$, where $\omega = 2\pi f$.

" " Capacity (C) only: $I = \omega CE$, where $\omega = 2\pi f$.

" " Resistance, Capacity and Inductance in series:—

$$I = \frac{E}{\sqrt{R^2 + \left(\omega L - \frac{1}{\omega C}\right)^2}}$$

where $\sqrt{R^2 + \left(\omega L - \frac{1}{\omega C}\right)^2} =$ Impedance Z

and $\left(\omega L - \frac{1}{\omega C}\right) =$ Reactance X.

The angle ϕ of lag or lead is given by:—

$$\tan \phi = \frac{\text{Reactance}}{\text{Resistance}} = \frac{\left(\omega L - \frac{1}{\omega C}\right)}{R}$$

$$\text{Admittance} = \frac{1}{\text{Impedance}}.$$

$$\text{Conductance} = \frac{1}{\text{Resistance}}.$$

10. MAGNETIC LAW EQUIVALENT TO OHM'S LAW

$$\text{Magnetic Flux} = \frac{\text{Magneto-motive Force}}{\text{Reluctance}},$$

$$\textit{i.e. } \phi = \frac{\text{M.M.F.}}{S}$$

M.M.F. $= 0{\cdot}4\pi NI$,
where N = number of turns on the solenoid,
I = current in amperes.

Energy stored in a magnetic field $= \frac{1}{2}LI^2$
where L = inductance of the circuit in henries,
I = steady current in amperes.

11. FLUX DENSITY AND PERMEABILITY OF IRON

$$\text{Permeability} = \frac{\text{Flux density in iron}}{\text{Flux density in air}},$$

$$i.e.\ \mu = \frac{B}{H}.$$

12. POWER IN ELECTRICAL CIRCUITS

D.C. Circuits.

Power (watts) = E.M.F. (volts) × Current (amps.),
$i.e.\ P = EI = I^2R.$

A.C. Circuits.

$$\text{R.M.S. value} = \frac{1}{\sqrt{2}} \times \text{maximum value.}$$

In a 3-phase system,

(*a*) Star Connection,
Line voltage $= \sqrt{3} \times$ phase voltage.
Line current = phase current.

(*b*) Delta Connection,
Line voltage = phase voltage.
Line current $= \sqrt{3} \times$ phase current.

With either connection, total power is given by

$$\sqrt{3}E_L\, I_L \cos\phi.$$

Where E_L = line voltage,
I_L = line current,
$\cos\phi$ = cosine of the angle of phase difference between the coil voltage and the current.

$$\text{Crest Factor} = \frac{\text{Maximum value}}{\text{R.M.S. value}}.$$

$$\frac{\text{R.M.S. value}}{\text{Average value}} = \text{Form Factor} \doteq 1{\cdot}11 \text{ in the case of a sine wave.}$$

$$\text{Power Factor} = \frac{\text{True Power}}{\text{Apparent Power}} = \frac{EI\cos\phi}{EI}.$$

$$\text{True Power} = EI\cos\phi = I^2R\cos\phi.$$

13. INDUCTANCE

(*a*) The inductance of a single-layer close-wound coil wound on a cylindrical former is given by Nagaoka's formula, which is:—

$$L = \pi^2 d^2 n^2 l K,$$

where d = diameter of coil in cms.,
l = length of coil in cms.,
n = number of turns per cm.,
K = factor depending on the ratio of diameter to length of coil.
L = inductance in micro-henries.

$\frac{d}{l}$.	K.	$\frac{d}{l}$.	K.
0·00	1·000	1·5	0·595
0·10	0·959	2·0	0·526
0·20	0·920	2·5	0·472
0·30	0·884	3·0	0·429
0·40	0·850	4·0	0·365
0·50	0·818	5·0	0·320
0·60	0·788	6·0	0·285
0·70	0·761	7·0	0·258
0·80	0·735	8·0	0·237
0·90	0·711	9·0	0·218
1·00	0·688	10·0	0·203

(*b*) The inductance of a multi-layer close-wound coil wound on a cylindrical former is given by Brooks and Turner's formula, which is:—

$$L = \frac{4\pi^2 a^2 N^2}{b + c + R} F_1 F_2,$$

where L = inductance in micro-henries.
a = mean radius of the winding in cms.
b = axial length of the coil in cms.
c = thickness of the winding in cms.
R = outer radius of the winding in cms.
N = total number of turns,

$$F_1 = \frac{10b + 12c + 2R}{10b + 10c + 1{\cdot}4R},$$

$$F_2 = 0{\cdot}5 \log_{10}\left(100 + \frac{14R}{2b + 3c}\right).$$

For a single-layer close-wound coil, the coil of maximum inductance from a given length of wire is given by the ratio:—

$$\frac{\text{Diameter}}{\text{Length}} = 2{\cdot}4.$$

14. CAPACITY

The capacity of a parallel metal plate condenser is given by:—

$$C\,(\text{cms.}) = \frac{nkA}{4\pi d},$$

where n = number of sheets of dielectric,
k = specific inductive capacity of the dielectric. For air $k = 1$,
A = area of one metal plate in square cms.,
d = distance between the plates in cms.

If a steady charging potential V is required to charge a condenser of capacity C farads with a quantity of electricity Q coulombs, then :—

$$Q = CV.$$

15. FREQUENCY, VELOCITY AND WAVE-LENGTH

The velocity of æther waves is 300 million metres per second.

$$\text{Velocity} = \text{Frequency} \times \text{Wave-length},$$

$$\textit{i.e.}\ \text{Wave-length (metres)} = \frac{300 \text{ million}}{\text{Frequency (cycles per second)}},$$

$$1 \text{ cycle per second} = 1 \text{ hertz}.$$

A wave-length of 300 metres corresponds to a frequency of 1 million cycles per second.

Frequency (kilocycles per second).	Wave-length (metres).	L.C. value (micro-henries and micro-farads).
300,000	1	0·000000281
100,000	3	0·00000253
50,000	6	0·0000101
25,000	12	0·0000407
15,000	20	0·000113
10,000	30	0·000253
5,000	60	0·00101
3,000	100	0·00281
1,200	250	0·0176
1,000	300	0·0253
900	333·33	0·0313
800	375	0·0396
700	428·75	0·0519
600	500	0·0704
500	600	0·101
400	750	0·158
300	1,000	0·281
200	1,500	0·633
100	3,000	2·53
60	5,000	7·04
40	7,500	15·8
30	10,000	28·1
20	15,000	63·3
10	30,000	253

16. OSCILLATORY CIRCUITS

(*a*) The wave-length of an oscillatory circuit LC is given by :—

$$\lambda = 1885\sqrt{LC},$$

where λ = wave-length in metres,
L = inductance in micro-henries,
C = capacity in micro-farads.

(*b*) The resonant frequency of an oscillatory circuit LC is given by :—

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

where f = frequency in cycles per second,
L = inductance in henries,
C = capacity in farads.

(*c*) If a voltage V is applied to an oscillatory circuit LC, then:—

$$\text{circulating current } I_R \text{ (ampères)} = V\sqrt{\frac{C}{L}} \text{ (approx.)},$$

$$\text{supply current } I \text{ (ampères)} = V\frac{RC}{L},$$

where R = resistance of the circuit in ohms,
L = inductance in henries,
C = capacity in farads.

The greater the ratio $\frac{C}{L}$, the less is the impedance of the circuit to current at a non-resonant frequency. In a receiver, the smaller the ratio $\frac{C}{L}$, the greater will be the cut-down of an interfering signal compared with the required signal, and therefore the resonance curve of the receiver will be sharper.

(*d*) The voltage across the inductance or condenser in a resonant circuit is:—

$$E_L = E_C = I\sqrt{\frac{L}{C}}$$

where I = current in ampères,
L = inductance in henries,
C = capacity in farads.

(*e*) Coefficient of coupling. If two oscillatory circuits, L_1C_1 and L_2C_2, are tuned to the same frequency (*i.e.* $L_1C_1 = L_2C_2$), and are coupled together, then the coefficient of coupling between them is given by:—

$$k = \frac{M}{\sqrt{L_1L_2}},$$

where M = coefficient of mutual induction.

Each circuit will, when coupled together, radiate two frequencies given by:—

$$f_1 = f \times \frac{1}{\sqrt{1+k}},$$

$$f_2 = f \times \frac{1}{\sqrt{1-k}},$$

where f is the natural frequency of the circuits L_1C_1 and L_2C_2.

(*f*) Inductance coupling. The coefficient of coupling between the two parts of the circuit shown in Fig. 1 is:—

$$k = \frac{L_M}{\sqrt{L_1L_2}}.$$

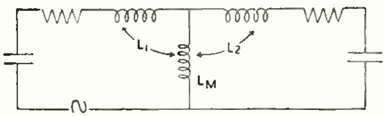


FIG. 1.

(*g*) Capacity coupling. See Fig. 2. In this case:—

$$k = \frac{\sqrt{C_1 C_2}}{C}.$$

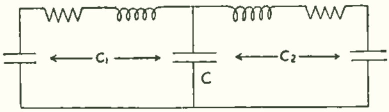


FIG. 2.

17. AERIALS

The natural wave-length of an aerial is approximately equal to four times its overall length.

The radiation resistance is given by:—

$$R_r = 1580 \frac{h^2}{\lambda^2} \text{ (approx.)},$$

where h = mean effective height or radiation height. For an inverted L- or T-shaped aerial, this is approximately 0·6 to 0·7 of the maximum height.

λ = wave-length.

Power radiated $= I^2 R_r$,

$$= I^2 \times 1580 \frac{h^2}{\lambda^2},$$

where I = aerial current (amps.).

18. SIGNAL STRENGTH

The signal strength from a transmitting station at a point distant d kilometres from the station is given by:—

$$E = \frac{377hI}{\lambda d}$$

where E = signal strength in milli-volts per metre,
h = effective height of aerial in metres,
I = maximum current in the aerial in amps.,
λ = wave-length in metres.

19. EQUIVALENT CIRCUITS

In two circuits coupled by a transformer in which the number of turns in the secondary winding is T times the number of primary turns, a resistance, inductance or capacity connected in the secondary circuit will be equivalent to a resistance, inductance or capacity respectively connected in the primary side of a value given by:—

(*a*) Resistance. $R_p = \frac{R_s}{T^2}$.

(*b*) Inductance. $L_p = \frac{L_s}{T^2}$.

(*c*) Capacity. $C_p = C_s T^2$,

where the suffix p indicates a primary quantity, and s a secondary quantity.

20. MILE OF STANDARD CABLE AND TRANSMISSION UNIT

(*a*) A mile of standard cable has the following constants:—

Resistance = 88 ohms per mile of loop.
Capacity = 0·054 micro-farad.
Inductance = 1 milli-henry.
Leakance = 1 micro-mho.

(*b*) Two powers, P_1 and P_2, differ by the number of transmission units given by:—

$$10 \log_{10} \frac{P_1}{P_2}.$$

(*c*) 1 Transmission Unit is equivalent to a Standard Cable Equivalent of 0·9221 mile at 800 cycles.

21. LOW-FREQUENCY AMPLIFIERS

(*a*) Theoretical voltage amplification per stage of a transformer-coupled amplifier is:—

$$\mu \frac{N_2}{N_1} \times \frac{X}{\sqrt{X^2 \times R_a{}^2}},$$

where μ = amplification factor of valve,
N_2 = number of secondary turns,
N_1 = number of primary turns,
X = reactance of primary = $2\pi f$L,
R_a = internal resistance of valve.

(*b*) The grid bias voltage required for a valve used as a low-frequency amplifier is given approximately by:—

$$\frac{\text{Value of high-tension voltage.}}{2 \times \text{magnification factor of valve}}$$

22. MECHANICAL FORMULÆ

(*a*) Work = Force × Distance.
(*b*) Momentum = Mass × Velocity.
(*c*) Force = Mass × Acceleration,

i.e. $P = \frac{ma}{g}$

where P = force in lbs.,
m = mass in lbs.,
a = acceleration in feet per second per second,
g = acceleration of a freely falling body,
= 32·2 feet per second per second.

(*d*) Kinetic energy of a body, mass m lbs. and velocity v feet per second,

= $\frac{1}{2}mv^2$ foot poundals,

= $\frac{mv^2}{2g}$ foot-lbs.

(*e*) Time of complete oscillation of a simple pendulum,

= $2\pi\sqrt{\frac{l}{g}}$ seconds,

where l = length of pendulum in feet,
g = acceleration of a freely falling body,
= 32·2 feet per second per second.

(*f*) Absolute temperature is 273 degrees below zero on the Centigrade scale.

TECHNICAL DICTIONARY

"A" BATTERY—An American term for the L.T. battery or *accumulator* used to heat the filaments of *thermionic valves*.

ABSORPTION CONTROL—A method of "controlling" the *high-frequency oscillations* delivered to the *aerial* in a wireless telephone transmitter, so that they vary in amplitude at the *low frequency* of *modulation*. The value of a *resistance* in the aerial circuit is made to vary in accordance with the low frequencies of the voice, thus modulating the amplitude of the high-frequency oscillations. The resistance usually takes the form of the *anode* circuit of a *three-electrode valve* in shunt, the resistance of the valve being varied by variations of its *grid potential* by means of a *microphone* placed in the circuit. Thus the valve absorbs a greater or less fraction of the power in the aerial circuit. Cf. *Choke Control* and *Grid Control*.

ABSORPTION WAVEMETER—A wavemeter consisting of a low-loss *oscillatory circuit* which is tuned to the transmission to be measured. Resonance is indicated (1) by lighting of a small lamp or the deflection of a galvanometer if used at or near a transmitter, or (2) by the stoppage of oscillations in a weakly oscillating receiver due to absorption by the wavemeter if used for receiver calibration.

A.C.—An abbreviation for *Alternating Current*.

ACCELERATION—The rate of increase of *velocity* of a body, equivalent to the force acting on the body divided by its *mass*.

ACCEPTOR CIRCUIT—A tuned *oscillatory circuit*, having the opposite characteristics of a *rejector circuit*.

ACCUMULATOR—One or more *secondary cells* connected in *series* or in *parallel*. Cf. "*A*" *Battery*.

ACOUSTICS—The science of sound.

ACOUSTIC WAVES—Waves of sound. They may be transmitted through a gas (as air), a liquid (as water), or a solid, their speed depending on the density of the medium. Sound waves have a speed of 1090 feet per second in air at a temperature of 0° C. and a pressure of 30 ins. of mercury.

ADJUSTABLE CONDENSER—See *Condenser*.

ADMITTANCE—The admittance of a circuit is the reciprocal of its *impedance* or apparent resistance. It is measured in *mhos*.

AERIAL—A wire or wires supported at a height above the ground and insulated from it except for a connection to earth through the wireless transmitter or receiver. For special types of aerial see under separate headings.

AERIAL CIRCUIT—In a wireless transmitter or receiver, the circuit between aerial and earth through which the high-frequency *oscillations* pass.

AERIAL IMAGE—It has been shown by T. L. Eckersley that *radiation* from an *aerial* situated at ground level can be resolved into radiation due to the aerial itself and radiation from an image of the aerial in the earth.

AERIAL INSULATION—By this is meant the insulation of the aerial from its supports and thus from earth. The aerial wire itself may be, and generally is, bare.

AERIAL INSULATORS—Pieces of non-conducting material used for fastening the *aerial* wire to its supports. They are generally made of porcelain or glass.

AERIAL RESISTANCE—By this term is meant the *resistance* of the *aerial* to *high-frequency currents*. It may be split up into three parts: (1) *Radiation resistance*, (2) *Dielectric loss resistance* and (3) *Ohmic resistance* of the wire itself. Aerial resistance (effective resistance) varies with frequency, and an aerial is most efficient when (1) is large compared with (2) and (3). See *Radiation Resistance*.

AERIAL TUNING CONDENSER, INDUCTANCE OR COIL—A *condenser* or *inductance* (variable or fixed) connected in the aerial circuit of a transmitter or receiver to *tune* the *aerial* to a particular *frequency*.

AIR CONDENSER—A *condenser*, either fixed or variable, having air as a *dielectric*.

AIR LINE—A telephone line, generally of bare copper, supported above ground-level on insulators fixed to wooden or metal poles. Most of the telephone trunk routes in this country are air lines, and these lines are used for *Simultaneous Broadcasting*. Cf. *Cable*.

ALTERNATING CURRENT—Abbreviated as A.C.—is a current which flows in alternate directions in a circuit, *i.e.*, it starts in one direction from zero, increasing to a maximum, through which it passes, decreasing to zero again, and then increasing in the other direction to a maximum and again decreasing to zero. This complete sequence is called one *cycle*, and the number of complete cycles passed through in one second is called the *frequency* or *perodicity* of the A.C. When two alternating currents pass through zero at the same instant and have their maximum values in the same direction at the same instant, they are said to be "in phase."

An alternating current is measured by its effective or Root Mean Square (R.M.S.) value, which is the value in amperes of the direct current which would produce the same heating effect. For sine waves it is $\frac{1}{\sqrt{2}}$ or ·707 of the maximum or peak value of the A.C.

ALTERNATOR—A dynamo for producing *alternating currents*.

AMMETER—An instrument for measuring current in "*amperes*." Abbreviation for "ampere meter." See *Voltmeter*.

AMPERAGE—Means the current in *amperes*.

AMPERE—The practical unit of electric current.

AMPERE-HOUR—The unit of quantity of electricity. An accumulator is rated in ampere-hours, *i.e.*, according to the *quantity* of electricity it will store.

AMPERE METER—See *Ammeter.*

AMPLIFICATION FACTOR OR AMPLIFICATION CONSTANT—of a three-electrode *thermionic valve*, often designated the "M" value, is the maximum *voltage amplification* which the valve can give. It is the ratio of the change of *plate voltage* to change of *grid voltage* necessary to bring about the same change in *plate current.* See *Voltage Amplification.*

AMPLIFIER—An apparatus used to increase the strength of electrical oscillations. In a wireless receiver, amplification may take place before the high-frequency *oscillations* are rectified by the *detector* valve or crystal, and also after rectification. If before, the amplifier is called a high- or radio-frequency amplifier, and if after, it is called a low- or audio-frequency amplifier. For other types of amplifier see under separate headings.

AMPLITUDE DISTORTION—In electrical apparatus, the variation in response at different amplitudes with an input of constant frequency. Cf. *Frequency Distortion.*

ANODE—The *plate* of a *thermionic valve.* See *Plate.*

ANODE BATTERY—Another name for *high-tension battery.*

ANODE BEND RECTIFICATION—Rectification using the bend (usually the lower one) in the anode current-grid volt characteristic of a *thermionic valve.* Cf. *Grid rectification.*

ANODE CIRCUIT—See *Plate Circuit.*

ANODE CONVERTER—A small rotary electric machine designed to run off an *accumulator* of about 6 to 12 volts, and to give an output voltage suitable for a high-tension supply to a *thermionic valve.*

ANODE CURRENT—See *Plate Current.*

ANTENNA—See *Aerial.*

ANTINODE—In any alternating-current circuit, the point at which the current or voltage value is a maximum. Cf. *Node.*

ARMATURE—The rotating part of an electrical generator or motor.

ARTIFICIAL AERIAL—An arrangement of *resistance, inductance* and *capacity* connected together to take the place of a radiating *aerial* in the testing of wireless apparatus.

ARTIFICIAL LINE—An arrangement of *resistance, inductance* and *capacity* connected together to represent an actual line for use in telephone circuits.

ASTATIC COIL—An *inductance* so wound that its external field is limited.

ATMOSPHERICS—Electro-magnetic *waves* set up by flashes of lightning or other electrical disturbances in the atmosphere affect wireless receivers by producing irregular "grinding" or "grating" in the telephones or loud speaker. Also called X's, strays or static.

ATTENUATION CONSTANT—A constant determining the relationship between the *current* sent out along a given uniform length of line and the *current* received. Its value depends upon the ohmic *resistance, insulation resistance, capacity* and *inductance* of the line.

The formula connecting current sent out and current received is:

$$C_r = C_s \epsilon^{-\beta l}$$

where C_r = current received,
C_s = current sent,
ϵ = 2·7183 (base of Naperian logs),
l = length of loop,
β = attenuation constant.

ATTENUATION FACTOR—A factor indicating the rate of reduction in amplitude of an *ether wave* as the distance from the point of origin increases. For *wave-lengths* within the broadcasting band, the *field strength* E_x at a point distant x from the transmitter is proportional to $\frac{1}{x}(S)$, where S is a multiplier of value always less than unity, which takes into account the attenuation due to the effect of the earths finite conductivity. According to Sommerfield, S is proportional to:—

$$\frac{\pi x}{\lambda}\left\{\frac{1}{2\sigma\lambda c}\right\}$$

where λ = wave-length of the emitted ray,
σ = earth conductivity,
c = velocity of light.

For pastoral country, σ has a value of 10^{-13} c.g.s. units, while for sea water, $\sigma = 10^{-11}$ c.g.s. units.

ATTENUATOR—An arrangement of calibrated *resistances* to introduce *loss* into a circuit. See *Transmission unit.*

AUDIO-FREQUENCY TRANSFORMER—A transformer which is used in an audio-frequency *amplifier.* It may be an input transformer (as from a telephone line), an intervalve transformer, or an output transformer (as to a loud speaker). It should be capable of dealing with all frequencies between 30 and 10,000 cycles per second so that none is favoured more than another, if it is used in a broadcasting receiver. It consists essentially of two separate windings on an iron core. See *Transformer.*

AUDION—Dr. Lee de Forest's first three-electrode *thermionic valve.* The term is still used in the U.S.A.

AUTODYNE—A *thermionic valve* incorporated in a circuit so that it generates oscillations due to grid and plate windings forming an *auto-transformer.*

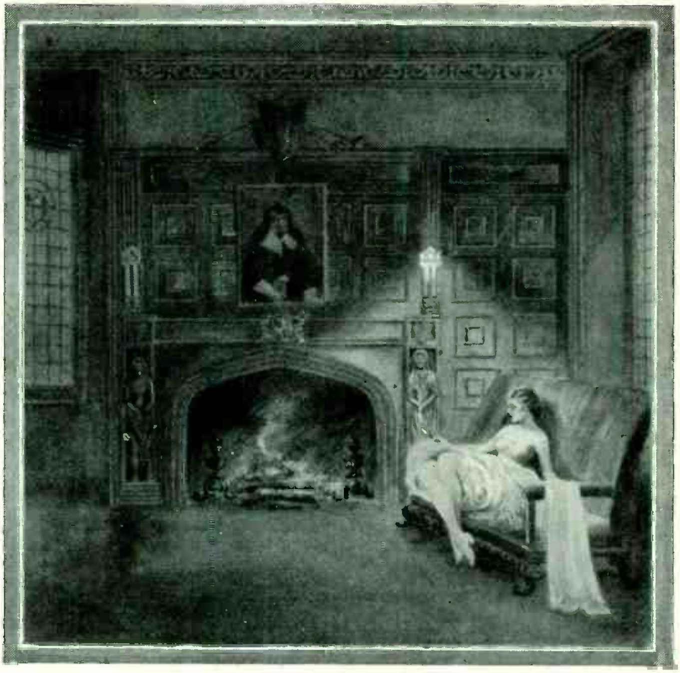
AUTO-TRANSFORMER — A *transformer* either for radio or audio frequency in which the primary and secondary windings are formed by one and the same coil having three connections to it.

"B" BATTERY—An American term for a high-tension battery used to supply the *plate current* in a *thermionic valve.*

BACK E.M.F.—An *electromotive force* or *voltage* which acts in opposition to the flow of current in an electrical circuit.

BAFFLE—A screen of non-resonant material, generally wood, largely used in conjunction with cone-type loud speakers instead of a horn, to ensure the radiation of the very low audible frequencies. Also used in certain cases to alter the acoustics of broadcasting studios.

BALANCED ARMATURE—A type of movement frequently employed in *loud speakers* and *relays,* and consisting of a piece of



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soft iron (the armature) magnetically and mechanically balanced between the poles of a *permanent magnet*. *Alternating currents* passing through the operating winding upset this balance, causing the armature and the diaphragm or cone to which it may be attached to move.

BALLAST TUBE—An American term for *Barretter*.

BAND-PASS FILTER—A *filter* circuit which is so designed that it will only pass a particular band of frequencies. See *Filter*.

BARRETTER—An instrument for keeping constant the flow of *current* in a circuit irrespective of any change in *voltage* (within limits) across the circuit.

BASKET COIL—A coil generally used as an *inductance* in a wireless receiver formed by winding wire round an odd number of pins projecting radially from a central boss. Such a coil has the appearance of certain forms of basket work.

BEAM WIRELESS—A particular system of wireless transmission in which the *waves* are concentrated on the receiver in the form of a beam. An electrical reflector is used, and as this must be of large mechanical dimensions in comparison with the *wave-length*, beam transmission is in practice confined to short wave-lengths.

BEAT RECEPTION—A method of receiving continuous waves in which use is made of the Beat principle. It should be noted that the *beats* themselves are inaudible and must be rectified to produce combination tones which will be heard, and which are usually referred to as the beat frequency.

BEATS—If two *oscillations* or *alternating currents* of different frequencies are superimposed, a further set of *oscillations* will be produced. This set will have a changing amplitude and the *frequency* of the amplitude change will be equal to the difference in the two original frequencies. If the two original frequencies are near together, then the difference between the two will be small, and in this case the beats due to the change of amplitude will be of low frequency.

BEVERAGE AERIAL—An *aerial* whose length is several times the *wave-length* to be received, its height being only a few feet from the ground. It may be either connected to earth or left insulated at the free end. It has marked directional properties and gives a relatively large ratio of signal to *atmospherics*.

BINDING POST—An American term for a *terminal*.

BI-PASS CONDENSER—A fixed-capacity *condenser* of suitable value connected across an electrical circuit or part of it so that certain desired frequencies will pass through it in preference to passing through the part of the circuit across which it is connected.

BLASTING—Used in the electrical sense to indicate *distortion*, although originally brought into use from the sound produced in the loud speaker on particularly loud signals when such *distortion* was occurring. In the general case blasting is produced in a valve by overloading it so that it does not work without *grid current*.

BLOCKING CONDENSER—A fixed-capacity *condenser* of any suitable value connected in a circuit to stop direct current flowing, but to be conductive to A.C. of the desired frequencies.

BORNITE—Used as a *crystal detector* in conjunction with *zincite*. Bornite is a chemical compound of iron, sulphur and copper.

B.O.T. UNIT—Board of Trade Unit. One *kilowatt-hour*. See *Watt-hour*.

BRIDGE—An electrical circuit for the measurement of various electrical quantities. See *Wheatstone Bridge*.

BRIGHT EMITTER—A *thermionic valve* in which the *filament* gives its normal *emission* only when heated to a high temperature so that it glows brightly.

BUZZER—A piece of apparatus so called because it produces a buzzing sound, due to an armature vibrating.

BUZZER WAVEMETER—A wavemeter in which a buzzer is used to energise a calibrated resonant circuit for use as a low-power transmitter for the calibration of receivers.

"C" BATTERY—Term used in America to denote the *grid-bias* battery.

CABLE—A telephone line or lines laid either direct in the ground or in earthenware ducts. The use of cables for trunk routes is rapidly increasing, owing to their greater immunity from interruption during bad weather. Where suitable routes are available, these circuits are used for *Simultaneous Broadcasting*.

CAPACITY—(of an accumulator or storage battery) is measured in *ampere-hours*, and indicates the number of *ampere-hours* the *cell* will give when fully charged. This *quantity* will depend on the discharge rate. In stating the capacity of a cell the manufacturers will also state the discharge rate. The capacity of an accumulator is sometimes stated on an ignition rate; this is double the actual capacity.

CAPACITY—(of a condenser or isolated body) is a measure of the charge (or quantity of electricity) it is capable of storing. If it holds a charge of one *coulomb* and the difference of *potential* between its plates is one *volt*, then the condenser is said to have a capacity of one farad. This is too large a unit for practical purposes. Therefore, the microfarad is more generally used, and is equal to one millionth of a farad.

CAPACITY COUPLING—Indicates that the coupling between two circuits is formed by a *condenser*. See *Coupling*.

CARBON MICROPHONE—See *Solid-back Microphone*.

CARRIER WAVE—The high-frequency *oscillations* emitted by a wireless telephone transmitter. These are modulated during telephony. The analogy is that the telephony (music, speech, etc.) is "carried" by the high-frequency *oscillations* from the transmitter to the receiver.

CASCADE—Pieces of electrical apparatus are said to be connected in cascade when the output of the first is connected to the input of the second, the output of the second to the input of the third, and so on.

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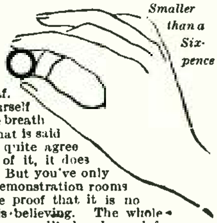

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CATHODE—See *Kathode*.

CAT'S-WHISKER—A fine wire used to make contact with a particular point of a *crystal* in a *crystal detector*.

CELL—See *Secondary Cell* and *Primary Cell*.

CHARACTERISTIC CURVE—See *Static Characteristic* and *Dynamic Characteristic*.

CHARGE—See *Capacity*.

CHECK RECEIVER—A wireless receiver installed in the *control room* of a broadcasting station to enable a constant check to be kept on the quality of the transmission.

CHOKE—A coil of wire which, although it may be of small D.C. *resistance*, will offer a high *impedance* to A.C., the *impedance* offered depending on the *frequency* of the A.C. If the choke is for use with A.C. of low frequency it will generally be wound on an iron core, whereas for use with high-frequency A.C. it will have an air core, *i.e.*, be wound on a former of non-magnetic material.

CHOKE CAPACITY COUPLING—A method of coupling *thermionic valves* together in *cascade* in a high- or low-frequency *amplifier*. A *choke* is placed in circuit with the plate of the valve and the signal E.M.F. produces a varying *potential* at the *plate* end of this choke, and this is applied through a *grid condenser* to the *grid* of the next valve. This condenser is necessary to prevent the high-tension potential from affecting the second grid. In order that the negative charge on this grid may gradually leak away, a *grid leak* resistance is connected between the grid and filament of the valve. See *Resistance Capacity Coupling*.

CHOKE CONTROL—A method of "controlling" the high-frequency *oscillations* delivered to the aerial in a wireless telephone transmitter, so that they vary in amplitude at the low frequency of modulation. A large iron-core choke is used in the common H.T. circuit to the modulator and oscillator valves. If the modulated output from the oscillator valves is delivered direct to the aerial, the modulation is said to be at high power. If the modulated output is passed through one or more magnifying stages before being delivered to the aerial, the modulation is said to be at low power. See *Modulation*. Cf. *Grid Control* and *Absorption Control*.

CLOSED-CORE TRANSFORMER—A *transformer* in which the iron core forms a continuous magnetic circuit, *i.e.*, it has no air gap. Cf. *Open-core Transformer*.

COEFFICIENT OF COUPLING—A percentage indicating the tightness or otherwise of the coupling between two circuits. See *Tight Coupling* and *Loose Coupling*.

COHERER—A *detector* used in early wireless experiments. It worked by virtue of the property of metal filings, which were only in imperfect contact, of cohering and forming a relatively good contact under the influence of *Hertzian Waves*.

CONDENSER—The simplest form of condenser consists of two metal plates separated by an insulator, which is called the *dielectric*. It has *capacity* and will store electrical energy.

CONDENSER MICROPHONE—A *microphone* consisting of two plates of a *condenser*, whose distance apart is altered by the sound waves impinging upon one of them. The consequent variations in *capacity* are made to affect an external circuit where they can be amplified to any desired extent.

CONDUCTOR—A substance which offers a comparatively low resistance to the passage of electric currents through it.

CONTINUOUS CURRENT—Another term for *direct current*.

CONTINUOUS OSCILLATIONS OR WAVES—Undamped *oscillations* or *waves*, *i.e.*, the amplitude of successive cycles remains constant and does not diminish. Abbreviated as C.W. Cf. *Damped Oscillations*.

CONTROL ROOM—The "Nerve-centre" of a broadcasting station. In this room are situated the low-frequency amplifiers and associated apparatus by which the microphone currents are controlled, before they are passed on to the *modulation system* of the transmitter.

CONTROL SYSTEM—Of a wireless telephone transmitter is that part of the transmitter which modulates the high-frequency *oscillations*. See *Choke Control* and *Modulator System*.

CORRECTOR CIRCUIT—An arrangement of *inductances*, *capacities* and *resistances* which is placed in a long telephone line circuit to counterbalance any effect the line may have on the speech currents passing along it, owing to the attenuation not being constant at all frequencies. See *Repeater Station*.

COULOMB—*Quantity* of electricity given by one *ampere* flowing for one second. One *ampere-hour* = 3,600 coulombs.

COUNTERPOISE—An arrangement used in some wireless transmitters instead of an "earth" connection, consisting of a system of wires supported on short *masts* underneath an *aerial* and insulated from earth.

COUPLED CIRCUIT—In a receiving set, the aerial circuit may be coupled inductively instead of connected directly as an effective method of obtaining greater selectivity. See *Coupling*, *Inductive Coupling*, *Direct Coupling*.

COUPLING—Two electrical circuits are said to be coupled when a change of *current* in one circuit produces an *E.M.F.* across the second circuit.

CROSS-TALK—A term used to denote *induction* between low-frequency circuits.

CRYSTAL—See *Natural Crystal*.

CRYSTAL DETECTOR—A form of *rectifier* of *alternating currents* which works by virtue of the contact between certain dissimilar *crystals*, only allowing *current* to pass in one direction.

CUMULATIVE GRID RECTIFICATION—See *Grid Rectification*.

CURRENT—The flow of electricity along a wire or other *conductor* from a point of high *potential* to a point of low *potential*. The unit of current is the ampere. Mechanical analogy is gallons of water per minute flowing through a pipe.

CUT OFF—The limits of *frequency* below or above which a *cable*, *air line*, *amplifier*, *microphone*, *loud speaker*, etc., ceases to transmit or reproduce.

CYCLE—See *Alternating Current.* One cycle per second is sometimes referred to as one Hertz.

DAMPED OSCILLATIONS OR WAVES—*Oscillations* or *waves* in which the amplitude of each successive *oscillation* or *wave* is smaller than that of the previous one. The amount by which each wave is smaller than the preceding wave depends upon the *logarithmic decrement* of the circuit. Cf. *Continuous Waves.*

DAMPING—The rate at which a train of oscillations dies away.

D.C.—Abbreviation for *Direct Current.*

D.C.C.—Double cotton covered (insulation of wire).

DEAD LOSS RESISTANCE—That part of the resistance of an aerial which does no useful work. See *Aerial Resistance.*

DECIBEL—One *transmission unit* (*q.v.*).

DETECTOR—In a wireless receiver is a device for rectifying the high-frequency oscillations See *Rectification.*

DETECTOR VALVE—A *thermionic valve* used as a *detector* or *rectifier.* See *Anode Bend Rectification, Grid Rectification* and *Rectification.*

DIELECTRIC—A substance whose resistance to the passage of electric currents is extremely high. The insulator separating the plates of a *condenser.*

DIELECTRIC LOSS—Loss of electrical energy due to the passage of current through a *dielectric* when a potential difference is applied across it. The loss decreases with increase of frequency. Cf. *Eddy Currents.*

DIODE—A *thermionic valve* having only two electrodes, *i.e.*, a *kathode* (filament) and an *anode* (plate). The original Fleming valve was a diode.

DIRECT COUPLING—See *Auto-transformer.*

DIRECT CURRENT—Abbreviated as D.C., and sometimes referred to as continuous current. A current which flows in one direction only. Cf. *Alternating Current.*

DIRECT RAY—In wireless transmission, the ray emitted parallel to the earth's surface.

DIRECTIONAL AERIAL—An aerial which will send out wireless *waves* in, or receive them from, one direction to a greater degree than other directions.

DIRECTION FINDER—A wireless receiver in which the directional properties of one or other forms of aerial are made use of to find the direction from which wireless signals are arriving.

DIS—Disconnection.

DISTORTION—A term used in telephony to indicate any deviation from the original *wave form* of the speech or music which may be brought about during any of the various changes which take place between the *microphone* and *loud speaker* or *telephones.*

DOWN LEAD—The wire which "leads down" from the elevated part of an aerial to the transmitting or receiving apparatus.

DRAPING—Material hung in a *studio* to decrease the *reverberation* and *echo.*

DRIVE CIRCUIT—An *oscillatory circuit* tuned to the same *frequency* as the main *oscillatory circuit* of a transmitter and coupled to it in such a manner that the latter is forced to generate *oscillations* of exactly the same frequency, thus preventing any slight wave change due to keying or heavy modulation.

DRY CELL—A *primary cell* in which the liquid *electrolyte* is replaced by a paste.

DULL EMITTER—A *thermionic valve* in which the *filament* gives its normal emission at a relatively low temperature, thus using only a little current and lighting up only to a dull red.

D.W.S.—Abbreviation for "Double Wound Silk" (the insulated covering of a wire).

DYNAMIC CHARACTERISTIC — Curves, generally of a *thermionic valve,* showing the performance under working conditions when the values of *plate* and *grid voltages,* etc., may be varying simultaneously.

DYNAMIC LOUD SPEAKER—See *Moving Coil Loud Speaker.*

DYNAMO—A rotary machine which generates direct-current electricity.

DYNE—The C.G.S. (centimetre-gramme-second) unit of force. One dyne will produce an acceleration of one cm. per second per second in a mass of 1 gramme.

$$1 \text{ dyne} = \frac{1}{981} \text{ gramme (approx.)}$$

EARTH CONDUCTIVITY—See *Attenuation Factor.*

EARTH POTENTIAL—The electrical *potential* of the earth is said to be zero and therefore connections made to the earth at various places will be at the same potential. It should be noted that if a large current is flowing through a lead connecting a wireless transmitter or receiver to earth, the potential of the earth terminal of the apparatus will only be zero if the resistance of the earth lead and connection is very low.

EARTH SCREEN—See *Counterpoise.*

EBONITE—A hard, black substance consisting of rubber treated with sulphur at high temperature. It is easily polished and has high insulating properties.

ECHO—The recurrence of a sound after an interval of time due to the original sound being reflected from a surface, *e.g.*, a bare wall.

ECHO ROOM—A room designed to produce *echoes.* In the broadcasting of certain musical items from a *studio,* an artificial echo is superimposed to obtain a more pleasing effect.

EDDY CURRENTS—If a piece of metal is placed in a varying *magnetic field,* currents will be induced in the metal. These are called "eddy currents." The higher the *frequency* of variation of the field, the larger will be the eddy currents. The metal will become heated by these currents, and thus energy will be dissipated.

EFFECTIVE HEIGHT—A value less than the actual height of an aerial and dependent upon its shape, situation, etc., which is used in the calculation of its *radiation efficiency.* Effective height can be calculated theoretically (for a *quarter-wave-length aerial* its value is $2/\pi \times$ actual

height), but is better obtained by practical measurements applied to the formula :—

$$h = \frac{E\lambda d}{377\ I}$$

where E = field strength at a distance d from the aerial,
λ = wave-length,
I = maximum current in the aerial.

EFFECTS STUDIO—A *studio* in which the noise effects incidental to a transmission are made. See *Mixing Unit*.

ELECTRIC FIELD—If a body becomes electrified, certain effects will be observable in its vicinity, such as the attraction or repulsion of other electrified bodies. The space in which these effects can be observed is said to be in the electric field of the body. The magnitude of these effects at a given distance is a measure of the strength of the field. Sometimes called Electrostatic Field.

ELECTRODE—A component part of a *vacuum valve*, or of a primary or secondary *battery*.

ELECTROLYTE—The liquid (generally dilute sulphuric acid) in a *secondary cell*.

ELECTROLYTIC CONDENSER—A type of condenser of relatively large capacity in small bulk suitable only for low-voltage circuits. The principles underlying its operation are quite different from those of the usual type. The condenser is a form of polarisation cell having, in general, aluminium electrodes and ammonium phosphate electrolyte. On applying a potential to the terminals of the condenser, a momentary current passes, liberating hydrogen, which forms an insulating coating over the negative aluminium electrode, thus rapidly stopping the flow of current. The capacity of the arrangement is proportional to the quantity of electricity which passes to liberate sufficient hydrogen to polarise the cell, and thus in turn to the electro-chemical equivalent of hydrogen. The order of these quantities is such that it is possible to obtain a capacity-bulk ratio of about one thousand times that obtainable with an ordinary air dielectric condenser. When the steady potential is removed, the hydrogen is re-absorbed. The maximum voltage for which these condensers are at present made is about 50 volts. For higher voltages a series arrangement of units is necessary.

ELECTRO-MAGNET—Soft iron becomes a magnet only in the presence of a *magnetic field*. If this field is provided by a current passing through a coil of wire wound round the soft iron, the latter is said to be an electro-magnet.

ELECTRO-MAGNETIC WAVES—See *Waves*.

ELECTROMOTIVE FORCE—(Abbreviated as E.M.F.) is electrical pressure or *voltage*. As, in the mechanical analogy, water is forced through a pipe by the "head" of water overcoming the resistance of friction in the pipe, so electrically the current is forced through the circuit by the E.M.F. overcoming the *resistance* of the wire.

ELECTRON—Thought to be the smallest particle of a substance which can exist as an entity. It is negatively charged electrically. See *Negative Charge*.

ELIMINATOR—An apparatus for providing high-tension, low-tension or grid-bias potential for a receiving set from the electric supply mains, thus eliminating the use of batteries.

E.M.F.—Abbreviation for Electromotive Force.

EMISSION—The stream of *electrons* which is given off from the *filament* of a *thermionic valve*.

ENERGY—The ability of a body to do *work* by virtue of its position or motion. The former is called "potential" energy, and the latter "kinetic" energy.

ETHER—For wave motion to be transmitted through space there is assumed to be an all-pervading medium through which it is transmitted. Ether is the name given to this assumed medium. See *Waves*.

EXPONENTIAL HORN—A loud speaker or other horn, the diameter of the aperture of which increases along its length in accordance with an exponential law of the type :

$$y = a\epsilon^{bx}.$$

FADE UNIT OR MIXING UNIT—A *potentiometer* arrangement placed in the input circuit of a microphone amplifier in order that the outputs of several microphones may be connected to the amplifier at will and at any desired strength.

FADING—The variation in strength of a signal received from a distant station assumed to be due to changes in the Heaviside Layer which cause (*a*) alteration of the angle of *reflection* or refraction of the indirect transmitted ray in an irregular manner, or (*b*) interference between the direct and the indirect (reflected or refracted) ray. See *Reflection*.

FARAD—The unit of *capacity*.

FEED BACK—See *Reaction*.

FEEDER—(in *high-frequency* circuits). An *air-line* loop employed to connect two high-frequency circuits remote from each other.

FIELD STRENGTH—The intensity of the *electric* and *magnetic field* due to a wireless transmitter at any point is called its field strength, which may be measured in millivolts induced in an *aerial* having an effective height of one metre, *i.e.*, field strength may be expressed in millivolts per metre.

FIELD WINDING—A coil usually wound on a laminated iron core to produce a strong electro-magnetic field when current is passed through the winding.

FILAMENT—In a *thermionic valve* the filament is a fine wire which is heated by the passage of electric current. Generally this filament itself emits *electrons*, but in some valves it heats a cylinder which surrounds it closely, and the latter gives the *emission*.

FILAMENT RESISTANCE—A *resistance* included in the filament-heating battery circuit to limit the *voltage* across the *filament* to the correct value.

FILTER—An electrical filter is a circuit composed of *inductances* and *condensers* which will pass or prevent from passing certain frequencies. See also *Band-pass*, *High-pass* and *Low-pass Filters*.

FLAT TUNING—A circuit is said to be flatly tuned if a large change in its resonant frequency (produced by changing its *inductance* or *capacity*) is accompanied by only a small change in the amplitude of the oscillatory current flowing in the circuit, the frequency of the applied voltage remaining constant. Cf. *Resonance*.

FLEMING VALVE—See *Diode*.

FLUX DENSITY—Is a measure of the strength of a *magnetic* or an *electric field*, and is stated as the number of lines of magnetic or electrostatic force per unit area of cross section of the field. Cf. *Permeability*.

FOUR-ELECTRODE VALVE—A *thermionic valve* having a kathode (filament), two *grids* and an *anode*. Sometimes called a tetrode. Cf. *Diode* and *Triode*.

FRAME AERIAL—An aerial, generally used for wireless reception, consisting of a number of turns of wire supported on a wooden frame of convenient shape. It has marked directional properties and is used on certain types of *direction finders*. See *Loop Aerial*.

FREQUENCY—The frequency of an alternating current is the number of complete *cycles* it passes through in one second. See *Alternating Current*. Frequencies are sometimes stated in Hertzs, where one Hertz = one cycle per second.

FREQUENCY: AUDIO-, HIGH-, RADIO-, SUPERSONIC-—See under appropriate letters.

FREQUENCY CHARACTERISTIC—See *Response Characteristic*.

FREQUENCY DISTORTION—In electrical apparatus, the variation in response at different frequencies with a constant input amplitude. See *Response Characteristic* and cf. *Amplitude Distortion*.

FREQUENCY DOUBLER—An apparatus for doubling the *frequency* of an *alternating current*. See *Harmonic Amplifier*.

FREQUENCY METER—See *Wavemeter*.

FREQUENCY MODULATION—A method of *modulation* in wireless telephony transmission which involves the shifting of the *carrier wave* frequency between defined limits at the rate of the modulation frequency. In other forms of *modulation* it is difficult entirely to elimiuate slight frequency modulation. This produces distortion, because effectively the *carrier wave* is not constant in frequency.

FULL-WAVE RECTIFICATION—A system of *rectification* in which both half *cycles* of an *alternating current* are utilised.

FUSE—Usually in the form of a piece of wire included in an electric circuit as a protective device. On the current passing a certain value this piece of wire melts, thus breaking the circuit.

GAIN—The measure of the performance of a thermionic *repeater* generally stated as the number of miles of *standard cable* or the number of *transmission units* to which the amplification of the *repeater* is equivalent. See *Repeater*.

GALENA—A sulphide of lead used as a crystal detector in conjunction with a fine metal wire called a *cat's-whisker*.

GALVANOMETER—A sensitive electrical measuring instrument.

GANGED CONTROL—A mechanical arrangement whereby the several high-frequency circuits in a receiving set may be tuned by one handle.

GENERATOR—A machine for converting mechanical energy into electrical energy. It may be either a *dynamo* or an *alternator*.

GRAMOPHONE ATTACHMENT—A device for converting directly the mechanical vibrations given by a record to a gramophone needle into electrical currents, which can be amplified and caused to work a loud speaker or to modulate a wireless telephone transmitter. For broadcast transmission of gramophone records this obviates the use of a gramophone soundbox and a microphone, with a consequent reduction in possibilities of *distortion*.

GROUND RAY—See *Direct Ray*.

GRID—The third electrode in a thermionic *triode*, which controls the stream of *electrons* emitted by the filament. Mechanically it may have many forms, the normal being a spiral of wire.

GRID BIAS—The *voltage* applied to the *grid* of a thermionic *triode* to determine its *potential* with respect to the *filament*. To ensure that a *triode* shall work on the straight portion of its *static characteristic* a negative bias must be applied, the voltage being dependent on the characteristics of the valve.

GRID CIRCUIT—The circuit connected between the *grid* and *filament* of a thermionic *triode*.

GRID CONDENSER—A condenser, usually fixed in capacity, connected directly to the grid of a valve so that it is between the grid and the rest of the grid circuit. Cf. *Resistance-capacity Coupling*.

GRID CONTROL—A method of "controlling" the *high-frequency* oscillations delivered to the aerial in a wireless telephone transmitter, so that they vary in amplitude at the *low frequency* of *modulation*. The low-frequency E.M.F.'s, due to speech, are introduced into the *grid circuit* of the oscillator valve, thus varying the grid potential relatively to its normal potential, and superimposing the low frequency of modulation on the aerial current. Cf. *Choke Control* and *Absorption Control*.

GRID CURRENT—If the *grid* of a *triode* becomes positively charged with respect to the filament, some of the *electrons* leaving the *filament* will not pass the *grid* on their way to the *anode*, but will return through the grid circuit to the *filament*, thus producing grid current. Cf. *Grid Rectification*.

GRID LEAK—A high resistance connected either directly across a *grid condenser* or else from the *grid* to the *filament* of a *triode* in order to maintain the mean potential of the grid at any desired predetermined value, providing a path for any charge, which may accumulate on the grid, to leak away.

GRID RECTIFICATION—Sometimes called cumulative grid rectification. For this system of grid rectification *grid current*

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must be allowed to flow in the *triode*, and use is made of the curvature of the grid volt–grid current characteristic. During an incoming high-frequency oscillation, the grid of the valve receives a negative charge through a grid condenser, and this reduces the value of the anode current. The presence of a *grid leak* allows this *negative charge* to leak away, thus ensuring that the mean *potential* of the *grid* shall not become so negative as to stop the *grid current* flowing. See *Rectification*.

GROUND—An American term for "*earth*."

HALF WAVE-LENGTH AERIAL—An aerial having an equivalent vertical height equal to one half of the wave-length in use. Cf. *quarter wave-length aerial*.

HALF-WAVE RECTIFICATION—A system of *rectification* in which only one half cycle of the alternating current is made use of. Cf. *Full-wave Rectification*.

HARD VALVE—A *thermionic valve* from which all the gas has been exhausted, particular care being taken that no gas is left even in the surface of metal parts in the valve. Cf. *Soft Valve*.

HARMONICS—*Frequencies* which are multiples of another frequency are said to be harmonics of it; thus a frequency of 50 cycles per second (or Hertz) has harmonics or frequencies of 100, 150, 200, etc., cycles, being twice, three times and four times the original frequency, and being called the second, third and fourth harmonic respectively.

HARMONIC AMPLIFIER—An apparatus for distorting the *wave form* of an *alternating current* to produce *harmonics* from which one is selected by suitable *filter circuits* and amplified. This process can be repeated any number of times within limits, if further multiplication of frequency is desired. A Frequency Doubler is an Harmonic Amplifier which selects the second harmonic.

HEAVISIDE LAYER—An upper layer of the atmosphere which is thought to exist and to vary in height from 60 to 150 miles above the earth's surface, and to become ionised by the sun's rays. Was originally postulated by Oliver Heaviside, and has since been held to account for *fading* of wireless signals and the transmission of short-wave wireless signals round the curvature of the earth. See *Reflection*.

HENRY—The unit of *inductance*.

HERTZ—A term sometimes used to designate frequency, meaning one cycle per second. Cf. *Kilohertz*.

HERTZIAN WAVES—Electromagnetic *waves* by which all wireless signalling is accomplished. They were called after Hertz, who first succeeded in producing them in 1888, but they were postulated by Clerk Maxwell, who gave mathematical proof of their existence in 1864.

HETERODYNE INTERFERENCE—Interference caused to broadcast reception by the *carrier wave* of an unwanted station beating with that of the wanted station, and giving an audible beat note in the receiver due to the two stations being on *wave-lengths* or *frequencies* separated by too small an amount. It should be noted that two nearly equal and relatively low-powered stations as far apart as 1000 miles can produce an audible beat note even at a few miles from either.

HETERODYNE RECEPTION—A method of receiving C.W. wireless signals in which use is made of a local *oscillator* to "beat" with or "Heterodyne" the incoming C.W. See *Beat Reception*.

HETERODYNE WAVEMETER—A wavemeter using the heterodyne principle by generating oscillations of a known frequency which may be tuned to the oscillations whose frequency is to be measured. When the "beat" note is zero the two sets of oscillations have the same *frequency*.

H.F.—Abbreviation for *High Frequency*.

HIGH FREQUENCY—There is no definite dividing line between high- and low-frequency *oscillations*; but oscillations or alternating currents of frequencies up to about 12,000 are generally considered as low—or audio—frequencies, while those above this are spoken of as *Supersonic*, High or *Radio frequencies*.

HIGH-FREQUENCY AMPLIFIER—An amplifier which amplifies high or radio frequencies, *e.g.*, the incoming wireless signals before they are rectified. See *Amplifier*.

HIGH-FREQUENCY CHOKE—A choke which offers considerable *impedance* to *high-frequency* currents. See *Choke*.

HIGH-FREQUENCY RESISTANCE—See *Aerial Resistance*.

HIGH-FREQUENCY TRANSFORMER—A *transformer* for coupling together *high-frequency* circuits, *e.g.*, an intervalve transformer in a *high-frequency amplifier*. See *Transformer*.

HIGH-PASS FILTER—A filter circuit which is so designed that it will pass all *frequencies* above a certain value. See *Filter*.

HIGH-POWER MODULATION—See *Choke Control*.

HIGH TENSION—The voltage applied to the *anode* or plate of a *thermionic valve*. Cf. *Low Tension*.

HIGH-TENSION BATTERY—A battery of *dry cells* or *accumulators* used to give the high-tension voltage for a *triode*.

HONEYCOMB COIL—A coil for use as a *high-frequency inductance* wound so as to reduce its *self capacity*, and so named from its resemblance to a honeycomb in appearance.

HORSE POWER—The unit of mechanical power, equal to 33,000 foot-pounds per minute.

HOT-WIRE AMMETER—An *ammeter* for measuring alternating or direct currents. The current to be measured is passed through a wire, which it heats. The wire expands, and the expansion is measured by a pointer moving over a scale. The temperature and therefore the expansion of the wire is proportional to the square of the current. The instrument is calibrated directly in *amperes*. See *Ammeter*.

H.T.—Abbreviation for high tension.

HYDROMETER—An instrument for measuring the specific gravity of liquids. Used in particular for finding that of *accumulator* acid.

HYSTERESIS—If a *magnetising force* be applied to a piece of iron and increased or decreased, the magnetisation of the iron will lag behind the magnetising force. This effect is known as magnetic hysteresis.

I.C.W.—Abbreviation for Interrupted Continuous Waves.

IMPEDANCE—The opposition offered to an *alternating current* by a *resistance*, *inductance* or *capacity*, or a combination of the three. It is expressed in *Ohms* and is dependent on the *frequency* of the A.C. except in the case of a pure resistance. See *Resonance*.

INDIRECTLY-HEATED CATHODE—(of a *thermionic valve*). A *cathode* which is not heated indirectly by the passage of current through it, but by radiation from a heater placed in close proximity to it. This gives an equi-potential cathode, which improves the performance of the valve, and at the same time allows the heating current to be supplied through a transformer from alternating-current power mains unaccompanied by objectionable hum.

INDIRECT RAY—In wireless transmission, the ray reflected from the *Heaviside layer*. See *Reflection*.

IN PHASE—See *Alternating Currents*.

INDUCED E.M.F.—If a *conductor* is moved in a *magnetic field*, or if the magnetic field changes in intensity so that the number of lines of magnetic force passing through the conductor is changed (either increased or decreased), then an *E.M.F.* will be induced across the ends of the conductor, its value depending on the rate of change of *magnetic flux* through the conductor.

INDUCTANCE—A *conductor* is said to possess inductance if a current flowing through it causes a *magnetic field* to be set up round it. A straight wire therefore has inductance, but the value will be greatly increased if the conductor is wound in the form of a coil with the turns close together, so that the flux due to one turn will cut not only itself but also the neighbouring turns.

INDUCTION—See *Inductive Coupling*.

INDUCTIVE CAPACITY—See *Specific Inductive Capacity*.

INDUCTIVE COUPLING—*Coupling* between two circuits by virtue of *inductances* in the circuits. A changing current in the one winding will cause a varying *magnetic flux* in it which will cut the other, thus inducing an E.M.F. in the latter. See *Tight Coupling* and *Loose Coupling*.

INDUCTIVE RESISTANCE—A *resistance* which has *inductance* and thus has an *impedance* to alternating currents which is greater than its D.C. resistance.

INERTIA—The property possessed by a body of opposing any change in its state of rest or uniform motion in a straight line.

INSULATION RESISTANCE—The resistance in megohms (millions of ohms) between two conductors or circuits which are insulated from each other.

INSULATOR—Any substance which offers an extremely high resistance to the passage of electric current through it, and which is therefore used to separate two circuits electrically from each other, or from earth.

INTER-ELECTRODE CAPACITY—The capacity between the *electrodes* of a *thermionic valve*. That between the *grid* and *anode* is appreciable in the majority of *triodes*, and gives a capacity coupling between the *grid circuit* and the *anode circuit*, thus causing the valve to generate *oscillations* if these two circuits are tuned to the same frequency. This capacity may be balanced out by suitable arrangements. See *Neutrodyne Receiver*.

INTERFERENCE—Unwanted signals in a wireless receiver due to any cause, *e.g.*, *atmospherics*, other transmitting stations, etc.

INTERFERENCE PATTERN. See *Mush Area*.

INTERNAL IMPEDANCE—Called also the "differential resistance" of a *thermionic valve*. The resistance referred to is that of the anode-filament circuit. It is given by the change of *anode voltage* divided by the change in *anode current*, the grid potential being kept constant. It will vary depending on the position on the *characteristic curve* at which it is measured. In general, it is measured over a small portion of the straight part of the curve.

INTERRUPTED C.W.—Abbreviated as I.C.W. A method of wireless telegraph transmission in which *C.W.* is used but is interrupted at an *audio frequency* so that it can be received on a wireless receiver without the use of *beat reception*.

INTERVALVE COUPLING—The components used to transfer *oscillations* from the *anode circuit* of one valve to the *grid circuit* of the following valve in a multi-stage *cascade* amplifier. It may be designed for radio or audio frequencies, and may be inductive (using a *transformer*), or capacitative (using condensers).

INTERVALVE TRANSFORMER—See *Intervalve Coupling Amplifier* and *Transformer*.

INVERTED L AERIAL—An aerial having a horizontal portion and a vertical down lead at one end.

IONISATION—When a gas is split up into minute particles carrying *positive* and *negative charges* of electricity, it is said to be ionised, and these particles are called ions. In such a state the gas becomes a conductor of electricity. Ionisation of a gas can be effected by applying a high *potential* across it.

JACK—A device used originally on telephone switchboards to allow connection to be made to a number of circuits by a plug having at least two concentric contacts. At the same time a number of separate contacts may be closed or opened in the jack to allow any desired switching arrangement. See *Plug*.

JAMMING—*Interference* with wanted wireless signals due to other wireless transmitters.

JIGGER—A *high-frequency transformer* used originally and so named by Marconi to couple the *aerial circuit* of a wireless transmitter to the circuit in which the *oscillations* are produced.

JUNCTION, THERMO-ELECTRIC OR VACUO —See *Thermo-couple*.

KATHODE—The *electrode* of a *thermionic valve* from which *electrons* are emitted. In general the kathode is the *filament*, and it is heated by the passage of a current through it.

KATHODE-RAY OSCILLOGRAPH — An *oscillograph* in which a stream of kathode rays (*electrons*) is made to impinge on a fluorescent screen which glows, at the spot on which they are focussed, under their influence. This kathode stream can be made to move to and fro at any desired frequency under the influence of electrostatic or electromagnetic forces, and the spot lengthens into a line of light on the screen. Two pairs of plates are mounted inside the bulb and are disposed at right angles to each other for connection to the alternating E.M.F. to be examined.

k.c.—Abbreviation for kilocycle.

KILOCYCLE—One thousand cycles. Abbreviation k.C. A *frequency* of 1000 k.C. is equivalent to a wave-length of 300 metres.

KILOHERTZ—One thousand cycles per second.

KILOWATT—The practical unit of electrical power = 1000 watts.

KILOWATT HOUR—The practical unit of electrical energy. See *Board of Trade Unit.*

k.w.—Abbreviation for kilowatt.

LAG—See *Phase Angle.*

LAMINATED CORE—An iron core used in *transformers,* chokes, etc. for use in *alternating-current* circuits, laminated or built up of thin sheets of iron, each sheet being insulated on one side by a coating of shellac varnish or other insulating material so that *resistance* will be offered to the passage of *eddy currents.* See *Transformer.*

LEAD—See *Phase Angle.*

LEVEL RAISER—Another term for a *Repeater.*

LEYDEN JAR—The original *condenser* consisting of a glass jar coated inside and out with metal foil. It was invented at the University of Leyden.

L.F.—Abbreviation for low frequency.

LIGHTNING ARRESTER—A spark-gap connected between aerial and earth to provide a low-resistance path to earth while a spark is maintained, thus protecting a receiver set from a lightning discharge.

LINEAR AMPLIFICATION—Amplification in which the output *voltages* at all values and *frequencies* are directly proportional to the input *voltages.*

LINES OF FORCE—A *magnetic* or *electric field* is said to consist of an infinite number of imaginary lines which are called lines of force, and the electric or magnetic force acts along these lines. The density of these lines, or the number per unit cross-sectional area, is said to be the measure of the strength of the field. See *Flux Density.*

LOADING COIL—An inductance connected in series with an *aerial* to increase the *wave-length* to which the aerial can be tuned with its existing *inductance* and *capacity.*

LOCAL OSCILLATOR—An *oscillator* arranged to produce *oscillations* " locally " to act as a separate *heterodyne* for heterodyne or *beat reception.*

LOGARITHMIC DECREMENT—A number indicating the *damping* of an *oscillatory circuit.* It is dependent upon the *resistance* of the circuit.

LOGARITHMIC HORN—A loud speaker or other horn the diameter of the aperture of which increases along its length in accordance with a logarithmic law of the type :

$$y = \log x.$$

LONG WAVES—The term usually applied to *wave-lengths* over 1000 metres, *i.e.* frequencies of less than 300 kilocycles per second.

LOOP AERIAL—An American term for *Frame Aerial.*

LOOSE COUPLING—Two inductances are said to be loosely coupled when they are so separated that the mutual *inductance* between them is small in comparison with their self-inductances.

LOSS—See *Transmission Unit.*

LOUD SPEAKER—A loud-speaking *telephone.* For true reproduction of Broadcasting it is necessary to have a loud speaker capable of reproducing all *frequencies* from 30 to 10,000 cycles equally well. The original loud-speaking telephone does not do this. Loud speakers are now made in many diverse forms with this end in view. See *Moving Coil Loud Speaker.*

LOW FREQUENCY—Frequencies up to about 12,000 cycles per second. Cf. *High Frequency* and see *Audio Frequency.*

LOW-FREQUENCY AMPLIFIER — See *Amplifier.*

LOW-FREQUENCY TRANSFORMER—See *Audio-frequency Transformer.*

LOW-PASS FILTER—A *filter* circuit which is so designed that it will pass all frequencies below a certain value.

LOW POWER MODULATION—See *Choke Control.*

LOW TENSION—The *voltage* applied to the *filament* of a *thermionic valve* as opposed to the high tension. Cf. *High Tension.*

LOW-TENSION BATTERY—The battery used to heat the *filament* of a *thermionic valve.* See " A " Battery.

L.T.—Abbreviation for low tension.

MAINS UNIT—An apparatus for supplying power to a wireless receiver from the electricity supply mains, either for *high tension, low tension, grid bias,* or all three. In all types a *filter circuit* for smoothing purposes is incorporated, and for use with alternating current mains some type of *rectifier* is also required.

MAGNETIC CIRCUIT—Refers to the path through the air or the iron core of a *transformer, choke,* etc., which provides a circuit for the *magnetic flux.* See *Reluctance.*

MAGNETIC DETECTOR—A *detector* which makes use of the *hysteresis* in an iron wire for rectifying high-frequency *oscillations* in a wireless receiver. It was first used by Marconi, and was used for many years, particularly in ship installations, on account of its reliability and robustness. It is, however, comparatively insensitive and now obsolete.

MAGNETIC FIELD—See *Electric Field.* (For " electric " read " magnetic.")

MAGNETIC FLUX—See *Flux Density*.

MAGNETIC SCREEN—A screen of magnetic material such as iron, generally in the form of a box, placed over a piece of apparatus to screen it from the effects of any *magnetic field* in the vicinity.

MAGNETISATION CURVE—A curve showing the relation between the *magnetising force* applied to a piece of iron and the resulting *flux density*.

MAGNETISING FORCE OR MAGNETO-MOTIVE FORCE—The force required to create a certain magnetic field. Analogous to *E.M.F.* in current electricity. See *Reluctance* and *Flux Density*.

MAGNETO-MOTIVE FORCE—In a *magnetic circuit* the M.M.F. may be compared to the *E.M.F.* in an electric circuit. The M.M.F. forces the magnetic flux through the *magnetic circuit* against the "*reluctance*" of the iron.

MAGNETOPHONE—A form of *microphone* in which the sound waves impinge on a light, flat coil of wire supported in a *magnetic field*. The coil moves in the field and thus has an A.C. generated in it. The magnetophone is relatively insensitive, and its output requires considerable amplification before signals of telephone strength are obtained.

MAIN STATION—A wireless telephony broadcasting station of medium power.

MANSBRIDGE CONDENSER—A form of fixed *condenser* particularly suited to give large capacities in a relatively small space. The *dielectric* consists of a strip of waxed paper which is coated on both sides with tinfoil to form the conductors. The whole strip is then rolled and pressed together.

MASS—The amount of matter in a body. In the C.G.S. system the unit is the gramme; in the F.P.S. system the unit is the pound (lb.).

MAST—A steel or wooden erection for supporting an *aerial*. Masts have been built to a height of about 900 feet.

MEDIUM WAVES—The term usually applied to *wave-lengths* between 100 and 1000 metres, *i.e.* frequencies between 3000 and 300 kilocycles per second.

MEGGER—An instrument for measuring high resistances.

MEGOHM—One million ohms.

METAL RECTIFIER—A *rectifier* which in its simplest form consists of two plates of different metals in contact, *e.g.* a plate of copper, with a coating of copper oxide, in contact with a plate of lead forms such a rectifier. By series parallel arrangements of connection, various currents and voltages may be dealt with. See *Rectification*.

METRE-AMPERE—A measure of the power radiated by a wireless transmitter given by the product of the *effective height* of the *aerial* in metres and the current in amperes at the base of the aerial.

N.B.—As the maximum value of current is not necessarily at the base of the aerial, it follows that the above is not a reliable measure of the power radiated. In the particular case of a *half wave-length aerial* the current at the base is in fact zero. It is necessary, therefore, that if the metre-ampere figure is to be a true measure of the power radiated, the current value must be the maximum in the aerial. and not necessarily the value at the base.

MFD.—Abbreviation for Microfarad.

MHO.—The unit of *admittance*.

MICROAMPERE—One-millionth of an *ampere*.

MICROFARAD—One millionth of a farad.

MICROHENRY—One millionth of a henry.

MICROPHONE—With the advent of Broadcasting the term microphone is now applied to any instrument which will convert sound waves into electrical currents; whether it be a *carbon microphone* which depends for its action on the varying resistance of carbon granules under the variable air pressure produced by the sound waves, or a *magneto-phone*, or a *condenser microphone*. These are the three most important types.

MICROPHONE AMPLIFIER — A low-frequency amplifier used in conjunction with a *microphone* and generally in its vicinity, to amplify the weak electrical currents given by the *microphone* to a desired amplitude.

MICROVOLT—One-millionth of a *volt*.

MILLIAMPERE—The thousandth part of an *ampere*.

MILLIVOLT—One thousandth of a *volt*.

MIXING UNIT—See *Fade-unit*.

M.M.F.—Abbreviation for Magneto-motive Force.

MODULATION—If *continuous waves* have their amplitude varied at an *audio frequency*, they are said to be modulated by it. For true reproduction of the audio frequency at the wireless receiver, it is essential that the change of amplitude of the continuous waves (*carrier wave*) shall be a true copy of the *wave form* of the audio-frequency *oscillations* at all frequencies and amplitudes. If this be the case, the modulation is said to be "linear." See *Choke Control*, *Grid Control*, *Absorption Control*.

MODULATION METER—An apparatus for indicating the depth of *modulation* in a telephone transmitter.

MODULATOR SYSTEM—The part of a wireless telephone transmitter in which the audio-frequency *oscillations* are magnified and caused to modulate the carrier wave. See *Choke Control*.

MOMENTUM—The product of *mass* and *velocity*.

MORSE CODE—An international code used for the telegraphic transmission of messages by wire or by wireless, consisting of different numbers and combinations of dots and dashes representing the letters of the alphabet.

MOTOR-BOATING—A term used to denote the very low frequency oscillations which may be produced in a receiving set, and generally caused by a common *impedance* in two or more anode circuits. This trouble sometimes occurs, particularly if high magnification valves are employed, when using an eliminator in which separate *smoothing circuits* for each stage are not provided.

MOTOR GENERATOR—A *generator* which is mechanically directly coupled to an electric motor by which it is driven.

MOVING COIL LOUD SPEAKER—A loud speaker the movement of which consists of a cylindrical coil of fine wire held between the poles of a *permanent* or *electro-magnet*. Speech currents passing through the coil cause it to move in the *magnetic field*, thus setting up vibrations at speech frequencies in a conical diaphragm of stiff paper or similar material, the apex of which is attached to the coil. See *Baffle*.

MULTI-VIBRATOR—An instrument for producing continuous electrical *oscillations*, usually of an audible frequency, and very rich in *harmonics*. The *frequency* of the fundamental, and thus of the *harmonics*, is governed by the *capacity* and the *resistance* in the circuit, but is variable within limits, so that it can be brought into step with an outside source. Thus a standard of frequency (*e.g.* a valve maintained *tuning-fork*) can be made to regulate the fundamental frequency of a multi-vibrator. The *harmonics* are multiples of the fundamental, and *high frequencies* are thus produced as standard frequencies against which *wavemeters* can be calibrated.

MUSH—A form of *interference* emitted by *continuous wave* transmitting stations using an arc to generate the *C.W*.

MUSH AREA—If two broadcasting transmitters are synchronised so that their *carrier waves* are of exactly the same *frequency* and *phase*, it will be found that outside a certain limited radius from each of the transmitters bad quality reception will result. The area in which this takes place is called a mush area. Its extent depends on the distance apart of the transmitters and whether the same or different programmes are being transmitted. See *Single Wave-length Working*.

MUTUAL INDUCTANCE—If two *inductances* are coupled together so that a changing current in the primary winding produces an E.M.F. across the secondary winding, the two circuits are said to possess mutual inductance. See *Inductance* and *Coupling*, and cf. *Self-inductance*.

NATURAL CRYSTAL—A chemical compound in crystal form which possesses the property of being able to pass an electric current in one direction only, and which therefore may be used as a *detector* in receiving sets.

NATURAL FREQUENCY OR NATURAL PERIOD—The *frequency* or *period* at which a circuit containing *inductance* and *capacity* will naturally oscillate if set in electrical vibration. The natural frequency is given by the formula $f = \frac{1}{2\pi\sqrt{LC}}$ cycles per second, where L is the inductance in henries and C is the capacity in farads. At this frequency, the condition of *Resonance* occurs.

NATURAL TIME CONSTANT—See *Time Constant*.

NATURAL WAVE-LENGTH—The *wave-length* at which an *aerial* or a *tuned circuit* will most readily oscillate by virtue of its own *inductance* and *capacity*. The natural wave-length of an *inverted* L-type aerial is about four times its length.

NEGATIVE CHARGE—The quantity of static electricity of negative sign which is not neutralised by the positive electricity in a body when it is negatively electrified.

NEGATIVE ELECTRIFICATION—A body is said to be negatively electrified when it contains an excess of *electrons* or particles of negative electricity.

NEGATIVE POLE—A pole that is at a lower *potential* relatively to another, the positive pole. Electron currents always flow from the negative pole to the positive pole, but it is generally assumed that electricity flows from positive to negative.

NEGATIVE POTENTIAL—See *Potential*.

NEGATIVE RESISTANCE—If when the *potential difference* across a piece of apparatus falls, the current rises, then the apparatus is said to have a "negative resistance." This property is made use of in various ways to produce continuous electrical *oscillations*.

NEGATRON—A special type of *thermionic valve* having four *electrodes* and possessing the property of *negative resistance*.

NEON LAMP—A glass bulb containing two metal *electrodes* and filled with neon gas at a low pressure. When a sufficiently high *potential difference* is applied across the *electrodes* the negative electrode glows, owing to a discharge taking place through the gas. If a neon lamp is placed across the *condenser* forming part of the closed circuit of a *wavemeter*, a visible indication will be given when the current in the wavemeter circuit is a maximum, that is to say, when the circuit is in *resonance* with the radiating oscillating circuit whose wave-length it is desired to measure.

NEUTRAL WIRE—The wire at earth potential in a *three-phase* system of electric power distribution.

NEUTRODYNE RECEIVER—A receiver employing a special circuit to neutralise the inter-electrode capacity of the H.F. valves. In the *high-frequency amplifier* part of this receiver the stray capacity coupling between the valve *electrodes* is neutralised by a reverse capacity coupling between the grid and a suitable point in the anode circuit, thus overcoming the inherent tendency of a multi-stage high-frequency amplifier to burst into self-oscillation.

NICKEL IRON—An alloy of iron containing a percentage of nickel. Such iron is of particular use for the cores of *transformers*, as, due to its high *permeability*, a considerably larger primary *inductance* is obtained for a given number of turns in the *primary winding* than when ordinary iron is used. Thus a flatter frequency response characteristic can be obtained. See *Transformer*.

NIGHT EFFECT—A general term used to denote various phenomena which take place in wireless transmission after sunset. See *Fading* and *Reflection*.

NODE—In any alternating-current circuit, the point at which the current or voltage value is a minimum. Cf. *Antinode*.

NODON RECTIFIER—A form of chemical

rectifier, having an aluminium *cathode* and a lead *anode* immersed in a solution of ammonium phosphate, and suitable for charging accumulators from alternating current mains.

NON-INDUCTIVE RESISTANCE—A *resistance* whose *inductance* is negligible. Such a resistance is useful when it is desired to alter the *damping* of an oscillatory circuit without altering the *natural frequency* of the circuit.

NOTE MAGNIFIER—See *Amplifier*.

OHM—The practical unit of *resistance*.

OHM'S LAW—One of the fundamental laws of current electricity, which states that in a circuit carrying a constant current, the value of this current is proportional to the *potential difference* across the circuit and inversely proportional to the *impedance* of the circuit. The practical units of *current*, *voltage* and *impedance* have been so chosen that a P.D. of one volt is required to force a current of one ampere through an impedance of one ohm. In other words—

$$\text{I (amperes)} = \frac{\text{E (volts)}}{\text{R (ohms)}}.$$

OPEN CIRCUIT—A circuit which is not continuous and through which current cannot flow.

OPEN-CORE TRANSFORMER—A *transformer* in which the *magnetic circuit* consists partly of iron and partly of air. Owing to its bad *characteristic curve* an open-core transformer is never used in a *low-frequency amplifier*. Cf. *Closed-core Transformer*.

OSCILLATION CONSTANT OR RESONANCE CONSTANT—The *natural frequency* of a circuit depends upon the L.C. value of the circuit, and the product L.C. is called the Oscillation Constant.

OSCILLATION TRANSFORMER OR JIGGER—An air-core *transformer* used for transferring high-frequency *oscillations* from one circuit to another.

OSCILLATIONS—The high-frequency alternating current which flows round an *oscillatory circuit* which has been set in electrical vibration by an outside source of power. If the power supplied is sufficient to compensate for the resistance (heat) losses in the circuit, then the *oscillations* will be continuous or *undamped*, but if the resistance loss is greater, then the *oscillations* will gradually die away and are said to be *damped*. If the *reaction* coil of a receiving set is tightly coupled to the grid coil which may also be the aerial coil, then the transfer of power into the latter may be sufficient to overcome the losses in the circuit and sustain *continuous oscillations* which may be radiated from the aerial and cause interference to nearby receiving sets.

OSCILLATION VALVE—See *Valve*.

OSCILLATOR—An apparatus (generally an electrical circuit employing a three-electrode valve) for producing *oscillations*.

OSCILLATOR VALVE—The valve in a transmitting set or in certain types of receiving sets that produces continuous oscillations.

OSCILLATORY CIRCUIT—A circuit containing *inductance* and *capacity* which when supplied with energy from an outside source is set in electrical vibration and oscillates at its *natural frequency*. The *resistance* of the circuit must not be greater than a certain value, dependent upon the values of *inductance* and *capacity*, otherwise the *oscillations* will not be continuous. See *Damping*.

OSCILLATORY CURRENT—The current in an *oscillatory circuit*.

OSCILLOGRAPH—An instrument for showing the shape of waves of *alternating currents* and particularly used for the examination of high-frequency *oscillations*. The *Kathode Ray Oscillograph* is the most common type.

OUTSIDE BROADCAST—A broadcast item taking place at some point other than the *studio*.

PACKING—A trouble which occurs with microphones of the loose-contact carbon type when the granules settle into a heap. The instrument becomes less sensitive, and the inherent carbon hiss increases. Generally cured by shaking.

PANCAKE COIL—A flat *inductance* coil.

PARALLEL CONNECTION—If two or more pieces of apparatus are joined across a common voltage supply they are said to be in parallel, and the current flowing through each path is inversely proportional to the *resistance* of the path.

PARASITES—Another term for *atmospherics*.

P.D.—Potential Difference. Difference of electric pressure between two points of a circuit. See *Voltage*.

PEAK VALUE—The maximum value of an alternating quantity. The peak *voltage* reached in any circuit is an important quantity, as the components of the circuit must be designed to withstand this voltage and not merely the average voltage value.

PEANUT VALVE—A type of three-electrode receiving valve requiring low *filament current* and *anode voltage*. The dimensions of the valve are very small and it is therefore of use where space and small battery consumption are a consideration.

PENTODE—A *thermionic valve* having five *electrodes*, a *filament*, a *plate* and three *grids*. Used in a receiving set, it has the advantage of having a high *magnification factor* coupled with a relatively large output.

PERCENTAGE COUPLING—The *coefficient of coupling* between two circuits expressed as a percentage.

PERIKON DETECTOR—A *crystal detector* consisting of *zincite*, and *bornite* in contact.

PERIOD—The time in seconds of one complete *cycle* of an alternating quantity.

PERIODICITY—See *Frequency*.

PERMANENT MAGNET—One which retains its magnetism for an indefinite time after it has been magnetised. Specially prepared steel is generally used. Heavy blows and heat will destroy the magnetism.

PERMEABILITY—The magnetic conductivity of a material, generally denoted by the symbol "μ" and given numerically by the ratio of the *flux density* (B) in the material to the *magnetising force* (H) producing that flux density, *i.e.*, $\mu = B/H$. The permeability of air and all other non-magnetic materials is unity, but that of iron varies according to the purity of and heat treatment given to the iron. The quantity is of considerable importance in *inter-valve transformer* design.

PHANTOM CIRCUIT—A telephone or telegraph circuit which can be superimposed on two *physical circuits* without mutual interference. Thus with four wires between two points, three channels, two physical and one phantom, can be provided.

PHASE ANGLE—When two things occur at the same time they are said to be in phase. If two alternating quantities do not pass through their maxima or minima at the same time one will lead relative to the other, and assuming the quantities are represented as rotating *vectors*, then the amount of lead (or lag looked at from the point of view of the other quantity) may be represented by the difference in angular displacement, the maximum, of course, being 360 degrees or 2π radians. The position and hence the value of either *vector* at any instant may be defined by its phase angle (remembering that 360 degrees represent a complete cycle) and the difference between the angles made by the two vectors is called the Phase Difference or Phase Displacement. If the *Periods* of the two vectors are the same, then the Phase Difference is constant. If a voltage *vector* leads or lags behind a current *vector* by exactly 90° (*i.e.*, $\pi/2$ radians) they are said to be "in quadrature." On a pure inductive load the current lags behind the voltage by 90°; on a capacitative load the current leads by 90°.

PHONE—Abbreviation for telephone.

PHOSPHOR BRONZE—An alloy of phosphorus, copper and tin, having greater tensile strength than pure copper and equally good electrical properties, and therefore largely used for *aerials*.

PHOTO-ELECTRIC CELL—A device which changes its electrical *resistance* according to the amount of light falling upon it.

PHYSICAL CIRCUIT—A telephone or telegraph circuit composed of two metallic conductors. Cf. *Phantom Circuit*.

PICTURE TRANSMISSION—A system for the transmission of still pictures by line or wireless. Cf. *Television*.

PITCH—In music there are various standard pitches for the tuning of musical instruments. In broadcasting a transmission is said to be "low pitched" or "high pitched" according to whether the lower or higher audio *frequencies* are present to a greater extent in the reproduction than in the original.

PLAIN AERIAL—An *aerial circuit* arrangement which is connected directly to the transmitting or receiving circuit without the use of any form of *loose coupling* or intermediate circuit. The tuning in such cases is liable to be flat.

PLATE—The usual name applied to the *anode* of a *thermionic valve*. It consists of a cylinder of metal (generally nickel, tungsten, molybdenum or copper) surrounding the *kathode* or *filament* and at a higher relative potential, which enables it to attract the negative *electrons* emitted from the *filament* and thus give rise to the *anode current*, *plate current* or *space current*.

PLATE BATTERY—See *High-tension Battery*.

PLATE CIRCUIT—That part of a circuit of a transmitter or receiver connected between the *plate* or *anode* of a valve and the source of high-tension supply.

PLATE CURRENT—The current flowing in the *Plate Circuit* and between the plate and filament in the valve. See *Plate*.

PLATE IMPEDANCE—The *internal impedance* of a *three-electrode valve*.

PLATE VOLTAGE—The positive voltage of the *plate* or *anode* relative to the negative end of the *filament*. See *Plate*.

PLUG—A device used in conjunction with a *jack* to allow of easy connection and disconnection between two portions of an electrical circuit. The contacts are formed by a central pin terminating in a tip and insulated from the other contact, which is in the form of a sleeve, and which fits over and is concentric with the central pin. Three contacts are sometimes provided by the addition of a small ring between the tip and the sleeve and insulated from both. See *Jack*.

PLUG-IN COIL—A convenient form of inductance coil, fitted with a plug and socket termination to facilitate quick coil changing. In order that the coil should always be fitted the same way round, it is provided with one plug and one socket which fit into one socket and one plug on the coil holder.

PLUG-IN TRANSFORMER—A *high-frequency transformer* in a form convenient for quick changing to another transformer to cover a different range of wave-lengths. The windings terminate in plugs which fit into sockets on the instrument.

POLAR DIAGRAM—A curve drawn round a point representing the transmitting aerial showing the field strength of the emitted wave in any direction at a given distance from the transmitter. Cf. *Wireless Contour Map*.

POLARISED ELECTRO-MAGNET — One whose magnetism is partly permanent and partly due to a magnetising current flowing in the winding. Whether the latter adds to the total magnetism or otherwise depends upon the direction of the magnetising current. By arranging that the value of permanent magnetism brings the iron on to the steep portion of the *magnetisation curve*, then a relatively small value of magnetising current in either direction will cause a large variation in *magnetic flux* in the core. A *telephone* makes use of this arrangement.

POLARISED RELAY—A *relay* in which a *polarised electro-magnet* arrangement is used. A soft iron armature is magnetised by a *permanent magnet* and one end is also under the influence of an electro-magnet. Thus this end will swing one way or the other according to the direction of the magnetising current flowing in the coils of the electro-magnet.

POLARITY OF MAGNETS—Every magnet has two poles, one at each extremity. The north pole tends to move towards the north magnetic pole and the south pole towards the south.

POLE—See *Polarity of Magnets, Positive Pole, Negative Pole.*

POLYPHASE—An alternating current system consisting of several *phases*, the currents in each *phase* having a certain definite and constant *phase difference* relatively to each other.

PORTABLE TRANSMITTER—A transmitter of low power and limited range which can easily be moved from place to place.

POSITIVE ELECTRIFICATION—The state of a body when it contains less than its normal number of *electrons.*

POSITIVE POLE—The *pole* that is at a higher *potential* relatively to the other (negative) pole in any piece of apparatus when considered from the point of view of the external circuit.

POTENTIAL AND POTENTIAL DIFFERENCE—The force tending to drive electricity from a point of higher potential to a point of lower potential. In current electricity, a potential difference may exist between the poles of a piece of apparatus, but the *electromotive force* generated by the apparatus will be slightly greater, the difference being lost in overcoming the internal resistance of the apparatus itself when a current flows. Potential difference is measured in *volts.*

POTENTIAL DIVIDER—An electrical apparatus which works on the same principle as a *potentiometer*, but which is used to obtain a variation of *potential*. Such an arrangement is often used to obtain variable grid potential by connecting across the *filament battery* in a receiving set.

POTENTIALLY - OPERATED DEVICE—A piece of apparatus whose operation is solely dependent upon changes of potential and not upon current. A three-electrode valve is an example of this, provided that the *grid* is always negative with respect to the *filament*, thus avoiding *grid current.*

POTENTIOMETER—An electrical apparatus for the accurate measurement of difference of potential. If a *resistance* is connected across a source of *potential*, the potential across any part of the resistance will be proportional to the resistance of that part. Thus by means of tapping points, any fraction of a known potential may be compared with a potential of unknown value. The term potentiometer is often loosely and incorrectly used to indicate a *potential divider.*

POUNDAL—The F.P.S. (foot-pound-second) unit of force. One poundal will produce an *acceleration* of one foot per second per second in a mass of one pound.

$$1 \text{ poundal} = \frac{1}{32} \text{ lb. (approx.)}$$

POWER—The rate of doing *Work*. Unit: one horse-power = 746 watts.

POWER AMPLIFIER—A *low-frequency amplifier* designed to handle without *distortion* relatively high power for working *loud speakers.*

POWER FACTOR—A number having a value less than unity by which the product of the *volts* and *amperes* in an alternating circuit must be multiplied to give the power in the circuit.

POWER VALVE—A *three-electrode valve* used in a *power amplifier*, and designed to handle a large output without *distortion*. To ensure this the plate current–grid voltage characteristic must be straight over as wide a range of grid voltage as possible.

PRIMARY CELL—A source of electrical energy, dependent upon the chemical action between two electrodes producing an *E.M.F.* Such a cell cannot be re-charged, as can a *secondary battery.*

PRIMARY CIRCUIT—The circuit which takes power from the source of supply and passes it on to the *secondary circuit*. The *voltage* may be stepped up or down during this transference of power from one circuit to another. See *Transformer.*

PRIMARY WINDING—See *Primary Circuit.*

PROTON—The smallest possible quantity of *positive electricity* existing in a free state.

PULSATING CURRENT—A current whose magnitude varies regularly, but whose direction remains constant.

PUSH-PULL AMPLIFICATION—A system of amplification employing two similar three-electrode valves per stage. The *grids* of the valves are fed from a single *secondary winding*, one end to each grid, and a centre tapping is connected to the common filament circuit. The two *plates* are connected one to each end of the output *transformer primary winding*, the H.T. being fed to the centre point of this winding.

QUADRATURE—See *Phase Angle.*

QUANTITY OF ELECTRICITY—In current electricity, quantity is measured by the product of the current flowing in a circuit and the time for which it flows. The unit is the coulomb, which is equal to one ampere flowing for one second, but the practical unit is the *ampere-hour* which equals 3,600 *coulombs.*

QUARTER WAVE-LENGTH AERIAL—An aerial having an equivalent vertical height equal to one quarter of the wave-length in use. Cf. *Half Wave-length Aerial.*

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. The value of a radian is approximately 57·5°, 2π radians being equal to 360°.

RADIATING CIRCUIT—A circuit carrying a *high-frequency* current, which is capable of throwing out its energy in the form of electric *waves*. The amount of energy radiated is proportional to the *radiation resistance*. The *aerial circuit* is a radiating circuit.

RADIATION—The transference of energy from a physical circuit carrying *high-frequency* current into space in the form of electric *waves*, the medium through which the waves travel being the *ether.*

RADIATION EFFICIENCY—In a radiating circuit part of the energy is radiated in the form of electric *waves* and part is lost owing to the *resistance* of the circuit. The percentage radiated of the total energy in the circuit is the radiation efficiency of that circuit. See *Aerial Resistance.*

RADIATION RESISTANCE (of an aerial)—That quantity expressed in ohms which when multiplied by the square of the value of *aerial current* in amperes gives the power in watts being radiated from the circuit in the form of electric *waves*. See *Aerial resistance.*

RADIO BEACON—A transmitting station situated near the coast, which sends out special telegraphic signals to assist the navigation of ships at sea.

RADIO-FREQUENCY—A frequency used for radio-transmission purposes. The range at present in use is from approximately 300,000,000 cycles per second down to about 12,000 cycles per second. Transmissions on the very high frequencies are still at an experimental stage only.

RADIO - FREQUENCY AMPLIFIER — See *High-frequency Amplifier.*

RADIO - FREQUENCY RESISTANCE — See *Aerial Resistance.*

RADIO-FREQUENCY TRANSFORMER—See *High-frequency Transformer.*

RADIO-GONIOMETER—A calibrated instrument used in the Bellini-Tosi system of *direction finding.*

RADIOTRON—Another name for an ordinary *three-electrode valve.*

RATIO OF TRANSFORMATION—The ratio of the primary to the secondary voltage of a *transformer.* In the case of an iron-core transformer this ratio is approximately the same as the ratio of the turns in the two windings.

RAYLEIGH DISC—A small light metal disc, so arranged in the path of a sound wave in air that the angle through which the disc is reflected becomes a measure of air pressure due to the wave. Thus a method is given for the calibration of *microphones* and *loud speakers* in absolute terms, but practical difficulties render the method suitable for use only in the laboratory.

REACTANCE—The *resistance* offered to a current in an alternating circuit, due to the presence of *inductance* or *capacity* or both. See *Impedance.*

REACTION—An arrangement in a *three-electrode valve* circuit whereby the amplified currents in the *plate circuit* react on the *grid circuit*, thus compensating to any desired extent for the losses in that circuit. This is generally effected by means of a coil connected in the *plate circuit* of the valve, which is magnetically coupled to the grid coil. If this coupling is sufficiently tight then the transfer of energy is so great that the losses are completely overcome and the circuit is set into self-oscillation. In this case the circuit radiates energy, and if this occurs in a receiving circuit it is likely to interfere with near-by receivers. See *Oscillation.*

REACTION CONDENSER—A variable *condenser* connected between two points in the external circuit of a *thermionic valve* to control the amount of reaction in the circuit.

RECTIFICATION—The operation of converting an *alternating current* into a unidirectional *pulsating current.* This operation occurs in the detection of wireless signals, a *detector* or rectifying valve being used for the purpose. The term rectification is also used in heavy current work to indicate the operation of converting a low-frequency alternating current into a pulsating current, which is generally passed through a *smoothing circuit* in order to obtain a D.C. current without ripple. Either *half-wave rectification* or *full-wave rectification* may be employed.

RECTIFIED CURRENT—The current resulting from the process of *rectification.*

RECTIFIER—A piece of apparatus which performs the operation of *rectification.*

RECTIFYING DETECTOR—See *Detector.*

RECTIFYING VALVE—A *thermionic valve* capable of rectifying.

REFLECTION — (*a*) Of wireless waves. Electric waves travelling away from an aerial in an upward direction strike the *Heaviside Layer*, which refracts and partially reflects the waves to the surface of the earth. Thus at any point there may arrive two electric waves, one direct from the source and the other reflected from the Heaviside Layer. See *Fading.*

(*b*) On land-lines. The interference caused to speech-current frequencies when transmitted along long land-lines, generally due to incorrect terminal conditions or changes in the composition of the line along its length. Some of the frequencies are reflected back, producing nodes and loops of current and potential along the line.

REFLEX CIRCUIT—A valve circuit containing a high-frequency amplifying valve which acts as a low-frequency amplifying valve as well.

REGENERATION—See *Reaction.*

REGIONAL STATION—A high-power broadcasting station designed to serve a large area.

REINARTZ CIRCUIT — A valve circuit especially suitable for the reception of short waves.

REJECTOR CIRCUIT—A tuned *oscillatory circuit*, consisting of an *inductance* and a *capacity*, the values of which are arranged so that the circuit offers a very high *impedance* to *oscillations* of a particular *frequency* which it is desired not to pass, and a low *impedance* to all other frequencies. Such an arrangement is used to obtain selectivity in a receiving set, the rejector circuit being tuned to the wave-length of the signal it is desired to receive.

RELAY—A device generally consisting of an *electro-magnet* and an armature which makes or breaks a local circuit when current is passed through the coils of the magnet. The coil current is generally small compared with the current in the local circuit.

RELAY STATION—A low-power broadcasting station which receives most of its programme material via a telephone line from a distant studio.

RELUCTANCE — The magnetic *resistance* offered to the passage of *magnetic flux* in a substance when a *magnetising force* is applied. Analogous to electrical *resistance.*

RELUCTIVITY—The reciprocal of *permeability.*

REMOTE CONTROL—The operation of electrical apparatus at a distance, generally by means of a *relay.*

REPEATER—A piece of apparatus placed in a long telephone line circuit in order to amplify the speech current before passing further along the line to a distant station. It consists generally of a *low-frequency amplifier* with suitable input and output transformers to match the incoming and outgoing lines. If it is desired to amplify speech currents passing in both directions at the same time, then a "two-way" repeater is used.

REPEATER STATION—One at which a number of *repeaters* is situated, and through which pass a large number of long-distance telephone lines. Such a station is used in broadcasting in connection with *Simultaneous Broadcasting.*

RE-RADIATION—When a valve receiver is adjusted with a tight *reaction* coupling, thus bringing the receiver nearly to the point of *self-oscillation*, the volume of the received signals is greatly increased and this increase will, to a certain extent, be re-radiated from the aerial of the receiver and will improve the signal strength in near-by receivers. If, however, the reaction is coupled too tightly the receiver will self-oscillate and cause interference. See *Reaction* and *Oscillation.*

RESISTANCE—The opposition which an electric circuit offers to the passage of an electric current. The power wasted in a resistance appears as heat. In a homogeneous wire the resistance is directly proportional to the length and specific resistance, and inversely proportional to the area of cross section. The practical unit is the *ohm*. See *Ohm's Law.*

RESISTANCE-CAPACITY COUPLING—A method of coupling *thermionic valves* together in cascade in a high- or low-frequency *amplifier*. A high *resistance* is placed in circuit with the *plate* of the valve, and the signal E.M.F. produces a varying *potential* at the plate end of this resistance, and this is applied through a *grid condenser* to the *grid* of the next valve. This condenser is necessary to prevent the high-tension potential from affecting the second grid. In order that the negative charge on this grid may gradually leak away, a *grid leak* resistance is connected between the grid and the filament of the valve.

RESISTANCE-COUPLED AMPLIFIER — A high- or low-frequency *amplifier* employing *resistance-capacity coupling* between valves.

RESISTOR—A *resistance* generally of fixed value, often used in a filament circuit to reduce the *low-tension* voltage to a value suitable for the valve in use.

RESONANCE—Occurs in a circuit containing *inductance* and *capacity* when an alternating *potential*, whose *frequency* is equal to the *natural frequency* of the circuit, is applied to it. When this occurs the current is in *phase* with voltage and the inductive *reactance* is neutralised by the capacity *reactance.*

RESONANCE CURVE—Curve showing the relation between the current flowing in a circuit containing fixed values of inductance and capacity when a constant voltage of varying frequency is applied.

RESPONSE CHARACTERISTIC—A curve showing the relation between input and output of a piece of electrical apparatus at different frequencies.

REVERBERATION—The continuation of a sound for a short period after the original sound has ceased, due to reflection from hard surfaces, *e.g.*, walls. Note the difference between reverberation and *echo.*

RHEOSTAT—A variable *resistance.*

SATURATION (MAGNETIC)—When a *magnetising force* is applied to a piece of iron the *flux density* in the iron will increase up to a point. When a further increase of *magnetising force* will not increase the *flux density*, the iron is then said to be saturated, and this point is called the "saturation point."

SATURATION CURRENT—As the *anode voltage* applied to a *three-electrode valve* is increased, the *anode current* also increases up to a point, when a further increase in *anode voltage* does not increase the *anode current*. This maximum value of current is called the "saturation current."

SCANNING DISC—In *Television* or *Picture Transmission*, a rotating opaque disc perforated with a series of holes in the form of a spiral. A ray of light passing through the holes is thus caused to move over (scan) a picture or an object placed behind the holes on the farther side from the source of light.

SCANNING FREQUENCY—In *Television* the rate at which the picture or object is scanned. See *Scanning Disc.*

SCREEN-GRID VALVE—A four-electrode valve having two grids, and designed to reduce the *capacity* between the *anode* and the control *grid*. Such a valve is particularly useful in a multi-stage *high-frequency amplifier.*

SCREENING—An arrangement to prevent one circuit carrying alternating current from affecting another adjacent to it. It generally consists of a sheet of metal (usually copper) placed between the two circuits.

SECONDARY BATTERY—A battery of secondary cells, the most common being the lead-acid type. These cells can be recharged when run down by having electricity pumped into them in the reverse direction.

SECONDARY CELL—See *Secondary Battery.*

SECONDARY CIRCUIT—See *Primary Circuit.*

SECONDARY WINDING — See *Primary Winding.*

SELECTIVITY—The power of being able to select one particular *wave-length* or *frequency* to the exclusion of others.

SELENIUM CELL—A *primary cell* whose *resistance* varies according to the intensity of the light falling upon it.

SELF-CAPACITY—The *capacity* that exists between different parts of the same piece of apparatus. For example, the self-capacity of an inductance coil is due to the capacity that exists between turns, and that of a three-electrode valve to the capacities between *filament*, *grid* and *anode.*

SELF-INDUCTANCE—If the current passing through a coil of wire is changed, a back E.M.F. is set up which tends to stop the change from taking place. This is due to the "self-inductance" of the coil and is analogous to mechanical inertia.

SELF-OSCILLATION—See *Oscillation*.

SERVICE AREA—Of a Broadcasting Station is the area in which listeners can be guaranteed a service, *i.e.*, an area in which the *field strength* of received signals from that station is such that satisfactory reception is assured. It is the ratio of the strength of the wanted signal to that of the interference which will determine the extent of this area. It has been found convenient to divide the area into four parts: (1) the *wipe-out area* in which the field strength is greater than 30 millivolts per metre, (2) "A" service area between 10 and 30, (3) "B" service area between 5 and 10, and (4) "C" service area between 2·5 and 5.

SHOCK EXCITATION—The forcing into *oscillation* of a tuned oscillatory circuit at its *natural frequency* due to a sudden energy impulse from an outside source.

SHORT-CIRCUIT—A connection having very low *resistance* made between two parts of a circuit. If this connection is made accidentally, then the current in the circuit, owing to the drop in the resistance, may rise to a very high value and do damage to the apparatus in that part of the circuit which is not short-circuited.

SHORT WAVES—The term usually applied to *wave-lengths* under 100 metres (*i.e.* frequencies of more than 3000 k.c. per sec.). The term "ultra-short" is sometimes used to designate this waveband.

SHORTENING CONDENSER—A *condenser* connected in *series* with the *aerial* in order to reduce its *resonant frequency* to a value below its *natural frequency*.

SHUNTED BUZZER—A modified *buzzer* often used to energise a receiving circuit in order that the wave-length of the latter may be measured.

SIDE-BANDS—When a constant high-frequency *carrier wave* is modulated by a low-frequency speech component in order to transmit telephony, a number of high-frequency waves is produced, the values of which are above and below the actual *frequency* of the *carrier wave* itself. The frequency bands occupied by these waves are called "side bands." See *Modulation*.

SIDE-BAND TELEPHONY—A system of telephony transmission in which the *side-bands* only are transmitted and not the *carrier wave*. The *carrier wave* having been modulated and the *side-bands* produced, the carrier wave is eliminated and supplied again at the receiving end. In this system of transmission there is a considerable saving in power, the disadvantage being that unless a special receiver, which will supply the missing *carrier wave*, is used, the sounds that will be heard will be unintelligible.

SIMULTANEOUS BROADCASTING—A system whereby the programme of one broadcasting station may be transmitted simultaneously from a number of other broadcasting stations, connections between the stations being made by ordinary telephone lines. See *Repeater Stations*.

SINE WAVE—A *wave form* representing an alternating quantity which varies according to a sine law.

SINGLE PHASE—A system of alternating current electricity consisting of one *voltage* and one *current* passing through one pair of wires only.

SINGLE WAVE-LENGTH WORKING—The working of two or more broadcasting transmitters on the same *carrier wave frequency*. The congestion of the ether caused by the opening of an ever-increasing number of broadcasting transmitters, when only a limited number of channels is available for them, and the consequent mutual interference, have rendered single wave-length working very desirable. Experiment to achieve this is still proceeding in this and in other countries. The solution lies in terms of absolute stabilisation of the transmitters' carrier frequency, probably by means of a *tuning-fork* drive and a certain reduction in *service areas* due to interference patterns produced by the *carrier waves* and *side-bands*. The extent of such *mush areas* depends on the distance apart of the transmitters, and, in effect, the *service area* of each of two equal power transmitters, radiating the SAME programme, will be of the order of one quarter of the distance between them—with a maximum range at night of the order of 20 to 25 miles—this limit being imposed by the increase in received strength of the distant transmitter at night due to *fading*. With DIFFERENT programmes the range of the *service area* will be very much more restricted—being only of the order of ½ to 1 mile at night, irrespective of the powers used at the two transmitters.

SKIP DISTANCE—The distance between the point where the direct ray from a transmitting station becomes so attenuated as to be inaudible, and the point where the reflected or indirect ray strikes the earth's surface. The skip distance is a function of the *wave-length* employed and increases with a decrease in wave-length.

SLAB COIL—An *inductance* coil wound in a flat shape having the disadvantage of high *self-capacity*.

SLIDE BACK—An apparatus for indicating in the *control room* of a broadcasting station the presence of grid current (and hence distortion) in the modulation system of the transmitter.

SMOOTHING CIRCUIT—A circuit consisting of a number of *inductances* and *condensers* used for eliminating the ripple or *pulsating* component of a uni-directional current, such as that obtained from a *rectifier*. A smoothing circuit is generally required if the resulting D.C. supply is to be used for supplying *high tension* to a wireless receiver or transmitter.

SOFT VALVE—One which contains an excess of gas. Extremely efficient when used as a detector, but difficult to operate.

SOLID-BACK MICROPHONE—A type of microphone employing two carbon discs, one attached to the diaphragm and the other to the solid back of the instrument, with carbon granules between them. See *Microphone*.

SPACE CHARGE—A cloud of electrons given off from the *filament* of a *thermionic valve*, which impedes the free flow of electrons between the *filament* and the *anode*.

SPACE CURRENT—See *Plate Current*.

SPACE RAY—See *Indirect Ray*.

SPECIFIC INDUCTIVE CAPACITY—Of a material, is the ratio of the *capacity* of a *condenser* with that material as *dielectric* to the capacity of an exactly similar condenser with air as dielectric.

SPECIFIC RESISTANCE—The *resistance* between two faces of a one-centimetre cube of any material.

SPEECH AMPLIFIER—See *Low-frequency Amplifier*.

SPREADER—A pole or hoop, generally of wood, used for separating the parallel wires of an *aerial*.

SQUARE LAW CONDENSER—A *variable condenser* in which the angle of rotation is proportional to the square of the *capacity*, and thus proportional directly to the change in *wave-length*.

STALLOY—A silicon-steel largely used for the cores of *low-frequency transformers*.

STANDARD CABLE — In line-telephony transmission a mile of Standard Cable is a unit of loss or gain, by which a measure of the ratio of input to output power in a circuit can be obtained. Standard cable, therefore, is an artificial cable having certain definite constants of *inductance*, *resistance* and *capacity*, etc., per loop mile with which other cables can be compared for loss and their performance specified as so many Standard Mile units. 1 Standard Mile unit = 1·084 *Transmission Units*. See *Transmission Unit*.

STANDING WAVES—Waves of sound produced in a *studio* due to reflection from the walls or ceiling or from objects in the studio itself.

STATIC CHARACTERISTIC—A curve showing the relation between various steady *voltages* and *currents* of a *thermionic valve*. Cf. *Dynamic Characteristic*.

STATICS—See *Atmospherics*.

STEP-DOWN TRANSFORMER—A *transformer* in which the *secondary voltage* is lower than the *primary voltage*, and the *secondary current* higher than the *primary current*.

STEP-UP TRANSFORMER—A transformer in which the *secondary voltage* is higher than the *primary voltage*, and the *secondary current* lower than the *primary current*.

STORAGE BATTERIES—See *Accumulators*.

STRAYS—See *Atmospherics*.

STUDIO—A room in which broadcast items are performed, generally *draped* to reduce *reverberation* and *echo*.

SUB-CONTROL—A low-frequency amplifying circuit preceding the *modulation system* of a transmitter.

SULPHATING—A white deposit of lead sulphate that appears on the plates of an *accumulator* when it is left uncharged for a long period. The removal of this deposit requires special treatment.

SUPERHETERODYNE RECEIVER — One employing a special circuit relying on a *beat reception* arrangement. The selectivity of such a receiver is considerable.

SUPERSONIC FREQUENCY—A *frequency* which is just above the audible range.

SUPER-REGENERATION—A valve receiver, employing *regeneration* or *reaction*, becomes most sensitive just before the reaction coupling is tightened up to the point at which the receiver oscillates. At this point the losses in the circuits are nearly balanced by energy fed from the *high-tension battery*. Super-regeneration provides a method by which the *oscillations* generated in the receiver are interrupted at a *frequency* above the range of audibility, thus allowing the receiver to be worked at a point where its circuits possess virtually *negative resistance*, and thus great sensitivity is obtained. The practical operation of such a receiver is, however, not simple.

T AERIAL—One in which the vertical down lead is attached to the middle of the horizontal span.

TELEPHONE—The instrument that converts the electrical energy of the receiving set into sound energy. It consists essentially of a soft iron diaphragm supported close to the poles of an *electro-magnet*. The speech currents passing through the coils of the electro-magnet attract the diaphragm, causing vibrations in the air which are audible.

TELEPHONE CONDENSER—A small fixed *condenser* sometimes connected across a *telephone receiver* or *loud speaker* to assist in the bipassing of the *high-frequency currents*. It is not essential, as the *self-capacity* of the telephone winding itself is generally sufficient for the purpose.

TELEPHONE TRANSFORMER—A *transformer* whose primary *winding* is connected directly in the receiving circuit and whose *secondary* is connected to the *telephones*, thus isolating the telephone itself from direct electrical connection with the receiver.

TELEPHONE TRANSMITTER — A *transmitter* designed for the transmission of speech or music.

TELEVISION—A system, as yet in the experimental stage only, whereby a fixed or moving object is made visible at a distance by electrical means.

TETRODE—See *Four-electrode Valve* and *Screen-grid Valve*.

THERMIONIC CURRENT—The electronic current flowing between the *filament* and *anode* of a *thermionic valve*.

THERMIONIC VALVE—A *vacuum tube* containing two or more *electrodes*. The action of the valve depends upon the *electron emission* from a heated kathode, the *electrons* being attracted to the *anode* which is given a positive *potential* with respect to the *filament*. The valve can be made to act as a rectifier, high- or low-frequency *amplifier*, or a generator of electrical *oscillations*. It forms the basis of all modern wireless engineering.

THERMIONIC VOLTMETER—An instrument using a two- or three-*electrode valve* for the purpose of measuring small differences of *potential*.

THERMO-AMMETER—A type of *ammeter* suitable for the measurement of *high-frequency currents.* Its movement is dependent upon the heating effect of the current passing through a wire and its consequent extension in length. See *Hot-wire Ammeter.*

THERMO-COUPLE—A generator of *E.M.F.*, consisting of two dissimilar metals joined together, their junction being heated above the temperature of the rest of the circuit.

THORIUM—A rare metal used in the manufacture of the filaments of some *dull-emitter valves*, the Tungsten filament being coated with thorium-oxide.

THREE PHASE—An alternating current system in which the current and voltage of each phase are quite distinct and the *phase* angle between any two phases is 120°.

TIGHT COUPLING—If two coils are placed so close together that most of the energy in one is transferred to the other by *induction*, they are said to be "tightly coupled"; that is to say, the mutual inductance between the coils is large in comparison with their *self-inductances.* Cf. *Loose Coupling.*

TIME CONSTANT—In a circuit containing *self-inductance*, any change in the value of current in the circuit will be opposed by a back E.M.F. which at any instant is proportional to the rate of change of current. Thus if a steady *voltage* is applied to such a circuit the *current* will not suddenly reach its maximum value of $\frac{E}{R}$, but will build up gradually, because the effective voltage at any instant will be the applied voltage minus the back voltage. The time taken to reach the maximum current value is called the "Time Constant" of the circuit and is equal to $\frac{L}{R}$ seconds in the case of a steady applied voltage, and $\frac{2L}{R}$ seconds where an oscillating voltage is connected across an *oscillating circuit*, R being the *resistance* in *ohms* and L the *inductance* in *henries* in each case.

TIME PERIOD—See *Period.*

TIME SIGNAL—The broadcast Greenwich Time Signal consists of six dot-seconds, the first at five seconds before the hour, and the sixth exactly at the hour.

TONE—The term applied to the sound heard in a telephone receiver when low-frequency *alternating* or *pulsating current* is passing through it.

TONE SOURCE—A calibrated apparatus capable of producing pure sine-wave low-frequency alternating currents of constant amplitude between the limits of audibility, *i.e.*, from about 25 to 12,000 cycles per second. The apparatus is largely used to obtain the characteristic curves of *low-frequency transformers, loud speakers*, etc., by supplying an input of known frequency and amplitude from the Tone Source and measuring the output.

TOROIDAL COIL—An inductance coil wound on a ring-shaped core. The coil may be made self-supporting, in which case no core is necessary.

TRANSFORMATION RATIO—See *Ratio of Transformation.*

TRANSFORMER—An apparatus for changing the *voltage* of an alternating current supply. It consists essentially of two windings tightly coupled to one another, so that energy in the one may be transferred to the other by *electro-magnetic induction.* Power and low-frequency transformers have a laminated iron core, while those used for high-frequency work have a non-magnetic core. The action of a transformer depends upon the E.M.F. which is induced in the *secondary winding* by the magnetic flux that is set up in the core due to the current flowing in the *primary winding.* The value of this E.M.F. is proportional to the number of turns which are linked by the *magnetic flux*, and therefore the *secondary voltage* is proportional to the number of turns in the *secondary winding*, losses being neglected. If the secondary is open-circuited, the primary will act as an ordinary *choking coil* and the only current flowing in the primary will be that due to its high *impedance.* This is called the *magnetising* or *no-load current.* When the secondary is connected to the ends of a *non-inductive resistance* a current will flow which will tend to produce a flux in the opposite direction to that already existing in the core, thus momentarily reducing the primary *reactance.* This will cause an increased current to flow in the primary until a state of equilibrium is again reached. The secondary ampere-turns must be counterbalanced by an equal and opposite number of ampere-turns in the primary, and, neglecting losses, the power (*i.e.*, the product of current and voltage assuming unity *power factor*) in the primary circuit is equal to the power in the secondary circuit. That is to say, the ratio of *voltages* equals the ratio of turns and the inverse ratio of currents.

TRANSIENT—An instantaneous value of any quantity occurring when the conditions governing that quantity are rapidly changing.

TRANSMISSION UNIT—A unit of gain or loss by which a measure of the ratio of input to output power, or vice versa, may be obtained on a logarithmic scale. The number of transmission units represented by the ratio of two powers P_1 and P_2 is given by the formula:

$$\text{T.U.} = 10 \log_{10} \frac{P_1}{P_2},$$

$$\textit{e.g.}\text{ if } \quad P_1 = 10{,}000 \text{ and } P_2 = 1$$

$$\frac{P_1}{P_2} = 10{,}000.$$

$$\text{Log } 10 \frac{P_1}{P_2} = \log_{10} 10{,}000 = 4{\cdot}0$$

$$\therefore 10 \log_{10} \frac{P_1}{P_2} = 40,$$

i.e. a power ratio of 10,000 to 1 = 40 Transmission Units. Cf. *Standard Cable.*

1 Transmission Unit = 0·9221 mile of Standard Cable.

TRANSMITTER (WIRELESS)—The apparatus used for radiating into space electric waves, which may represent either telegraphic or telephonic signals. It consists generally of some form of *oscillation* *generator*, the output of which is remotely controlled by a Morse key for the sending of telegraphic signals, or modulated by a *low-frequency* (speech) current for telephony.

TRICKLE CHARGER — An *accumulator* charger which is arranged to charge at a low rate, so that a *battery* which has been in use during the day can be left on charge all night, and thus be fully charged for subsequent use. The mechanical analogy is water trickling to fill a tank.

TRIODE—Another term for a *three-electrode valve*.

TRUE POWER—Is the *apparent power* (product of volts and amperes) multiplied by the *Power Factor* of an alternating current circuit.

TUNED ANODE—A type of *intervalve coupling* used between two high-frequency amplifying valves in cascade, or between a high-frequency valve and the detector in a receiving set. An *oscillatory circuit* is connected in the *plate* circuit of the first valve and tuned to the frequency of the received signals. A *rejector* action is thus obtained and the high oscillating voltage set up across the inductance of the *oscillatory circuit* is passed on to the grid of the second valve by means of a *grid condenser*. Cf. *Resistance-capacity Coupling*.

TUNED CIRCUIT—An *oscillatory circuit* whose *resonant frequency* has been adjusted to a desired value.

TUNED PLATE CIRCUIT—See *Tuned Anode*.

TUNER—An arrangement of one or more *oscillatory circuits* whose *resonant frequencies* are easily variable to receive any desired signals or to give an *acceptor* or *rejector* action.

TUNING—The operation of adjusting a *tuned circuit* to give *resonance* at any desired *frequency*.

TUNING COIL—An *inductance coil*, either fixed or variable in value, used in a *Tuned Circuit*.

TUNING CONDENSER—A *variable* condenser used in a *Tuned Circuit*.

TUNING-FORK—A piece of steel designed to have a natural period of vibration of a definite *frequency*. By means of a *thermionic valve* circuit these vibrations can be maintained, and used as a frequency standard. See *Multi-vibrator*.

TUNING INDUCTANCE—See *Tuning Coil*.

TUNING NOTE—A *modulation* of the *carrier wave* of a broadcast transmitter with some form of continuous low-frequency note, so that listeners can tune in their receivers to the best advantage before the start of the actual programme. In some countries such a signal is radiated as an identification signal and is peculiar to a particular station.

TWO-ELECTRODE VALVE OR DIODE—A *thermionic valve* containing two *electrodes* only, a *plate* and a *filament*. The original form of the *thermionic valve* is still used for rectifying purposes, but largely replaced by the *three-electrode valve* for other purposes.

TWO PHASE—An alternating current system having two distinct circuits carrying current, the *currents* and *E.M.F.'s* of these circuits differing in *phase* by 90°

TWO-POLE SWITCH OR DOUBLE-POLE SWITCH—A switch which opens or closes both *poles* of a circuit at one operation. In a "single throw" switch this operation is done to one circuit only, in a "double throw" two circuits may be controlled alternately.

TWO-WAY REPEATER—See *Repeater*.

UMBRELLA AERIAL—An *aerial* arrangement consisting of a vertical centre pole from the top of which the aerial wires radiate symmetrically towards the ground.

UNDAMPED OSCILLATIONS OR UNDAMPED WAVES—A train of electrical *oscillations* or waves whose amplitude is constant. The basis of all *continuous wave* telegraphy and telephony transmission.

UNIDIRECTIONAL—A *current* flowing or a *voltage* acting in the same direction but not necessarily with a constant *amplitude*. See *Pulsating Current*.

UNILATERAL CONDUCTIVITY—The property possessed by certain apparatus of being able to pass a current in one direction only. The most important examples of such apparatus are the *thermionic valve* and the crystal, which are used in the process of *rectification*.

UNIT (BOARD OF TRADE)—The commercial unit of electrical energy equal to 1,000 watt-hours or one kilowatt-hour.

UNIT POLE—A *magnetic pole* which when placed at a distance of one centimetre from an equal *pole* exerts on it a force of one dyne.

UNLOADED AERIAL—One which has no added *inductance* or *capacity* and which will oscillate at its *natural wave-length* when energised from an outside source.

ULTRA-SHORT WAVES—See *Short Waves*.

UNTUNED AERIAL OR APERIODIC AERIAL—The *aerial circuit* of a receiving set which has not been specially *tuned* to the *frequency* of the incoming signal, an arrangement which is sometimes advantageous in the reception of short waves. The *aerial* is inductively coupled to the closed circuit *inductance* in the usual way.

VACUUM—A space entirely free from all matter.

VACUUM TUBE—A general name for all types of tubes or glass bulbs containing *electrodes* and from which all the gas has been exhausted.

VACUUM VALVE—A vacuum tube possessing *unilateral conductivity*, *e.g.*, the *two-* or *three-electrode thermionic valve*.

VALVE—See *Vacuum Valve*.

VALVE AMPLIFIER—See *Amplifier*.

VALVE DETECTOR—See *Detector Valve*.

VALVE OSCILLATOR—See *Oscillator*.

VALVE RECEIVER—A wireless receiver employing one or more *thermionic valves*.

VARIABLE CONDENSER — One whose *capacity* is easily altered and consisting generally of two sets of plates which can move relatively to each other. Cf. *Square Law Condenser*.

VARIOCOUPLER—An arrangement consisting of two *inductance* coils, which can be moved relatively to each other to vary the *inductive coupling* between them. Cf. *Variometer*.

VARIOMETER—A form of variable *inductance* consisting of two coils, one of which rotates within the other. The coils are connected in *series* and by altering the relative position of the coils the *magnetic fields* set up by the currents in them are made either to assist or to oppose each other. Thus the effective inductance value of the combination is continuously variable between these limits without any alteration being made to the actual amount of conductor in the circuit. In a well-designed unit, an inductance ratio of about 10 to 1 may be obtained.

VECTOR—A straight line whose length represents the magnitude of a quantity and whose direction represents its direction in relation to other vector quantities. Vectors may be added or subtracted by the method of parallelogram of forces.

VELOCITY—Distance traversed in unit time. The term implied a given direction and in this sense has not the same meaning as "speed."

VELOCITY OF ELECTRIC OR ETHER WAVES—Electric or Ether *waves* travel through space with the same *velocity* as light (which is itself an *electro-magnetic wave*), about 300 million metres per second or 186,000 miles per second.

VERNIER CONDENSER—The name given to a *variable condenser* of small *capacity*, generally used in *parallel* with a larger *variable condenser* in order to give a fine adjustment. It may either be a separate unit or incorporated in the main condenser, which will then have two control knobs.

VOLT—The practical unit of electrical pressure. If one volt is applied across the ends of a resistance of one ohm, a current of one ampere will flow. See *Ohm's Law*.

VOLT-AMPERES—The product of the *voltage* and *current* in an alternating current circuit. This gives the apparent power in the circuit, and to obtain the *true power* the former has to be multiplied by the *power factor*.

VOLTAGE—A term meaning *electromotive force* or *potential difference* measured in *volts*.

VOLTAGE AMPLIFICATION—The ratio of the output *voltage* to the input *voltage* of an amplifier. In a three-electrode valve amplifier, the static voltage amplification or *amplification constant* is dependent upon the physical measurements and *internal impedance* of the valve, but the dynamic factor (*i.e.*, the voltage ratio actually obtained when the valve is used in an amplifying circuit) depends also upon the external *impedance* of the plate circuit and is always less than the static constant, gradually approaching that value as the external *impedance* is increased relatively to the total *impedance*. There are, however, other considerations which limit the value of the external *impedance*.

VOLTAGE AMPLIFICATION FACTOR—See *Amplification Constant*.

VOLTAGE DROP—Across a circuit or a piece of apparatus is the *E.M.F.* or *potential difference* that is used up in driving a current through the circuit or apparatus. By *Ohm's Law*, the voltage drop in a direct current circuit is the product of the *current* in *amperes* and the *resistance* in *ohms*. In an alternating current circuit, it is the product of *current* and *impedance*.

VOLTAGE MULTIPLIER—A fixed *resistance* which is connected in series with a *voltmeter* to decrease the sensitivity of the instrument and allow higher *voltages* to be read.

VOLTMETER—An instrument used for the measurement of *voltages*. It is connected directly across the voltage to be measured and has a high *resistance* permanently in series with it so that the *current* passing through the instrument may be limited to a small value. In the moving coil type, the *current* is passed through a coil which is free to rotate between the *poles* of a permanent horseshoe magnet. The coil tends to move so that its *flux* is at right angles to the magnet flux, thus for a given current the coil will take up a certain definite position and the pointer attached to it will indicate a certain voltage value on a scale. This type of instrument can only be used for the measurement of direct currents. In the cheaper and less accurate moving iron type, the coil carrying the current is fixed and is made to attract a pivoted iron disc to which the pointer is attached. Such an instrument will measure either direct or low-frequency alternating currents. There are other types, such as the *hot-wire instrument* for high-frequency measurements, but the moving coil and moving iron instruments are the most common. The working parts of an *ammeter* are similar, but the instrument is connected in series with the supply and the fixed resistance or " shunt " is connected in *parallel* with the instrument.

VULCANITE—See *Ebonite*.

WANDER PLUG—A brass plug connected to the end of a flexible wire to make connection with any one of a number of sockets in a *high-tension* dry battery or *grid battery*.

WATER-COOLED VALVE—A thermionic valve in which arrangement is made to cool the *anode* by circulating water round it.

WATT—A practical unit of electrical *power*, and equal to one joule per second. The watts in a D.C. circuit are equal to the product of the volts and amperes. In an A.C. circuit, this product gives the *apparent power*, which has to be multiplied by the *power factor* to give the *true power*.

WATTFUL CURRENT—That part of the current in an A.C. circuit which is in *phase* with the applied voltage, and which can therefore do useful work.

WATT-HOUR—The work done by a power of one watt in one hour. The commercial unit of electrical energy is the Board of Trade Unit which equal 1,000 watt-hours.

WATTLESS CURRENT OR WATTLESS COMPONENT—That part of the current in an A.C. circuit which is 90° out of phase with the applied voltage, and which therefore cannot do useful work.

WATTMETER—A meter for indicating directly the power in a circuit.

WAVES (ELECTRICAL)—A movement in the ether consisting of electric and magnetic forces alternating in direction, produced by electrical *oscillations* in a conductor. These disturbances spread outwards in the form of *electro-magnetic* or *ether waves* and travel at the speed of light, 300 million metres per second. Energy is conveyed by these waves. They are not perceptible directly to the ear, but can be made to be so by the aid of a suitable *detector*. See *Radiation*.

WAVE DISTORTION—See *Distortion*.

WAVE FORM—The shape of the curve obtained when values of an alternating quantity are plotted on a time base.

WAVE-LENGTH—The distance between the crests of two successive *waves*. All electro-magnetic waves travel with the same velocity (300 million metres per second) which is obviously equal to the product of *wave-length* and *frequency*, *i.e.*,

$$\text{Wave-length (metres)} = \frac{300{,}000{,}000}{\text{Frequency (cycles per second)}}.$$

In an *oscillatory circuit*, its *natural wave-length* (λ) is given by $\lambda = 1{,}885\sqrt{LC}$, where λ is in metres, L is the *inductance* of the circuit in *microhenries* and C is the *capacity* in *microfarads*.

WAVEMETER—An apparatus for measuring *wave-length*. The most general types are the *buzzer wavemeter*, *heterodyne wavemeter* and *absorption wavemeter*.

WAVE SHAPE—See *Wave Form*.

WAVE TRAP—A *rejector* or *acceptor* circuit used in some receiving sets in order to minimise the interference caused by an unwanted signal whose *frequency* is close to that of the signal it is desired to receive.

WEAK COUPLING—See *Loose Coupling*.

WEIGHT—The property possessed by a body due to gravitational force. Cf. *Mass*.

WET BATTERY—A term often used to denote an *accumulator* battery. Cf. *Dry Battery*.

WHEATSTONE BRIDGE—An instrument used for determining the electrical *resistance* of an apparatus by balancing it against another of known resistance.

WIPE OUT—The state of affairs that occurs in a valve receiving set employing *grid-leak rectification* when an exceptionally powerful signal, *e.g.*, an atmospheric, gives the *detector* grid such a high negative charge that the operation of the receiver is paralysed until the charge has had time to leak away through the *grid resistance* to earth.

WIPE-OUT AREA—The term given to the area very close to a transmitting station where the *signal strength* is so great that it is impossible, however selective the receiver, entirely to tune out the signal in favour of another and more distant one.

WIRED WIRELESS—A system of communication employing high-frequency currents in which the transmitter and receiver are very similar to those used for wireless communication, but in which the medium is not the ether but ordinary telephone or power cables. By varying the *frequency*, several communication channels can be established on the same pair of wires.

WIRELESS BEAM—See *Beam Wireless*.

WIRELESS CONTOUR MAP—A curve drawn round a point representing the transmitting aerial showing the distance from the transmitter in any direction at which a given field strength is produced.

WIRELESS LINK—An arrangement in which use is made of a *portable transmitter* for broadcasting purposes. The item is first radiated by the portable transmitter on a short wave-length, received by a receiving station and sent by telephone line to a distant transmitter from which it is again radiated.

WOOD'S METAL—A soft alloy of lead, tin, bismuth and cadmium which melts at 60° C.

WORK—Work is done when a force overcomes a resistance over a certain distance. When a current of one ampere flows through a resistance of one ohm, the potential difference necessary is one volt. The power in the circuit is one *watt* and the work done per second is one joule.

X—The usual symbol for *reactance*.

"X's"—Another name for *atmospherics*.

"X" STOPPER—An *acceptor* or *rejector* circuit incorporated in a wireless receiver to minimise interference due to atmospherics.

Z—The usual symbol for *impedance*.

ZERO LEVEL—A level of transmission in telephony, the value of which is defined arbitrarily and serves as a datum level with which the level in other parts of the circuit may be compared. Cf. *Transmission Unit*.

ZERO POTENTIAL—See *Earth Potential*.

ZINCITE—An oxide of copper used together with *bornite* as a *crystal detector*. This combination is known as a "*Perikon detector*."

INDEX

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